Coastal Morphology of Basnæs Nor and the Surrounding Waters

By Poul Brøndum

Description of the coastal morphology of a low coast milieu in eastern Denmark based on an original detailed mapping including a barrier island, fed-formations, recurved-spits, an inlet and the inner part of the offshore zone. Changes in the morphology of a recurved-spit system have been followed during a period of one year.

"A fed *is a marine foreland, formed in attachment with the mainland in front of a bay on the basis of diverging recurved spits. On the sea side old parts of the fed will often be eroded and younger parts will grow in width. During this process the coastline is curving around a fulcrum which is moving towards the distal point of the fed".*
Axel Schou

Introduction

At the SW coast of Sjælland, between the towns Skælskør and Næstved, lies the island of Glænø, the fed formations of which (definition of the Danish *"fed"*, see above) debar Basnæs Nor and Holsteinborg Nor from the sea, Smålandshavet, thus creating a double shoreline system (Axel Schou, 1945, 49). Towards the N the embayed shoreline reflects the original relief of the moraine landscape. The outer coast, facing S is however quite influenced by wave action and consists of tall moraine cliffs and marine foreland. As a matter of course the existence of the outer coast reduces the force of the littoral processes on the inner coast. Besides, a marked shortening and simplification of the coastline has taken place. Thus the length of the inner coast, measured from the pier of Bisserup Havn to the base of Sevedøfed, is approximately 20 km against 12 km of the outer coast.

The investigation was concentrated on the westernmost part of Glænø Vesterfed (Ordnance Map M 2922 from 1940 called Bredefed) and Stenfed. In the summer of 1969 the author first observed that the western part of Bredefed had changed very remarkably. The channel marked on M 2922 was closed during the period 1940–45, but a new broad inlet was made during the gale in October 1967. In 1969, this inlet was already about 250 m broad and Bredefed presented towards the W a very beautifully developed recurved spit complex. Prior to the gale in 1967, Bredefed and Stenfed had been connected apart from a weakly developped break which it was possible to cross at foot according to local people. Geodetic Institute air photos from 16/6–1967 thus show two gullies of an approximate width of 40 and 20 m respectively,

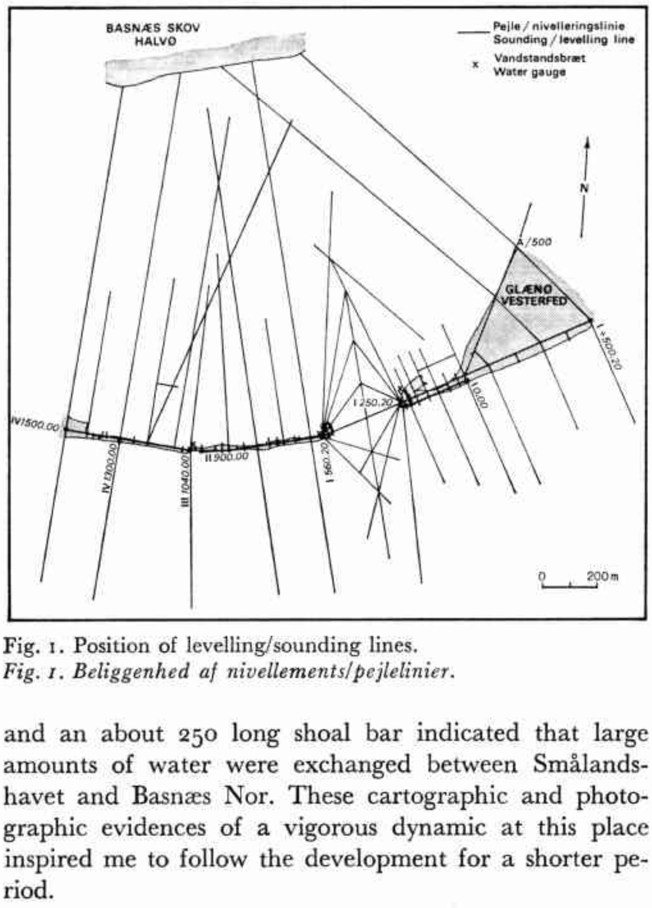

Fig. 1. Position of levelling/sounding lines.
Fig. 1. Beliggenhed af nivellements/pejlelinier.

and an about 250 long shoal bar indicated that large amounts of water were exchanged between Smålandshavet and Basnæs Nor. These cartographic and photographic evidences of a vigorous dynamic at this place inspired me to follow the development for a shorter period.

The mapping

The field work was started 10/9–1969 with the primary purpose to map the newly created inlet with surrounding land and water areas and try to collect more knowledge of the dynamic forces. Towards the end of the month however, a number of gales raged with rather extreme water level conditions as the result, and the mapping had to be restricted to the recurved spit system. In the summer of 1970 the mapping of the area was redone in order to record changes, if any. The working field was also extended to comprise the inlet and its surrounding land and water areas. Towards the E the westernmost 500 m of Bredefed were included and towards the W the eastern end of the foreland formation called Næbbet.

The position of the levelling and the sounding lines

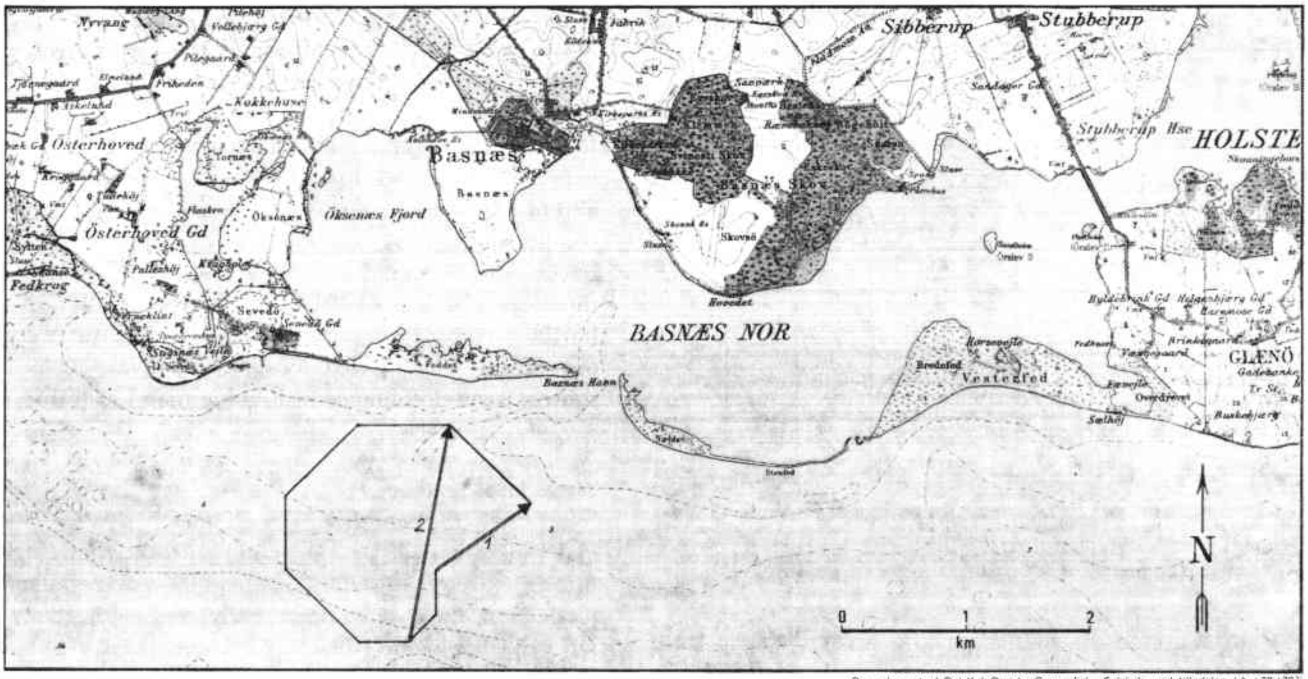

Fig. 2. Survey map with direction resultant inserted.
Fig. 2. Oversigtskort med indtegnet vindvirkeresultant.

appears from fig. 1. A base line was placed highest possible on the marine foreland. As the mapping in September 1969 only included the recurved-spit system at the western part of Bredefed, the zero point of the base line was chosen at the eastern part and base was calculated positively towards the W. The levelling lines orthogonally to base were calculated to be positive towards the N. Besides the base line along the S-coast there was established a line along the NW-coast for the mapping of the coastal configuration of Bredefed. Both lines were 500 m long, reckoned from 0.0, and have been connected with line levelling between the points 100, 300, and 500 m respectively from 0.0. For establishment of the course of the contour line on the beach, transverse lines were levelled at 100 m-intervals, as shown in fig. 1.

As far as Stenfed is concerned, the base was levelled, and where relief variations made it necessary, the orthogonal lines too. At the eastern part of Stenfed, there was also made a tachymetric levelling.

The measuring of the recurved spits at the western part of Bredefed was made after same methods in September 1969 and in June–July 1970, the line system from 1969 being reconstructed in 1970. Besides the base, transverse lines were drawn through 0.0, 30.0, 70.0, 110.0, 150.0, and 190.0, 220.0 and 250.0. The line levelling was supplemented by tachymetric levelling between the transverse lines, the latter being the core of the mapping. They were remeasured at intervals from September 1969 to July 1970 in order to study the development of the profile and the material balance over a longer period.

The levelling was made with an instrument of the type Zeiss Opton Ni 2. From Vesterfed to Stenfed the transfer of the DNN level was made on the basis of numerous observations of the water level on both sides of the breach.

To support the drawing of contour lines, a morphological map was made of the beach zone of the field. An especially detailed map was made of the recurved spit system, and the mapping was repeated between September 1969 and July 1970 simultaneously with a remeasuring of the transverse profiles. The method applied was pacing with a square prism from the known points in the levelling lines, and the distance between these – being short, the relief could be recorded rather correctly.

The mapping of the land areas was made with a contour interval of 25 cm and in the scale 1:1.000. The map has later been photographically reduced. All contours are stated in relation to DNN (Danish Ordnance Datum).

The depths of the surrounding water areas were determined by soundings on lines established in a known point of the levelling net marked by means of flags.

The depth was sounded at certain intervals simultaneously with a trig. spotting of the sounding place from another known point ashore. Thus position and depth were determined, and the sounded depth was later adjusted in relation to DNN on the basis of water gauge records. The soundings were made by a 4 m levelling rod with readings in whole centimetres. It is estimated that the sounded depths (dependant a.o. on the softness of the bottom and the wave height) are correct within $\pm$ 5 cm.

After the establishment of a sounding line it was fairly

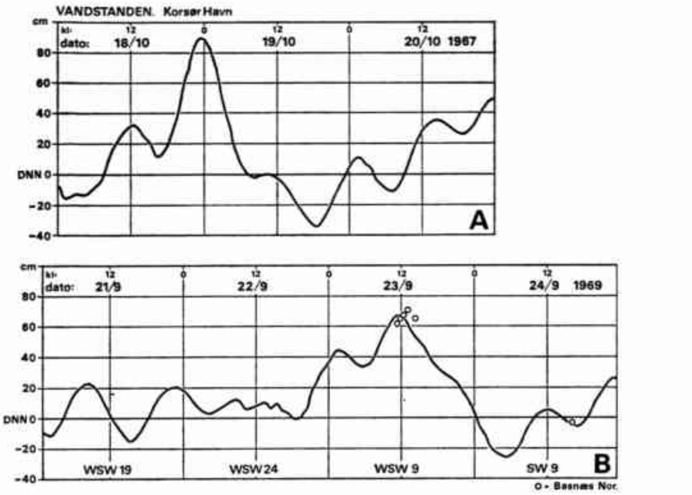

Fig. 3. Water level conditions for the harbour of Korsør and for Basnæs Nor.
Fig. 3. Vandstandsforhold for Korsør havn og Basnæs Nor.

easy to continue the soundings to a great distance from the starting point. In many cases the soundings were therefore continued as far as to the coast of Sjælland to get a rough picture of the bottom topography here near the inner cost.

Often it proved very difficult to make the soundings, as the bottom topography could hardly be distinguished even in calm weather, and this was naturally hampering the choice of representative points. These have therefore been selected best possible after author's estimate. An echo sounder might have eliminated possible errors, but was not at disposal.

The air photos from 16/6–1967 were a good help when planning the location of the sounding lines and when drawing the depth contour lines as the bottom relief shows very clearly on the photos. As far as the breach between Stenfed and Vesterfed is concerned, the value of the photos was somewhat reduced, however, as the great inlet was formed in October 1967.

The wind conditions

The island of Sprogø, situated in the Storebælt about 30 km NW of the investigated area, is the nearest station with records upon which a direction resultant may be calculated. In the following the wind conditions around Sprogø are presumed to be representative for the coastal area of S-Sjælland.

The direction resultant, calculated after *Axel Schou's* method, is directed towards the NE (No. 1 in fig. 2). Consequently the strongest wave action should be from the SW. The direction coincides with the maximum fetch being about 65 km. According to Schou's theory it is to be expected that the direction of the simplified coastline runs NW–SE, but this is not the case here. The coastline tends to take a WNW–ESE course. When omitting the land winds, the resultant will correspond to that of *Guilcher* (No. 2 in fig. 2). This is seen to be at right angles to the presumed terminant direction of the coastline.

How representative are the Sprogø-observations for the Basnæs Nor area? As in Munch-Petersen's and Bruun's expressions for wave force, the wind power figures in 2nd and in 4th power respectively, a possible variation in wind conditions between the Storebælt-area and the Smålandshavet will be overdimensioned; these expressions have therefore not been used. The direction resultant gives hardly a complete picture of the wind and drift conditions of the investigated locality. However, it seems to show a weak dominance of E-going material transport.

Water-level conditions

The water-level conditions at Basnæs Nor were not specially investigated. In connection with the soundings and during extreme situations readings of water gauge were made and these were later correlated with the water-level records in the harbour of Korsør taken regularly by the Meteorological Institute.

Table 1: The registrated high-water level for Korsør harbour and for Basnæs Nor.

	High-water level			Time of the day		
1970	Korsør	Basnæs	Difference	Korsør	Basnæs	Difference
21/6	+ 19	+ 16	− 3	14^{00}	14^{00}	0^{00}
22/6	+ 21	+ 19	− 2	14^{30}	15^{00}	0^{30}
3/7	+ 7	+ 7	0	12^{45}	13^{30}	0^{45}
6/7	+ 7	+ 11	− 4	14^{00}	14^{45}	0^{45}
7/7	+ 15	+ 11	− 4	16^{30}	17^{30}	1^{00}
8/7	+ 15	+ 14	− 1	17^{00}	18^{00}	1^{00}
9/7	+ 26	+ 24	− 2	18^{30}	19^{30}	1^{00}
	Low-water level			Time of the day		
8/7	− 7	− 4	+ 3	11^{00}	11^{45}	0^{45}

The following conclusion seems justified by the collected material, though given with some reservations because of the sparse material from Basnæs Nor. The difference between high- and low-water is 0–5 cm less in Basnæs Nor than in the harbour of Korsør, which gets high- and low-water a half to one hour earlier. As the great resemblance between the Storebælt-area and Smålandshavet has previously been demonstrated (*J. Egedal*, 1949) it should be justified to consider the water-level conditions in the harbour of Korsør as representative for the investigated area.

The difference between high- and low-water has been calculated for four periods in 1969 and 1970, as the regular, almost sinus-shaped course of the water-level curve pointed at the tide as main reason for the fluctuations in water-level. The average difference was found to be 27

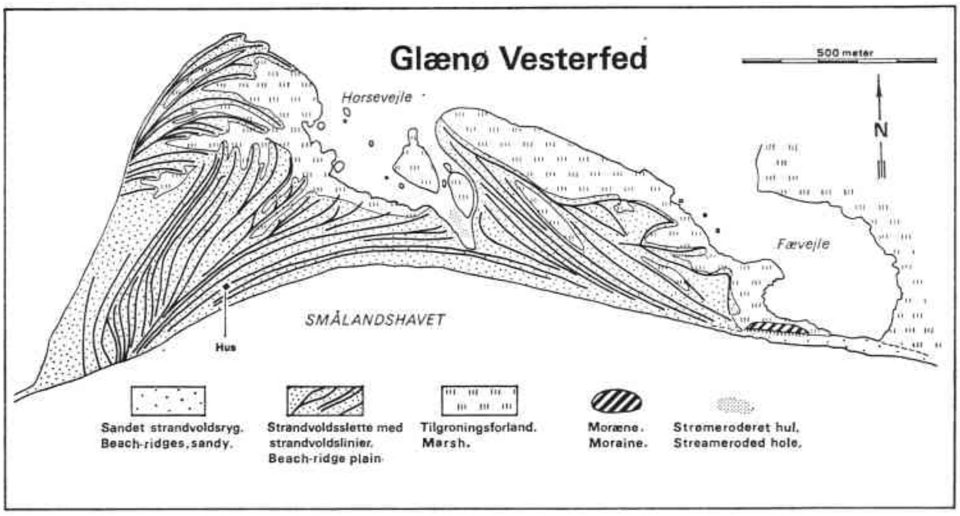

Fig. 4. Morphological map of Glænø Vesterfed.
Fig. 4. Morfologisk kort over Glænø Vesterfed.

cm. In appendix to Nautisk Meteorologisk Årbog from 1929, the tide at Korsør (calculated on records from the period 1890–1925) is stated to be 22 cm as an average, whereas the spring tide range was 28 cm. Thus there is quite a good accordance between the values from 1929 and those from 1969–70. It is therefore presumed that for Smålandshavet at Basnæs Nor a fluctuation of water-level, induced by the tide, of 20–25 cm is normal.

Often the highest water-levels in Smålandshavet occur with strong western winds. However, conditions are somewhat complicated by the fact that the extreme high-waters occur later than the wind which caused them. Both the hurricane-like westernly gale 17/10–1967 and the violent western gale 22/9–1969 were followed by extreme high-waters which arrived about 24 hours after the gale (fig. 3). Very frequently extreme low-waters follow the extraordinary high-waters. The drop in water-level often takes about 18 hours, and a high-tide will thus occur between the wind-induced high-water and the following low-water. The intermediate high-tide will be weakly developed or might be reflected only in a decrease of the speed at which the water-level is decreasing.

Differences of 0.8–1.0 m between highest and lowest water-level within a period of about 18 hours are not uncommon. Under special circumstances the differences may be still greater. After the October gale in 1967 the difference between highest high-water (+90 cm at 23.00 hrs. the 18/10–1967) and lowest low-water (−35 cm at 18.00 hrs. the 19/10–1967) was thus 125 cm in the harbour of Korsør. Naturally these extreme high-waters and the following rapid and great fluctuations in water-level affect the morphology of the area to a high degree. During the October-gale in 1967, the effect of the high waves, together with the in- and outflowing water masses at same level as the uppermost part of the marine formations of Stenfed, made a large extension possible of the weakly developed gap at the western part of Vesterfed.

The development of the coast during 200 years

The map from 1770 published by Videnskabernes Selskab (The Royal Danish Academy of Sciences) renders it possible to get fairly realistic measures of the extension of the forelands and the width of the inlets. At that time the Basnæs Havn inlet between Sevedøfed and Næbbet had a width of about 800 m. Through Vesterfed there was a smaller inlet, at the present Horsevejle, only 30–40 m broad.

The map from 1813 published by the same society shows that there was a gap both through the base of the fed at Glænø Vesterfed and at Sevedøfed and further that Stenfed was also broken through. The old inlets through Basnæs Havn and Horsevejle were still active. From the map of Generalkvartermesterstaben from 1831 (The Military Mapping Service) it appears that the new inlets and the Horsevejle-inlet were closed again. The rapid closing of the many new gaps seems to indicate that they were formed as a result of a strong gale in connection with high-water and that the new situation was unstable. Besides the reduction of the number of inlets, the width of the Basnæs Havn inlet had diminished from about 800 m in 1770 to about 640 m in 1831.

The Ordnance Map from 1891 shows almost the same topography as the one from 1831. The Horsevejle-inlet has again become active but the narrow width (about 20 m) indicates that the importance of it for the total exchange of water has not been great. The fed areas remained almost unchanged from 1831 to 1891.

The next changes in the course of the shoreline appear from the Ordnance Maps from 1940 and the air-photos from 1967 taken by the Geodetic Institute. The apparently stable situation from 1831 to 1891 has terminated. Since 1891, a considerable narrowing of the inlets have taken place on account of an accelerated growth both of length and of width. The building of the dam between Glænø and Sjælland may have displaced the balance to

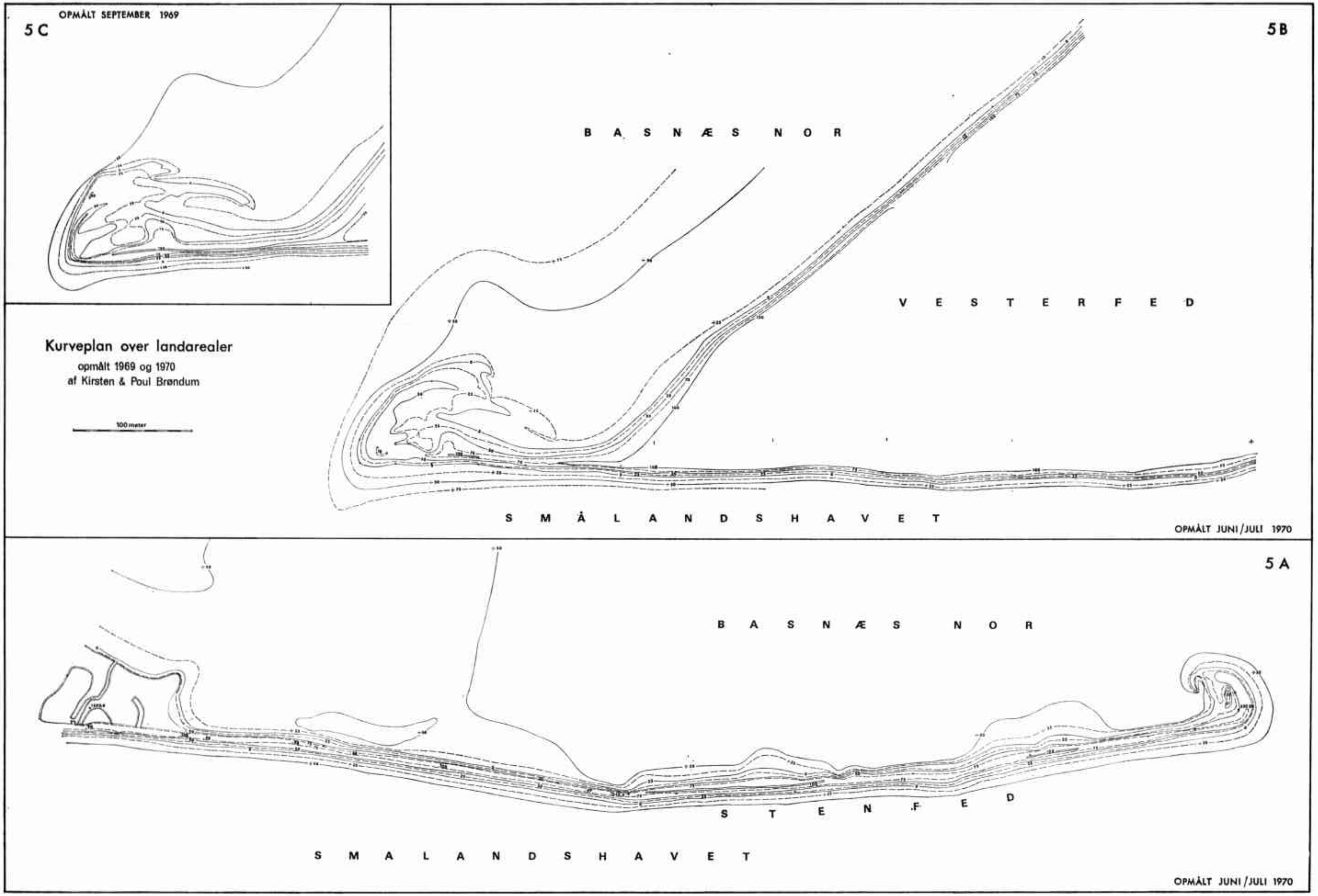

Fig. 5. Contour maps. A and B surveyed June/July 1970, C in September 1969.
Fig. 5. Kurveplaner. A og B opmålt juni/juli 1970, C opmålt september 1969.

the disadvantage of the inlets which have increasingly sanded up and narrowed. However, the development may also be a result of an increased longshore drift. In the early thirties a virus attacked the grasswrack and large sand areas became thus exposed to wave attacks, and the longshore sand drift increased substantially. From a width of about 640 m in 1831 and 1891, the inlet of Basnæs Havn diminished to about 340 m in 1940 and about 200 m in 1967. The Horsevejle-inlet sanded up between 1891 and 1940. A very constant simplification of the S-coast of the spit complex has caused a growth of beach ridges which now contribute to closing of the Horsevejle-inlet, while erosion along the SW-coast of Vesterfed and along the E-part of Stenfed made this place more exposed to erosion than earlier. This may be seen from the frequent flood breaks or small fissures. As to the development of the inlet at Stenfed E, reference is made to the discussion of Stenfed and of the recurved-spits of Vesterfed.

Description of the locations

Sevedøfed

Sevedøfed is 2 km long and 200–300 m broad. The way it was formed is reflected in a system of diverging beach-ridges the distal parts of which distinctly show recurved-spit structures. During the growth of the fed, the coastline has curved clockwise because of erosion of the neighbouring moraine core and of the proximal part of the fed simultaneously with accumulation of its distal part. Each beach-ridge represents an earlier coastline. Along the N-side of the fed, a new foreland has grown up partly as a result of the lee conditions and partly supported by a weak rising of land (+50–+75 cm since the Littorina period). A highlying moraine has also favoured the formation of foreland. Borings 1957 (Hedeselskabet, The Danish Heath Society) have demonstrated that the moraine at the proximal part of the fed is highlying. Along the northern side the moraine is thus met at a depth of only 25–77 cm below DNN.

Because of the erosion, the proximal part is quite narrow. In 1969 the width was determined to be about 20 m, and the height was about 1 m DNN. In spite of the dominating erosion, the narrow land connection still exists. Yet it retreats northwards as a stable form at the same speed as the supporting core of moraine and the proximal part of the fed. This is due to waves spilling material from the sea side to the leeside, i.e. the quantity of material of the land remains unchanged.

Schou (1945) presumed that the lengthwise accumulation had ceased and that the fed had reached its final size. The increment from 1772 to 1942 was about 300 m, i.e. a yearly increase of about 1.8 m. Frequent occurrences of strong currents in a more than 2 m deep creek just E of the outermost end should prevent further growth. A comparison between the map from 1940 and the air photos from 1967 shows, however, that the length of Sevedøfed has increased by 100 m during this period corresponding to a yearly increase of about 3.7 m. Apparently the accumulation has then accelerated since 1940 with a further reduction of the width of the Basnæs Havn inlet as the result. A contributing factor has also been the growth towards the NW of the foreland Næbbet. After Stenfed E in October 1967 was broken through the sanding up of Basnæs Havn inlet continued.

It was when studying Sevedøfed that *Schou* (1945) defined the form complex "fed" an cited above this article. His definition covers the general characteristics of the formation of a fed: 1) attachment with an older land formation, 2) diverging beach ridges and, 3) erosion of the proximal and accumulation on the distal part with a bending of the foreland as the result. These features are also characteristic for recurved spit complexes in general. A fed can therefore be described as a special formation of a recurved spit complex. If very wide, fed formations may assume the character of beach-ridge plains.

Næbbet

E of the Basnæs Havn inlet lies the 1 km long and 100–150 m broad foreland called Næbbet which continues in Stenfed towards the E. Næbbet has been built up by scattered beach-ridges which in their distal NW-part show beautifully developed recurved-spit structures. Between the ridges a new foreland has grown up. The numerous beach-ridge systems parallel to the coast as seen on Sevedøfed are not found here. The coast towards Smålandshavet and Basnæs Nor is formed by integration of many beach-ridges. These compound beach-ridges show great morphological resemblance with Stenfed, especially evident where the S-coast is eroded back filling the lagoons of the foreland.

Along the E-part of the S-coast the erosion is considerable. At the westernmost of the levelling lines the width of the foreland has thus been reduced from 100 m in 1939 to 75 m in 1970, i.e. an annual retreat of about 1 m. The erosion area comprises the easternmost two thirds of the S-coast. To the NW material is being accumulated as a double-sided beach-ridge and recurved-spit system directed towards the NW. The double-sided accumulation is indicated by formation of beach-ridges partly on the sea-side towards the SW and partly on the lagoon-side towards the NE.

The NW-part of Næbbet, also on the map from 1891, is seen very clearly today with the spit terminus bending NE approximately 200 m SE of the actual land end. Since 1891 the increment has been 200 m or an average of 2.5 m per year. From 1770 to 1891 the increment only amounted to 100 m or an average of 1 m per year. Though some reservation must be made as to the cor-

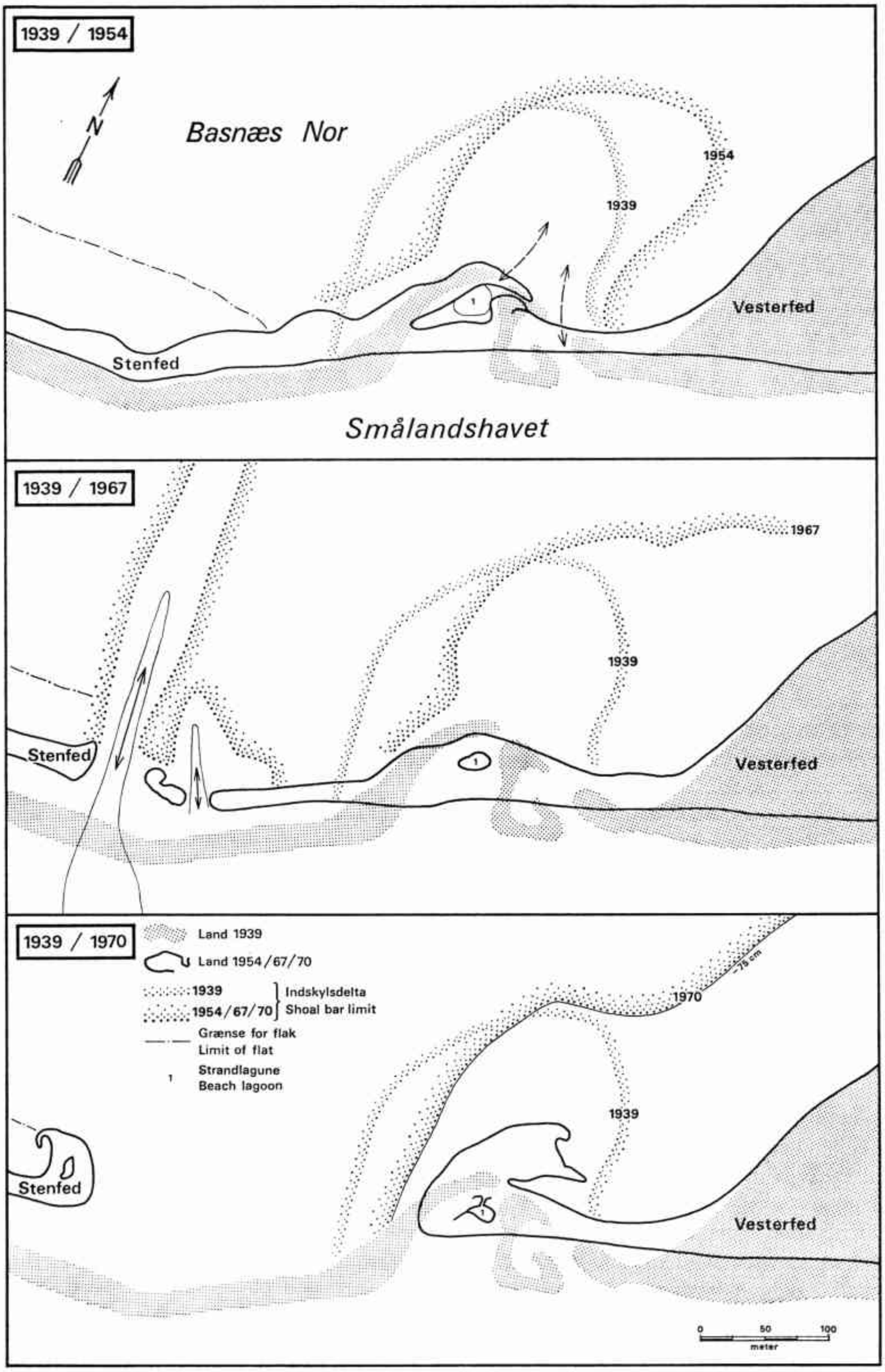

Fig. 6. The development of the inlet to Basnæs Nor 1939–1970.
Fig. 6. Udviklingen af indløbet til Basnæs Nor 1939 til 1970.

rectness of the map from 1891, it may safely be stated that the accumulation has accelerated since 1891.

The location of Næbbet is conditioned by a flat seen on the N-side of Næbbet and along the W-part of Stenfed. A great number of blocks are scattered over the flat and indicate its origin as an abraded moraine core. By borings the moraine core has been demonstrated a few centimetres below the sand surface.

The high level of the flat has been a decisive factor for the stabilization of the recurved spits of Næbbet, and erosion of the moraine core has delivered material to the accumulation processes. At the Næbbet itself, the material found along the S-coast becomes more and more fine-grained towards the NW. At the transition from Stenfed to Næbbet the material is markedly stony, but with a considerable intermixture of sand. At Basnæs Havn, sand is the dominating sediment. It must be taken into consideration, however, that drift material from the W supplies sand.

Glænø Vesterfed

Glænø Vesterfed is connected with the moraine landscape in the E by a land isthmus about 300 m long and 30–60 m broad including Sælhøj, (+6 m DNN), the only visible moraine core of Vesterfed.

The fed itself is divided into two by the shallow Horsevejle (fig. 4). The E-part is about 1000 m long and 400 m broad. Towards the SW this foreland has been built up by a system of beach-ridges orientated WNW-ESE. The southernmost beach-ridges lie parallel to the coast and continue westwards along the S-coast of Bredefed. They consist of sand and only the youngest of them facing S are still bare. A dense beach meadow vegetation covers the oldest part of the foreland.

To the N is a lower-lying flat dominated by a more humid marsh vegetation. This flat is more plane than the beach-ridge flat and shows no ridge and furrow topography. The flats are intersected by a system of waterlogged, creek-like channels draining the flats after highwaters.

The N-part of the foreland was formed due to the favourable lee conditions on the shallow flat behind the beach ridges. Here the salt-tolerant vegetation has been able to entrap sediment and thus contribute to build up the foreland. The sediment is supplied during rough weather when the contents of suspended material is topmost and the high-waters most frequent.

Thus the foreland E of Horsevejle is connected with an older land mass which was built up by diverging beach ridges and the coastline is bending because of erosion in the E-part and accumulation in the W-part. This foreland must therefore be characterized as a fed, bordered on its northern side by a new foreland.

W of Horsevejle lies the 1200 m long Bredefed which is 600 m at its broadest place. Bredefed is almost triangular, broadest at the E-part and more pointed towards the WSW.

The most dominant feature of Bredefed is the beach ridge systems. 2–300 m from the W-end of the fed, a N–S going beach ridge system cuts the actual coastline at nearly 90° angles. Farther towards the E, the course of the beach ridges is more SW–NE running, and farthest to the NE they are completed by recurved spit structures curving northwards. The farther S and E one goes on the Bredefed, the more parallel to the coast the beach-ridges lie. They continue in the southernmost part across the former inlet at Horsevejle. These youngest as well as the older beach ridges with the distal recurved spit structures mentioned have been created by the sea in the S.

The westernmost portions of the younger beach ridges cut several of the old ones, but are themselves cut by the actual coastline in the westernmost part of the fed. Thus there is an erosion area at the W-part and an accumulation area at the E-part of the Bredefed S-coast.

Besides these two beach ridge systems another one is found in the northwestern part of Bredefed, where beach ridges are seen with distinct recurved spit structures running W–E. In the E-part they are curving SE. Towards the W they are abruptly cut off by the shoreline facing Basnæs Nor. It is therefore only the distal part of this beach ridge system which remains today. It has been formed by drift material along the NW-coast of the foreland by wave action from Basnæs Nor. The NW-coast can be divided into an erosion area towards the S and an accumulation area towards the N.

Bredefed is thus built up under influence of two forces. Both the coast towards Smålandshavet and the one towards Basnæs Nor are curring, the S-coast clockwise with a W-E course and the NW-coast anticlockwise with a N-S course.

The formation of Bredefed has taken place on either side of a moraine core which has supplied material. The existence of it is for instance revealed by a number of larger blocks just NW of the W-end of Bredefed. Besides it can be seen from the distribution of material in the beach ridges and along the coasts of the fed. The south coast of the W-part consists of 5–10 cm big rounded pebbles. From here on and towards the W and the E the grain size is decreasing. The stone material continues westwards along the southern side of the recurved spits which terminate Bredefed, but here there is also much sand. The stony beach continues about 7–800 m towards the E, and then it changes abruptly into a sand beach. Same change can be found in the W- and the E-part respectively of the beach-ridges forming the fed. The fine-grained material is the most easy to move and is moving most rapidly. Consequently it will be deposited farthest off the abraded moraine core.

Attempts to demonstrate the moraine core by means of borings with a 1.25 m long auger were not successful. NW of the fed the coarse-grained sand was not penetrated and on the fed itself the many pebbles hampered borings.

Bredefed can be characterized as an individual, double-sided formed fed, because the beach ridge system both towards the NW and the SE have been built up by diverging beach-ridges increasing in width and with a curving of the coastline as the result. The formation of foreland has not taken place in front of a bay as in the classical example, but the existence of two water areas with at times sufficiently strong waves to erode and transport material from both sides has made the formation possible. Due to the closely situated beach-ridges and the great extension of the foreland, Bredefed is better characterized by the term: a beach-ridge plain.

Stenfed

Between Næbbet and Glænø Vesterfed lies the 900 m long Stenfed, separated from the recurved spit system of Vesterfed by a 250 m broad inlet to Basnæs Nor. The width of Stenfed, defined as the part being above 0 m DNN, variates between 12 m and 23 m, and the height variates between about +0.80 m DNN in the easternmost part and +1.13 m DNN. By far the greatest part of Stenfed has a top level of about +1.00 m DNN (fig. 5A).

The delimitation of Stenfed from the surrounding marine flats has been based on the contour map (fig. 9) and the sounding profiles. Around contour −40 cm to −60 cm there is an even transition from the topmost point of the beach-ridges to the offshore zone, and the −50 cm contour is therefore taken as an approximate boundary line. At the E-end of Stenfed the transition zone is deeper lying.

Along the N-side of Stenfed the transition to the marine flats is also found around −50 cm DNN. As the sloping of the westernmost part of Stenfed is very steep, the boundary-line is here well representated at the −25 cm contour. Along the eastern part of the N-side of Stenfed the −50 cm contour is taken as the borderline to a 25–35 m broad flat between −50 cm and −75 cm. This flat is bounded by a slope towards the even bottom of the Basnæs Nor.

Stenfed can be characterized as an elongated ridge, built up on marine flats. Part of the ridge has been built up above sea level. The width of Stenfed is only 25–33 m, in a few places broader because of sand flats along the N-side. Stenfed appears above sea level as an elongated ridge, built up by beach-ridges lying parallel to the coast and which have been washed up upon each other. The crest of the individual beach-ridges can be followed very far, often from the inlet in the E and along the S-side of Næbbet in the W. Stenfed is thus a compound beach-ridge system, built up by integration of many beach-ridges.

The name Stenfed (sten = stone) indicates the kind of the material. At places, pebbles with a diametre of 5–10 cm dominate. They originate from one or more moraine cores, to-day a.o. revealed by the abrasion flat N of the W-part of Stenfed. Furthermore, sand is found, partly mixed up with the stony material and partly in the shape of sand beach-ridges along the S-side and banks along the N-coast spilled over by waves during gales. On the N-side there is an abrupt change from Stenfed, with its high contents of stones, to the marine flats consisting of sand. This is emphasized by the abrupt change in the profile gradient. Stenfed's N-side has gradients of 1:6–1:8, whereas the nearby marine flats are almost horizontal. The steep, stony slope towards Basnæs Nor is an accumulation slope for stony material which during gales and high-water has been washed over Stenfed by the waves. Wave-wash from Smålandshavet and the effect hereof were observed several times during the autumn of 1969.

Stenfed cannot be characterized as a marine foreland, as there is minimum of vegetation. Permanent vegetation is only found in two minor areas, where Stenfed is highest and broadest, but the plants do not have any greater morphological effect.

The E-end of Stenfed is a recurved spit complex which was visited aperiodically between September 1969 and October 1970. In September 1969 it was seen as a large recurved spit resembling a crosier. By and large this shape was maintained during the autumn and winter months. During the winter 1969/70 the marine processes stopped for about three months because of the freezing of the sea. On April 27, 1970, the appearance of the spit was almost the same as in the autumn of 1969, the distal part had only been pressed towards the SE by waves raised by W- and NW-winds, and the lagoon was almost completely barred. Soon, the separation between open sea and lagoon was accomplished. On June 3, 1970, it was recorded that a new recurved spit had been created from the NW-part of the old recurved spit system. The distal part of the new spit was also bending S, i.e. landward towards the stone ridge of Stenfed, and the growth of it continued through the summer of 1970. On October 4, 1970, it had thus grown 11 m towards the S.

The material to the recurved-spits on Stenfed's E-part is supplied by the E-going drift along the S-side of Stenfed. The longshore beach drifting is dominated by the sand fraction, and the sand is also dominating in the recurved-spits. The transport to and the deposition on the spits are made by a turning of the wave fronts around the E-end of Stenfed. A smaller drift of material is also supplied along the N-side of Stenfed. The effect of the W- and the NW-winds causes the strong deflection towards the S and a dislocation towards the E of the existing spits. In this, they differ markedly from the recurved-spits of Vesterfed discussed later.

Overwashed material from the windward side has caused a dislocation of Stenfed towards the N, fastest at the E-part, E of the broad moraine flat. The reason must be that Stenfed is here moving towards deeper water in the Basnæs Nor where it will be more frequently spilled over. The narrow flat along the E-part has decreased from a width of 100 m in 1939 to minor 50 m in the summer of 1970. Only with a considerable supply of material, Stenfed will be able to exist as a stable form above sea level. With a position about 50 m N of to-day's, the base of Stenfed will be 50–80 cm lower than it is now, because Stenfed will migrate outside the northern limitation of the narrow flat. If Stenfed should retreat at a constant speed, a critical situation will arise around the turn of the century. It must be presumed that a considerable extension of the new Stenfed-Vesterfed inlet will occur, and a further sanding-up, possibly a closing of the Basnæs Havn inlet, is to be expected.

The gap in 1939 at Bredefed's W-end also seemed to have been caused by Stenfed which here reached the N-border of the mentioned flat. The consequent lowering of Stenfed's top level has thus disposed it to be especially open for erosion here. This explains why just the E-part of Stenfed has been notably weak since 1939.

The formation of Stenfed is connected with the existence of a moraine-core and a broad, shallow offshore zone towards the S. Cross profiles of Stenfed and of the southern offshore zone as well as of the bottom topography in Basnæs Nor show that an erosion has taken place at the landward side of the southern offshore zone. Part of the abraded material can be refound in the pebbles of Næbbet and Stenfed, whereas the greater part of the finer material has been removed by longshore transport. Apparently the pebbles are not transported very far according to the limited extension found towards the E along the S-side of Bredefed. As erosion of the offshore zone is evident, the Næbbet-Stenfed must have been built up by a landward transport of coarse material on a shallow flat, perhaps supported by material supplied from the W. On the basis of the dominance of the landward directed transport by the formation of Stenfed this can be characterized as a pebble-barrier.

The recurved-spit system

Besides the map surveyed in 1970, air photos from 1939, 1945, 1954, and 1967 were studied for information about the recurved-spits and the new inlet to Basnæs Nor. On the basis of this material fig. 6 was made.

In 1939, Stenfed was broken through just W of Bredefed's W-end and in the middle of the gap there was a small island lying N-S and with E-turned recurved-spits both at the N- and the S-end. This situation appears from the Ordnance Map from 1940. N of the gap a sandy shoal bar was deposited by inflowing water. It is not possible to ascertain how long this inlet was active. Air photos from 1945 show that it was then again closed.

In 1954 Stenfed was still intact. The sand masses N of Stenfed had then been pushed farther towards the E by wave-action in Basnæs Nor during W-winds. On the N-side of Stenfed a water-filled lagoon was enclosed by a bar, identical with the free E-end of Stenfed from 1939, together with the N-end of the above-mentioned island from 1939 in the inlet.

The air photos from 16/6–1967 show that a new, smaller inlet had been formed farther towards the W than in 1939. Also in 1967 the new inlet was divided into two streams by a small residual of the Stenfed barrier. At the intrance to the inlet the conditions were in 1939 the following: the above mentioned lagoon, the former free E-end of Stenfed and the N-end of the small island from 1939 were still to be found on the N part of the residual of Stenfed, which remained attached to Bredefed. The form elements from 1939 were strongly modified, however, on account of beach-ridge formations along the northern coast. The position of the lagoon was identical with the position of the western, broadest inlet from 1939. The extent of the washed-in sand masses from 1939 had not changed remarkably since 1954 (fig. 6).

In June 1967 the width of the W inlet was about 40 m, and of the E one about 20 m. In September 1969 the width of the gap was about 250 m, and the residual of Stenfed in the middle had disappeared. From September 1969 to June–July 1970 no remarkable extension of the inlet was registered and it has only taken place towards the E. The E-end of Stenfed has thus not been displaced towards the W since 1967. In 1967 the residual of Stenfed, still connected with Bredefed, was almost 400 m long. In June–July 1970 the length of it had been reduced to 250 m. Simultaneously with the erosion of the W-part, recurved-spits were being built up at the N side of the broader stretch lying to the E which had partly been built up of form elements from the gap in 1939. Here, the formation of the recurved spit system has to a very high degree been favoured by the existence of the shallow flat consisting of washed-in sand from the 1939 gap.

On the basis of the analysis made, it is possible to estimate the size of the coastal regression. Since 1939 the S-coast, off the present recurved spit complex, has advanced 35–40 m towards the N. At the E-end of Stenfed the regression had been about 60 m. The faster regression W of the inlet may be due to the fact mentioned previously that Stenfed is here migrating on a bottom sloping north.

From the morphological maps of September 1969 to July 1970 (fig. 7) and fig. 5 B of July 1970, it appears that the lagoon is still existing though is has diminished considerably in the course of autumn 1969. This was a consequence of the erosion still working along the S- and the NW-coast of the spit system. A new form element, a swash bar has been formed in the SW-part of the lagoon. The flat to the N is built up of beach-ridges which in the distal part to the E run across the sand flat from the 1939 gap as free recurved-spits. The connecting link between the form elements in the W-part of the system and

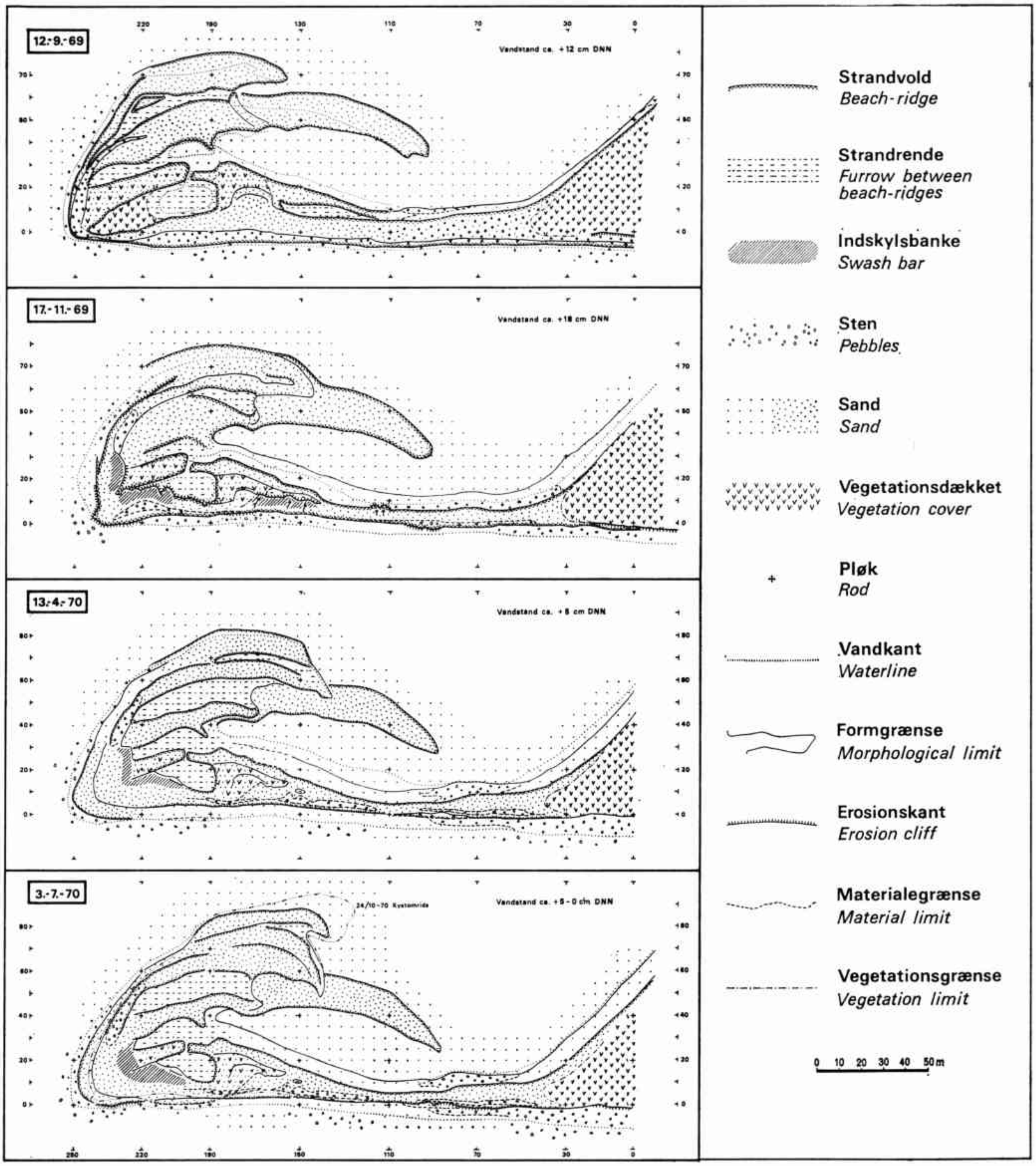

Fig. 7. Changes in the morphology of the recurved spit complex from September 1969 to July 1970.
Fig. 7. Ændringerne i krumoddekompleksets morfologi fra september 1969 til juli 1970.

Bredefed is a beach-ridge which is the easternmost part of Stenfed as it appeared before the gap in 1967. Morphologically there is a complete accordance between this 100 m long ridge and Stenfed.

Within the recurved-spit complex a great variety of materials can be found. The beach-ridge corresponding to Stenfed is composed of sand and pebbles. The S-coast appears both as a sand-beach and as a pebble beach and differs from the pebble beach to the E along the S-side of Bredefed's W-part. The swash bar now partly filling the lagoon, consists of sand mixed up with pebbles of a 5–10 cm diametre. These originate from abrasion of the beach-ridge. The flat N of the lagoon consists of sand. Pebbles are found on the top of some of the beach-ridges and along the W part of the coast. There is a decreasing grain size from the SW towards the NE and the E.

In summer, the N-side of the beach-ridge is sparsely grown with *Honckenya peploides* whereas the S-side is bare. The only place in the recurved-spit complex with a dense vegetation cover is seen at the lagoon. The W-part of its bottom was in 1969 covered with a dense vegetation of *Glaux maritima,* and the beach-ridges around it had a scattered growth of *Artemisia maritima, Rumex crispus, Honckenya peploides* and *Puccinellia maritima.* Most of the sand flat N of the lagoon and the free spits were without vegetation.

As a consequence of the very sparse vegetation, the morphological processes are only influenced by plants to a small extent.

Correspondingly as described under stenfed, a delimitation from the surrounding offshore zone was made of the accumulation forms Bredefed and the recurved spit system. On fig. 5 B the borderline along the S-coast is seen to be at a 75–100 cm depth. The –75 cm contur level N of the spit system represents approximately the border for the washed-in sand masses from the gap in 1939 as it appears from the air photos of 1967.

The formation of this recurved-spit system differs characteristically from these at the E-end of Stenfed. The material for the latter is mainly supplied by the E-going material transport along the S-coast, whereas the material for the building up of the Vesterfed recurved spits is provided by erosion of the complex itself. Strong waves caused by winds from the W and the SW cause erosion along the NW-coast. The greater part of this material will be transported towards the NE and be deposited in the free recurved-spits of the N part of the complex. Simultaneously the deliberated eroded material along the S-coast will be transported towards the E.

As the inlet breaks the longshore transportation of material this means that by W-winds the transport will diminish along the S-side of the spit system with increased erosion as the result. This explains the strong erosion along the SW coast of the system during the investigation period with a consequent bending of the coastline towards the N (fig. 7).

Between September 1969 and July 1970 there have thus been erosion of the S- and of the NW-coast of the recurved-spit complex and accumulation of the free spits of the N-part of the complex. During the period of investigation the erosion was about 1700 m^3 and the accumulation about 1200 m^3, i.e. a loss of material of about 500 m^3. This indicates an area of erosion in contrast to the classical recurved-spit system found at Stenfed.

The inlet between Stenfed and Glænø Vesterfed

In 1970 the width of the inlet was about 250 m. Between Stenfed and the recurved spits the inlet bottom was built up as an almost level sand flat sloping gently to the N and to the W (fig. 8). There was a very abrupt transition from the pebble formations of the recurved spit system and of Stenfed to the sandy flat lying in level –125 cm to –150 cm DNN. In the W-part of the inlet a shallow creek cuts the sand flat. The position of this creek corresponds exactly to that of the W-inlet in the summer of 1967.

To the S the sand flat is bounded by a flat, stony ridge which is a WSW continuation of a stony abrasion flat along the S-coast of the system. This stony ridge follows almost the course of the –125 cm contour-line. These stony parts must be a remainder from a more southernly position of the Stenfed barrier.

In the summer of 1967 there was an about 250 m long and 50 m broad shoal bar N of the westernmost of the two inlets through Stenfed, and this bar can also be seen on the contour map from 1970 (fig. 9). A delimitation of it is difficult, however, partly because the primitive equipment did not allow sounding points close enough and partly because it was difficult to map this flat of great extension and without distinction. The configuration is therefore only to be considered an attempt.

The shoal forms an oblong, pointed bar directed northwards. The topmost sounding on the bar is –126 cm. The extent of it has doubled since 1967. The bar has been formed by inflowing water in connection with high-water. Dynamically as well as morphologically the bar and the inlet are closely related to flood channel systems in the Danish Wadden Sea. The pre-existing basis of the shoal bar has been the position of the W inlet. Gradually as the inlet is extending eastwards, an intensification of the processes building up the bar to the E is to be expected, but this cannot be interpreted precisely on the existing contour maps.

In relation to the inlet there is no outer shoal bar. This cannot be expected as the tide is only minor (*P. Bruun,* 1966). Instead there is a deformation of the break-point bars S of the inlet, where they are deflecting seaward.

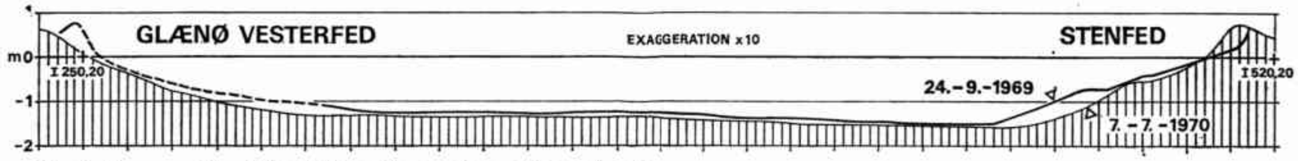

Fig. 8. Cross profile of the inlet to Basnæs Nor 1969 and 1970.
Fig. 8. Tværprofil af indløbet til Basnæs Nor 1969 og 1970.

In September 1969 and in July 1970 a cross profile of the inlet was made. Comparing the profiles (fig. 8) it appears that the level of the bottom was about 10 cm lower in July 1970 than in September 1969. Furthermore, the width of the inlet had increased. At the E-end of Stenfed the position of the coastline was unchanged, but erosion had increased the gradient of the stony slope towards the sand flat of the inlet, exemplified by 0 cm DNN to −150 cm DNN, from 1:32 to 1:26. At the W-end of the recurved-spit complex the erosion had changed the gradient from 1:37 to 1:29 calculated between 0 cm DNN and −100 cm DNN. Taken as a whole, however, these changes must be characterized as modifications of an already existing profile.

It has been mentioned that there is no shoal bar S of the inlet, but the longshore sand drift can take place across the break-point bars S of the inlet in connection with oblique waves breaking on the bars. With moderate exchanges of water between sea and lagoon the passing will not be much disturbed. On the other hand the inlet means an effective interruption of the beach drift. By wave refraction in the inlet the E-going material along Stenfed can be deposited in the recurved-spits of Stenfed. By oblique storm waves beach material can be transported seawards to the break-point bar and via this pass the inlet. A cross transportation of pebbles across the inlet has not been observed, however. Apart from the stony ridge in the SW-part of the inlet, the bottom has been exclusively built up by sand. Thus the inlet constitutes an effective obstruction to transportation of pebbles from the W to the E, and also to transportation of sand in the swash zone.

Basnæs Nor

The investigated part of Basnær Nor comprises about 1.6 km^2. The abrasion flat N of Næbbet and Stenfed and the conditions prevailing at the new inlet to Basnæs Nor have been discussed earlier. In the N, the Basnæs Skov peninsula continues submarine southwards as a shallow flat. Like the flat N of Næbbet and Stenfed, this one can be explained as an abrasion flat in the moraine. The Basnæs Skov peninsula is well defined by an about 1/2 m high erosion cliff, and along the coast and dispersed over the flat stones from the moraine are to be found. Most of the flat is covered by sand, however.

Also the shallow parts along Bredefed's NW-coast have been built up partly by abraded moraine. The large boulders found here confirm this. They are especially found in the SW-part. But also here most of the flat is covered by sand.

The central, deepest part of Basnæs Nor slopes westwards. In this central part two flats deviate from the even bottom. N and S of these flats there are creeks in the bottom with depths exceeding −2 m DNN.

A safe geomorphological interpretation of the bottom relief of Basnæs Nor will not be possible without further investigations. Neither time nor material was sufficient for this purpose in 1970. However, there are no doubt thick covers of sedimentations in the deepest parts of Basnæs Nor. This is indicated for example by the extensive, horizontal flats, the former relief of which is hidden under covers of sediments. By hammering down flags into the deeper parts of Basnæs Nor to mark the sounding lines, it was observed that the flags met great resistance in the surface layer but, this penetrated, the flags were easily pressed down. Here the sandy deposits contained much organic material.

The existence of the initial moraine landscape has been decisive for the bottom conditions of Basnæs Nor. The pre-condition for the existing central deep part of Basnæs Nor has been a former depression surrounded by higher-lying moraines, which in the Basnæs Skov peninsula rises above zero. The shallow parts of Basnæs Nor are either directly or indirectly seen to have had the highlying moraine as a pre-condition. The deep part of Basnæs Nor has functioned as a sedimentation basin partly for the fine-grained abrasion material, partly for material from land but also for material supplied from Smålandshavet. The original relief has thus gradually been made indistinct. A foreland complex has debarred Basnæs Nor from Smålandshavet, whereby the influence of the littoral processes in Basnæs Nor has been reduced.

Based on the contour map (fig. 9) and the sounding profiles, the boundaries have been drawn of the flats along the N-coast of Stenfed, along NW-coast of Bredefed, and along the S-coast of the Basnæs Skov peninsula as well as of the westernmost of the two flats in the central part of Basnæs Nor. Because of the preliminary character of the survey at the easternmost flat, a boundary line between this and the shallow bottom of Basnæs Nor was not drawn. It is emphasized that the boundary lines are only to be taken as indications, as marked slopes at the transition from the flat to the shallow bottom of Basnæs Nor are often missing.

Fig. 9. Contour map/morphological map of the water areas 1970.
Fig. 9. Kurveplan/morfologisk kort over vandarealerne 1970.

The offshore zone to the south

The shore near bottom of Smålandshavet S of Stenfed and Bredefed is sloping gently southward. At the survey most of the soundings were continued seaward below −3 m DNN (fig. 9).

Table 2: The gradient of the inner part of the offshore zone.

profile	− 500	− 300	− 100	0	+ 600	+ 800	+ 1300	+ 1500
A	208	302	420	425	515	525	510	500
B	1:85	1:145	1:204	1:205	1:238	1:245	1:245	1:238
C	1:150	1:250	1:275	1:275	1:250	1:250	1:250	1:250
D	1:225	1:350	–	–	1:360	1:300	1:290	1:450
E	30	13	14	18	35	35	20	20

A: Distance in metres between 0 m DNN and – 3 m DNN.
B: Gradient between − 1 m DNN and − 3 m DNN.
C: Average gradient of the breaker zone.
D: Gradient of the line connecting the bar tops.
E: Distance in metres between 0 m DNN and − 1 m DNN.

There exist a difference in the width and the gradient of the breaker-zone E and W of the inlet. The distance from 0 m DNN to –3 m DNN (A) is S of the house on Bredefed (easternmost in the measured area) only 2/5 of the corresponding distance S of Stenfed. The gradient of the line connecting the profile where it cuts the –1 m and the –3 m DNN, gives an impression of the gradient of the inner part of the offshore zone. Close to the –1 m contour an abrupt decrease of the gradient occurs at the transition from the pebbles of the beach to the sandy sediments of the offshore zone. W of the inlet the values of the gradient are very similar (1:238–1:245), whereas the values E of the inlet vary a lot (1:85–1:205).

In order to determine an average gradient for the even, sandy part of the offshore zone upon which the break-point bars have been built up, the gradient was determined of the straight line that corresponds best to the average gradient of the offshore zone. In fact this gives the gradient of the breaker zone. Hereby greater accordance is obtained between the gradient values E and W of the inlet. Determined in this way the gradient of the breaker zone is 1:250–1:275. Only in the easternmost profile the gradient is steeper (1:150). Maybe the explanation is that the underlying plain, upon which the break-point bars have been built up is steeper here.

Also the average gradient of a line connecting the top of the break-point bars has been determined (D). Calculated in this way, there are still differences in gradient between the easternmost profile and the other ones. The low gradient figure in the westernmost profile is due to the fact that the second and the third break-point bar are much developed and lie far from the coast.

On fig. 9 the sites of the break-point bars and the corresponding troughs have been marked. It appears that there is a greater regularity S of Stenfed than S of Bredefed.

S of Stenfed the first bar is almost parallel to the coast. Distance from the shoreline is 50–100 m, and top level is about –1.0 m DNN. Second bar is very well-developed and runs by and large parallel to the shoreline at a distance of 175–225 m. Top level is –1.2 to –1.4 m DNN.

Farther seaward there are more bars, but after the second bar the forms appear in a smaller scale and are more difficult to recognize. In profiles 600, 1300, and 1500 the third bar is very clearly demonstrated with a top level about –1.5 to –1.7 m DNN. In profile 600 and 1300 a fourth bar is shown with top level about –1.9 m DNN. 500 m S of the inlet a bar with top level –2.15 m DNN is seen. The continuation of this bar towards the E and the W is not known, however.

By wave action against the coast, breaking will occur when $d_b/H_b = 4/3$. The topmost level of the third bar being about –1.6 m, waves of a height of about 1.2 m will break on this bar if the water level is approx. 0 m DNN. The wave height necessary for breaking on the second bar is about 1 m, whereas breaking on the first bar corresponds to a wave height of about 0.75 m. The distinctness of both second and third bar shows that wave heights of 1–1.2 m are common during gales. During breaking, the waves loose energy and the height will diminish. However, it will often be high enough to cause new breaking on the next bar. During gales, breaking is frequently observed on three or more bars. Where the bars lie close to each other as along the S-side of Vesterfed, E of the house, breaking may therefore occur in the whole width of the breakerzone.

S of the inlet between Bredefed and Stenfed the course of the bars is very disturbed, as the bars are here either discontinued or they form arches with the convex side turned southwards. Corresponding arches of the bar system can be observed from the air photos from 1939, where Stenfed was also broken through. The deformation of the bar systems must be seen as a result of the collisions between currents through the inlet and the waves as well as the wave-induced currents in Smålandshavet.

The distance of 100–250 m between the sounding lines involves that the contour map only shows a rough picture of the bottom topography of the offshore zone. The relative great distance from the shoreline to the –3 m contour line S of Stenfed corresponds to small gradients and an abrasion flat superimposed by sand. S of the house on Bredefed the smaller distance to land of the –3 m contour indicates the limit of the original moraine core. The location of the bars on the offshore zone, seen on the air photo from 1967 also indicates this. Along the S-side of Vesterfed E of the house on the fed, the location of the bars was almost parallel to the coast and the width of the breaker-zone was 175–200 m. (The width has been taken on the air photo). Along the S-side of Stenfed and Vesterfed W of the house the width of the breaker-zone was 300–400 m.

The topography of the offshore zone variates a great deal, which appears on air photos from different times.

In 1967 there were 2–3 bars on the offshore zone covered by the contour map, whereas the air photos from 1939 and 1945 show 3–4 bars. Extended, even areas between the sand-bars, as seen on the air photos from 1967 and from the contour map from 1970, existed to a much smaller extent in 1939 and 1945.

The air photos from 1967 show that the first bar was situated 50 m from the coast, the second bar 150–200 m, whereas the third bar was situated 300–400 m from the coast. In the summer of 1970 the distances were 50–100 m, 175–225 m, and 250–325 m respectively. There is thus good accordance as to the distance from the coast of the bars in June 1967 and June–July 1970.

Conclusion

The marine forelands studied have been formed on the basis of existing, high-lying moraines. Sevedøfed farthest to the W is a fed formation built up mainly of material supplied from the W. Næbbet-Stenfed is a barrier island built up by supplies of pebble material from the offshore zone. Abrasion has been demonstrated of a high-lying moraine core which has supplied material. Recurved-spit formations in the foreland and at the W-part of Næbbet as well as at the E-part of Stenfed show that also longshore drift of material has been of importance.

Glænø Vesterfed has been built up of a number of individual, morphological units and complexes which have later grown together. The recurved-spits farthest to the W is an erosion-accumulation complex formed in connection with the part of Stenfed which in 1967 was separated from the remaining part by the gap. The processes work on a flat consisting of washed-in sand masses in connection with an inlet which existed in 1939. Bredefed is a double-sided built up beach-ridge plain formed in connection with a moraine core at its westernmost part. Between the distal parts of the beach-ridges to the NE a new foreland is growing up. The E-part of Vesterfed was originally an individual fed formation formed in connection with the moraine core of Glænø. At the closure of the Horsevejle inlet it has been connected with Bredefed.

It is to be expected that the new inlet at the W-part of Vesterfed remains stable and will gradually be further extended. At the same time a sanding up and possible closure of the Basnæs Havn inlet may be expected. During the formation of the marine forelands the shoreline has grown shorter and the trend is a simplification with a WNW-ESE orientation.

RESUMÉ

En kystmorfologisk studie af Basnæs Nor samt af de tilgrænsende vandarealer.

»*Et* fed *er et marint forland, opbygget i tilknytning til en ældre landmasse foran en bugt på grundlag af divergerende krumodder. På havsiden vil ældre feddele almindeligvis eroderes, og yngre dele vil vokse i bredde. Kystlinjen svinger under udviklingen om et drejepunkt, der vandrer mod fedspidsen*«.

Axel Schou

Glænø ligger ved Sjællands SW-kyst mellem Skælskør og Næstved, og dens feddannelser afsnører Basnæs Nor og Holsteinborg Nor fra Smålandshavet.

Undersøgelsesområdets og opmålingsnettets beliggenhed fremgår af fig. 1. Undersøgelsen blev startet i sept. 1969, men stormfuldt vejr begrænsede målearbejdet til den vestlige del af Glænø Vesterfed. Først i juni-juli 1970 fik målefeltet den udstrækning, som er vist på fig. 1. Opmålingen blev foretaget ved kombination af nivellement og pejling i forbindelse med vandstandsobservationer. En sammenligning mellem de registrerede vandstande ved Basnæs Nor og de samtidig af *Meteorologisk Institut* målte vandstande i Korsør Havn viser, at forskellen mellem høj- og lavvander er 0–5 cm mindre ved Basnæs Nor end ved Korsør, samt at høj- og lavvande indtræffer ca. $^1/_2$–1 time senere ved Basnæs Nor (tabel 1). Der forekommer en tidevandsbestemt vandstandssvingning på 20–25 cm for Smålandshavet ved Basnæs Nor. Ekstreme vandstandsforhold må derimod sættes i forbindelse med særlige vindforhold. De store højvander er således en følge af vestlig storm, og de forekommer oftest med ca. 1 døgns forsinkelse i forhold til stormen (fig. 3).

Til illustration af vindforholdene er målinger fra den nærmeste station, Sprogø, anvendt. Vindvirkerresultanten er tegnet, dels efter *A. Schous* metode (nr. 1 i fig. 2), dels efter *A. Guilchers* anvisninger (nr. 2 i fig. 2) med udeladelse af vindene fra land. Det ses, at kysten tenderer mod en retning vinkelret på Guilchers vindvirkeresultant. Både nr. 1 og nr. 2 i fig. 2 antyder imidlertid, at der sker en nettotransport af materiale langs kysten fra W mod E, og dette bekræftes af observationer i naturen.

Sevedøfed er ca. 2 km langt og 200–300 m bredt. Det er opbygget af divergerende strandvolde med samtidig erosion ved den proximale og akkumulation samt breddevækst ved den distale ende. Forlandsdannelsen er begunstiget af en højtliggende moræne samt af en svag landhævning.

Mens Sevedøfeds længdevækst fra 1772 til 1942 var ca. 300 m, svarende til en årlig vækst på ca. 1,8 m (*A. Schou*, 1945), er der fra 1940 til 1967 sket en årlig vækst på ca. 3,7 m.

Næbbet er 1 km langt og 100–150 m bredt. Det er opbygget af spredt liggende strandvolde, imellem hvilke der er dannet tilgroningsforland. Kysterne mod Smålandshavet og Basnæs Nor er udformet som strandvoldsrygge, dannet ved integration af mange strandvolde.

Langs den østlige del af Næbbets sydkyst sker der en årlig kystregression på ca. 1 m, mens akkumulationsprocesserne dominerer ved NW-enden, hvor der er sket en årlig længdevækst på ca. 2,5 m siden 1891.

Glænø Vesterfed 2-deles af den lavvandede Horsevejle. Den østlige del er ca. 1000 m lang og 400 m bred. Mod S opbygges den af sandede strandvolde, der er kastet op fra Smålandshavet (fig. 4), mod N af tilgroningsforland, gennemsat af loagtige render. Hele den østlige del, der ved en tange er tilknyttet Glænøs morænekerne, må morfologisk betegnes som et fed.

W for Horsevejle ligger det 1200 m lange Bredefed, der på bredeste sted er ca. 600 m (fig. 4). Bredefed er domineret af strandvoldssystemer, der vifteformet breder sig ud over forlandets flade. I den NE-lige del er lavningerne mellem strandvoldene udfyldt af tilgroningsforland. Strandvoldsdannelsen er sket både fra Smålandshavet og fra Basnæs Nor. Sydkysten kan opdeles i et vestligt erosions- og et østligt akkumulationsområde. Ligeledes kan NW-kysten deles i et SW-ligt erosions- og et NE-ligt akkumulationsområde.

Forløbet af strandvoldene på Bredefed (fig. 4) afslører, at de er dannet i tilknytning til en morænekerne, der ved abrasionen har bidraget med materiale til opbygningsprocesserne. Dette indiceres bl.a. af det store indhold af rullesten både i den SW-lige del af strandvoldene og langs sydkystens vestlige del.

Bredefed kan karakteriseres som et tosidigt opbygget fed, dannet af de littorale processer i hhv. Smålandshavet og Basnæs Nor. På grund af de tætliggende strandvolde og forlandets store udstrækning karakteriseres Bredefed dog bedre ved termen strandvoldsslette.

Mellem Næbbet og Glænø Vesterfed ligger det 900 m lange Stenfed, der over havniveau er 12–23 m bredt (fig. 5). Stenfed er opbygget af kystparallelle strandvolde, der er kastet op over hinanden. Navnet Stenfed antyder materialets art. Rullesten med 5–10 cm diameter er stedvis helt dominerende. Kildelokaliteten for dette materiale skal søges i en eller flere morænekerner, der i dag bl.a. afsløres af et moræneabrasionsflak N for Stenfed og Næbbet.

Dannelsen af Stenfed-Næbbet skyldes abrasion af morænekerner på det lavvandede strandplan. Stenmateriale er blevet frigjort og er blevet transporteret ind og indbygget i Stenfed-Næbbet, der derfor kan karakteriseres som en rullestensbarriereø.

Overskyl af materiale fra luvsiden bevirker, at Stenfed rykker mod N. Tilbagerykningshastigheden er størst i den østlige del E for det brede abrasionsflak. Her bevæger Stenfed sig mod dybere vand i Basnæs Nor, hvorfor overskylningshyppigheden forøges. Et smalt flak, beliggende N for Stenfeds østende er således reduceret i bredde fra ca. 100 m i 1939 til mindre end 50 m i 1970. Hvis tilbagerykninghastigheden holdes konstant vil en kritisk situation opstå omkring århundredeskiftet, når Stenfed rykker ud over det smalle flaks nordlige begrænsning. Der må forventes en voldsom udvidelse af det i 1967 dannede indløb til Basnæs Nor, og en yderligere tilsanding, evt. tillukning, af Basnæs Havn indløbet kan finde sted.

I 1939 var Stenfed gennembrudt V for Bredefeds vestende. N for gennembruddet dannede de indgående vandstrømninger et lavvandet flak, bestående af indskyllet sand (fig. 6). I 1954 var Stenfed atter intakt, men gennembruddet fra 1939 blev afsløret af en lagune i forlandet. I forbindelse med en orkanagtig storm d. 17/10 1967 og et ekstremt højvande d. 18/10 1967 (fig. 3) udvidedes et svagt brud gennem Stenfed, og i 1969 og 1970 blev det nye indløbs bredde bestemt til ca. 250 m. Efter 1967 er et krumoddekompleks opbygget ved vestenden af Bredefed, bestående af den rest af Stenfed, der forblev landfast med Bredefed og den nord for liggende strandvoldsflade, der er opbygget på det lavvandede flak, som blev dannet af det indskyllede sand fra 1939-gennembruddet. Krumoddekompleksets morfologi og ændringerne fra sept. 1969 til juli 1970 fremgår af fig. 5 og fig. 7.

Materialet til opbygning af Vesterfeds krumoddekompleks fremkommer for en stor del ved erosion af komplekset selv. Materiale, der er frigjort ved erosion langs NW-kysten under vestlig vind, vil blive ført mod NE til aflejring i kompleksets nordlige del. Samtidig mistes materiale ved erosion langs sydkysten. Her er erosionsevnen forøget, fordi indløbet bryder den østgående materialtransport i havstokken, hvorfor denne ikke er mættet umiddelbart E for indløbet. Dette forklarer den voldsomme erosion, der er konstateret ved krumoddekompleksets SW-kyst fra sept. 1969 til juli 1970 (fig. 7).

Det nydannede indløb mellem Vesterfed og Stenfed havde i juli 1970 en bredde på ca. 250 m, og dets udseende var ikke ændret væsentlig siden sept. 1969 (fig. 8). I den sydlige del af indløbet fandtes en stenet ryg, der er tolket som en tidligere beliggenhed af Stenfed-barrieren. Indstrømmende vand har dannet en indskylsbarre af sand N for indløbet. Denne er forsøgt afgrænset på fig. 9.

Sandtransport forbi indløbet kan ske over revlerne syd for indløbet. Derimod danner indløbet en effektiv afbrydelse af materialtransporten i havstokken. Ved bølgerefraktion vil materiale, der transporteres mod E langs Stenfeds sydside, blive indbygget i et krumoddesystem ved Stenfeds østende. Indløbet forhindrer desuden forbipassage af rullesten.

Bundtopografien i Basnæs Nor er bestemt af det oprindelige morænelandskab (fig. 9). Hvor morænen har ligget højt, finder vi i dag abrasionsflak. På disse har abrasionsprocesserne efterladt store blokke fra den oprindelige moræne. Den centrale dybe del af Basnæs Nor har virket som et sedimentationsbassin. Her skjules det oprindelige relief af tykke sedimentlag.

Hældningsforholdene på det sydlige strandplan er søgt anskueliggjort i tabel 2. Det bemærkes, at der er stor forskel på afstanden mellem kystlinien og – 3 m kurvens beliggenhed (A) samt på hældningerne E og W for indløbet til Basnæs Nor. S for indløbet har strømningerne forstyrret forløbet af brændingsrevlerne (fig. 9), mens deres forløb på den flade inderste del af strandplanet S for Stenfed derimod er meget regelmæssig. Brændingszonens aftagende bredde E for indløbet resulterer i tættere liggende revler. Brændingszonens bredde og revlernes forløb antyder begrænsningen af den oprindelige morænekerne, som dannelsen af de marine forlande er knyttet til.

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