Investigations within the Coastal Defence Project, 1993-96

In 1993 work on the project on 'Coastal defence in Denmark 200-1300 AD' - already mentioned in this Newsletter[1] was begun by Anne Nørgård Jørgensen. The aim of the project was to collect and make an assessment of information on coastal defences, socalled barrages, in Denmark.[2] In association with this there were also analyses of the cultural landscape in the hinterland of selected fjords with barrages.[3] In addition new investigations were carried out in the field, and in conclusion there was continued analysis of developments in military history, involving the holding of the symposium Military Aspects of Scandinavian Society and other seminars.[4]

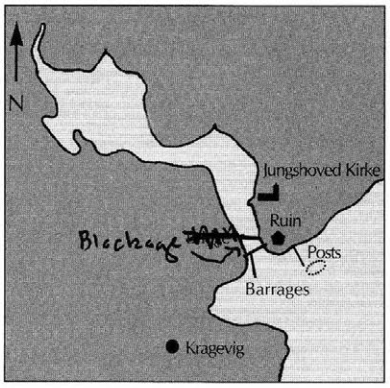
From among these subjects it is the field investigations that are the theme of the present report. From studies of the archives and cataloguing of the already-known barrage-material in Denmark it became clear that the main emphasis of the project would have to be placed on obtaining datable material, and on searching for new, hitherto unknown barrages. This led to the investigation of 11 barrage-structures in all, either in sea-water or in areas previously covered by the sea and now reclaimed, and to investigation of a few other coastal-defence structures (fig. 1). The total field-work was distributed between 10 maritime archaeological investigations and 8 land ones. It was possible to carry out so many maritime investigations because of the project, housed by the Centre at the same time, on 'Development of seismic methods of location of prehistoric and historic structures covered by seabed sediment', on which Ole Grøn was working.[5]

In the last three years work has been carried out on development of methods of seismic surveying on the seabed, and efforts have particularly focused on the use of the Chirp II system from Datasonics (CAP 6600), which gave specially good results with regard to barrages and harbour structures. In some cases it is possible to see individual vertical and angled posts, and also horizontal pieces of timber which show up as clear structures several metres down into the seabed-sediment. Unlike most older systems, which use signals with only one or two fixed frequencies, the Chirp system 'sweeps' the interval from 2 to 23 kHz.

Fig. 1. *Map of investigated structures.*



Fig. 2. *Jungshoved Nor. Section of barrage found by seismic surveying in 1995.*



This gives an improved combination of penetration-power and degree of resolution in the profiles created by the system. The profiles can be seen on a colour monitor during sailing and are also stored on exabyte tape. In order to retrace the structures (anomalies) which are seen in the profiles, sailing is combined with DGPS navigation (differential GPS satellite navigation). Experience shows that the extent of inaccuracy with this system when one makes observations in virtually straight lines is less than ±40 cm. When a diver has to dive down and find a particular recorded object of limited size, perhaps lying 50-100 cm down in a layer of soft mud, it is absolutely essential, given the expense of diving-time, to send the person concerned down precisely to the location of the object. Each second a DGPS position is also stored on the exabyte band, so that the seismic data and the location-data are stored in the same format. With the help of the Navipac programme from the EIVA firm it was possible to follow the sailing route on a monitor during sailing, so that the navigational course could be held precisely.

Jungshoved Nor, southeast Sjælland

One of the areas which attracted interest during the maritime barrage investigations was Jungshoved Nor, where the National Museum, during an excavation in 1980 in the ruin of Jungshoved Castle, had registered a structure with posts in the water to the south of the castle. In addition there was information from amateur archaeological investigations in 1964 about a possible bridge-structure. Three further investigations were carried out.[6] In 1994 searches were conducted in the cove for the ends of the bridge, using a conventional sediment echo-sounder, which guided the investigators to traces of a bridge-end, but was subject to too much influence from other natural phenomena on the seabed. Use of the Chirp II system in 1995 gave much better results. Traces were found of two barrage-structures which had blocked the mouth of the cove. The one further to the south (nearer the mouth of the cove) was 8-10 m wide and built of large horizontally-positioned oak trunks (fig. 2). A possible breakwater from a harbour-structure on the east side of the cove, and two structures which suggest interpretation as ferry landing-places connected with an old stretch of road were also located at this site. The system of posts which had earlier been identified south of the castle ruin was re-found and its position recorded. It proved extremely difficult and time-consuming, and therefore costly, to take up samples of oakwood for dedrochronological dating from the trunks in the 8-10 m wide barrage. After discussion with naval engineers it was decided to try to cut across the trunks using a controlled explosion instead of sawing them. The experiments showed that this method does less damage to the surrounding structural remains than sawing through them after having excavated in the seabed around the struc-

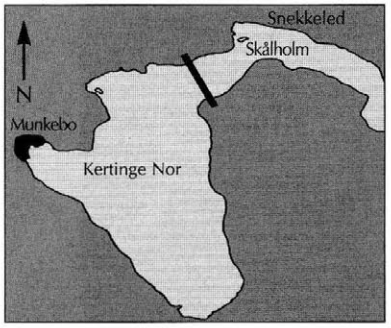


Fig. 3. *Munkebo. Post-system at Kertinge Nor, registered in 1996.*

ture. It has in fact been shown to be possible by this method to obtain good samples with fine sections, even from oak trunks one metre thick, without causing damage to other parts of the structure. The dendrochronological analysis unfortunately produced no result, and datings are now awaited from wood samples sent to the C-14 laboratory in the National Museum. These will establish whether the structures in the cove were associated with the history of the castle, which spans the period from around 1200 until it burned down in 1658.

Munkebo, Kertinge Nor, Fyn

Seismic surveying of Kerteminde Fjord was considered desirable for several reasons, partly because the National Museum's Institute of Maritime Archaeology (NMU) collected 14 wood samples from a post-construction at the narrow entrance to the fjord in 1989, and partly because of the Ladby ship, which is situated close to the coast near the fjord and is the focus of one of the centre's other projects. There is also a place-name in the area which may be associated with ship-building and fleet-harbours: Snekkeled.

In May 1996 survey-work with Chirp II produced the discovery of a structure in the western part of the fjord which was interpreted as a possible barrage. This structure was named after the adjacent parish of Munkebo (fig. 3). In August the same year diving was carried out at the site, and it turned out to be a stretch of thin poles, mainly of oak wood, three metres wide and 200 m long. Eight wood samples were collected, four of them for C-14 analysis.[7] There was an interesting structure in the middle of the fjord which looked as if it might be an opening for sailing access, but this could not be investigated at the same time because it was covered by up to 2 m of loose sediment. In relation to other barrages this is a minor structure. The hinterland of the bay has produced finds chiefly from the Roman Iron Age, indicating a high level of activity at that time. This probable barrage could well also be related, however, to the fact that the bay may have been an assembly-place for anchoring a unit of the fleet, which might have had an overland link to the west with Odense Fjord at Draget. It is hoped that the awaited dating will clear up the issues concerning the Munkebo structure.

Gudsø Vig, Kolding Fjord

One of the particularly interesting barrage complexes is Gudsø Vig, which was investigated by NMU in 1985. Then and on other occasions no fewer than four barrage structures came to light; Gudsø Vig IV, which is dated to the pre-Roman Iron Age, Gudsø Vig II and III from the Germanic Iron Age and Viking Age, and Gudsø Vig I, which is not fully registered, but from which datings are available to the late Viking Age and Middle Ages. After fruitless surveying for barrage Gudsø Vig I in May 1996, the area at the entrance to the bay behind the barrages was searched. Several previously unknown parallel structures came to light, cutting across precisely at the narrowest point.[8]

In one case, in relation to the structure known as D1, it could be observed during diving that it consisted of a single stretch of densely-branching large oak trees with clearly-shaped felling surfaces, placed root-end to tree-tip (fig. 4). The stretch of trunks was situated from the surface of the sediment-layer to about half a metre down into it. Immediately around the trunks and branches there was a deposit-layer of shell-debris and gravel. Since no vertical poles which might have fastened the trunks in place were observed this may well have been a floating barrage. Two samples were taken for dating. Beside a structure named D2 a band of shell-debris and gravel 0.5 m wide was found 5-15 cm below the surface of the seabed. The most logical explanation for this is that it silted up around a structure which was later removed. Similar conditions seem to exist along a stretch from the previously inspected Gudsø Vig IV to Hovens Odde.

Deposits of shell-debris and/or large particles around barrages are a phenomenon which is known from e.g. Margrethe's Bro and Æ'Lei in Haderslev Fjord, the Munkebo and Nakkebølle barrages, and from Henninge Nor. If the interpretation of the registered structures from Gudsø Vig as sailing barrages is correct, chronologically they must be assumed to be from between 600 and about 1300 AD, to correspond with the period covered by the other structures in the bay. Constructions which include large trunks have so far only been dated to the early Middle Ages in Denmark.

In addition to barrage structures an anomaly was observed between the little island of Krabborre and Hovens Odde in the south. Diving at the site produced evidence of a solid oak-wood construction which ran between the island and the mainland. Nearest to land it looked as though the construction consisted of actual caissons. The archaeologist Erik Jørgensen had earlier noted a structure on this site. Probably these are the remains of a bridge giving access to a medieval castle structure in Gudsø Vig.

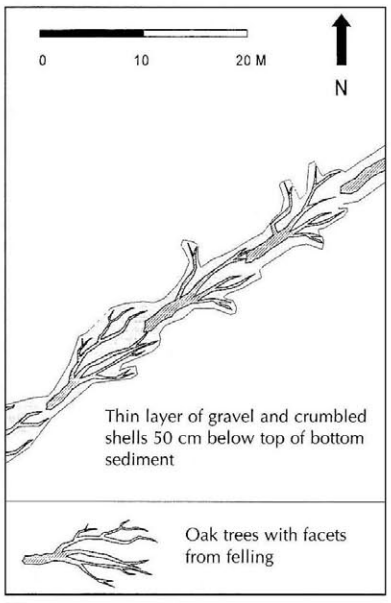


Fig. 4. Gudsø Vig. Barrage-structure D1, located in 1996, which raised the number of known barrages in Gudsø Vig to five (drawing by Ole Grøn).

Nakkebølle Fjord, southern Fyn

In 1965 Crumlin-Pedersen received information that some years earlier a boat-builder had found about 120 posts at the mouth of Nakkebølle Fjord. The timber had been used for furniture, carving-work and a garage. The amount of truth in this story is not known with certainty, but during the succeeding investigations Crumlin-Pedersen's attention was drawn to fence-posts of oak which were said to have come from the fjord. The barrage was supposed to have run from 'Kuske's' field to Limmerodde in an outward

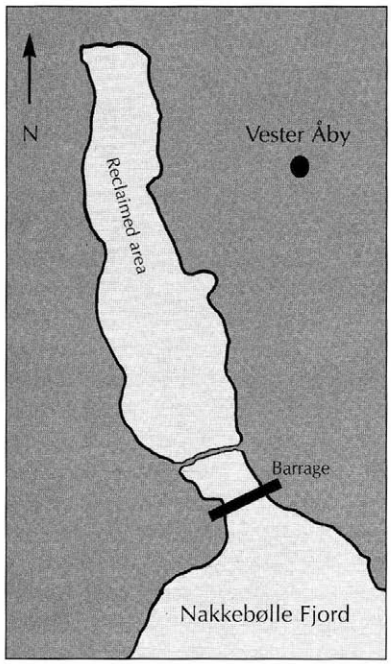


Fig. 5. *Nakkebølle Fjord. The strongly-built post-structure which was registered in 1996.*

curve, and the timber at the bottom of the fjord was still a problem for fishermen in the area. It was tempting to investigate the structure with the help of seismic surveying, and eventually this was carried out in the area in April, September and October 1996.[9] During this work two anomalies were registered with 40 m between them, on an ESE-WNW axis. The southernly point was a newly dug drainpipe from the refugee centre on the west bank of the fjord. The northerly one was the remains of a belt, up to 20 m wide, of large dispersed oak trunks surrounding a stretch of vertical poles, 1-3 m wide, which had probably served to fix the trunks. Samples for dendrochronological dating were taken from the northern structure using explosives (fig. 5). These samples are currently being dated in the National Museum.

Vordingborg, southern Sjælland

A structure consisting of two barrages, known as Queen Margrethes Stiger, near the ruins of Vordingborg Castle at the entrance to the North Harbour at Vordingborg, was investigated by Crumlin-Pedersen in 1978. An inner and an outer barrage were registered, together with a ship-wreck behind the inner barrage-structure, and all of these were C-14 dated to 11th-12th centuries. Beside the inner barrage another sturdy construction came to light, and this was thought to be the foundations of a tower. With the aim of establishing more information about this structure a diving investigation was begun in September 1995.[10] The structure turned out to be very robustly built. The south-western corner, which was excavated, consisted of a vertical corner post through which two beams had been inserted. In addition to the registering of this structure, measuring and re-registering of the timber found in the 1978 investigation was carried out. A large number of samples were taken, and they resulted in dendrochronological dating of the strongly-built structure to the years AD 1168/69. This structure could thus be securely situated in the context of Valdemar I's activities and the earliest history of Vordingborg Castle.

In the course of practice-exercises in the use of the then newly-acquired Chirp II equipment, an acoustic survey was carried out in the North Harbour at Vordingborg in October 1995.[11] The aim was to try out the equipment on a structure which was already known, and to investigate whether there were other structures which were not directly visible concealed under the mud in the harbour area. In spite of lack of experience with the equipment, it was possible to see both the known structures and other concentrations of posts

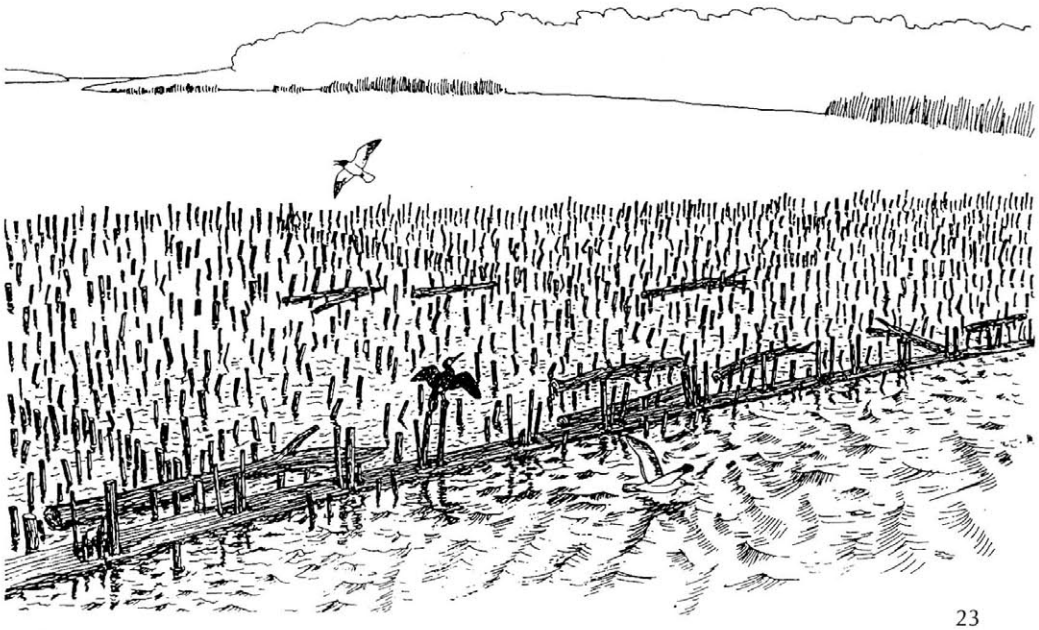
which might constitute repairs to them. It therefore became clear that further diving investigations in the North Harbour would be necessary, and that great care would be required in the event of future alterations to the use of the harbour area.

Margrethe's Bro and Æ'Lei, Haderslev Fjord

Margrethes Bro (Bridge) and *Æ'Lei* ('the Gate') in Haderslev Fjord is one of the best known barrage-complexes from Danish prehistory. The structure was built in the late 4th century and was later repaired several times; the latest dating so far is to the year AD 418. There is also a medieval barrage or bridge structure which is situated close to *Margrethes Bro*. The barrages have been investigated on a number of occasions, most extensively by NMU in 1989 as regards *Æ'Lei*, and in 1991 in the case of *Margrethes Bro*. Since those structures have previously been the subjects of surveys, they were clearly suitable for use as reference points in the testing of different seismic systems. This was carried out in 1995. At *Æ'lei* the stretch of posts was registered in a width varying between 15 and 30 m, while for most of its length it measured 25-30 m.[12] Margrethes Bro seems to have a complex structure consisting of several stretches which can be interpreted as building phases.[13] Further investigations will be necessary to establish more detailed information about these stretches of posts.

Investigations in reclaimed fjords

One of the special advantages in investigating barrages is that in several cases they are situated in former fjord-areas which are now dry land. This make the investigation itself much less demanding in terms of resources than maritime investigations, and at the



Investigations of barrages in Danish fjords and bays can contribute to our knowledge about periods of crisis in coastal defence. This is the Æ'Lei barrage from AD in Haderslev Fjord, reconstructed on the basis of the National Museum's investigations. Drawing by Jørgen Andersen.

same time one has the opportunity to register finds using normal excavation techniques, i.e. measuring and drawing under reasonable conditions. These tasks can be carried out relatively simply and inexpensively by any archaeological museum, and for that reason attention should be drawn to this type of find in the hope of generating interest among archaeologists and promoting the investigation of these structures. There is plenty of potential for this in the form of the 300 or so areas of reclaimed fjord-land in Denmark.

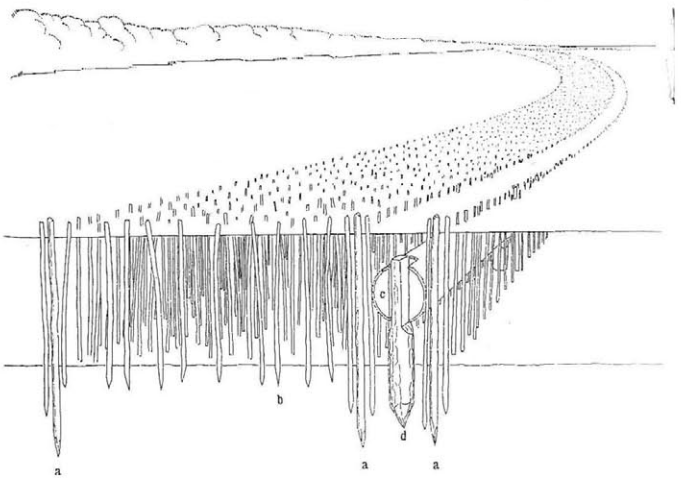
Hominde, Lolland

In 1933 the first Danish barrage-investigation took place in Rødby Fjord, or more precisely in Vestre Skarholmsrende, led by C.G. Schultz of the National Museum. This structure was located again in 1994 and is now a fully-documented barrage-structure.[14] The total extent of the Hominde barrage is at least 200 m. It is possible to identify the placing of Schultz's field precisely to within a centimetre, because the deep excavation which Schultz carried out over a field of 1.5 x 1.5 m, in order to see how far down the posts were in the subsoil, was located in 1994. At the deepest point in Vestre Skarholmsrende the barrage is up to 8.5 m wide, whereas at the ends it is only between 1 and 2 m wide. After the excavation a cross-section profile sketch was drawn up, to illustrate how deep the posts had been driven into the former seabed and also what earth-layers were observed in 1994 and in 1933 (fig.6). The newly completed dendrochronological investigations showed that the strong construction of the barrage, with its large horizontal trunks, was built in AD 1139/40. The results of the excavation have been described earlier in this Newsletter and will therefore not be given in detail here.[15]

Henninge Nor, Langeland

Like Hominde, the Henninge Nor barrage is a barrage structure in a former fjord-area, and it was investigated earlier in this century. Henninge Nor is in the northern part of Lindelse Nor, and the barrage itself is situated in the western part of Henninge Nor, between Lille Hestehave on the southern bank of the Kamsø coast, in the middle of the cove. In 1946 Haakon Berg from Langelands Museum investigated the barrage. Eleven years previously, in 1935, Jens Winther had registered a similar structure at Egholm, further NE. Although there were reports and photos available from 1946, it was nevertheless decided to locate the structure again in order to take wood samples for more precise dating. During the investigation, which took place in June 1996 under the direction of Langelands Museum, a field of 12.5 x 12 m, near the eastern shore, was exposed.[16] The barrage consists of stout, pointed, upright posts distributed over an area 1.5 m wide on the outer side of a belt of closely-packed thinner pointed posts, fig.7. The wood samples came from beech and alder, and four samples were

Fig. 6. Reconstruction of cross-section through the Hominde barrage. Drawing by Leif Hammelev.



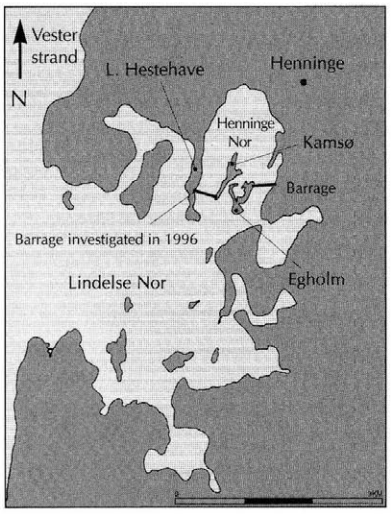


Fig. 7. *Henninge Nor barrage, which was investigated in 1996.*

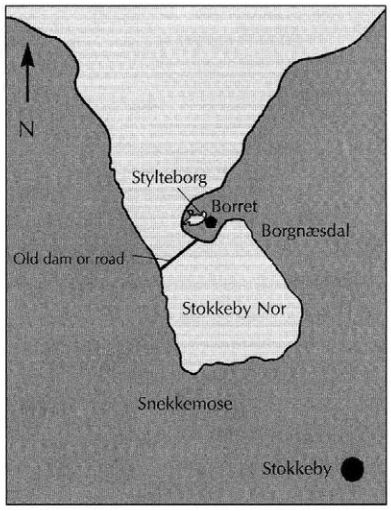


Fig. 8. *Stokkeby Nor with the dam and the place-names in the hinterland.*

extracted for C-14 dating in the National Museum. It is tempting to expect a dating to the Middle Ages, but it is still too early for this to be certain.

In connection with the investigation a maritime survey was made of Lindelse Nor, using Chirp II; it is suspected that there are several more structures hidden in other areas of the cove, but further seismic explorations would be needed to determine whether this is the case.

Stokkeby Nor, Ærø

Observation of a number of noteworthy place-names: *Stokkeby* (posts), *Snekkemose* (ship-name), *Ornum* (land belonging to the Church, a nobleman or the king), *Borgnæs* and *Borgnæs-nakke* (castle, earthwork) and finally the placing of the fortification of *Stylteborg* on the small island in the middle of the dried-up cove on the northern coast of Ærø, led to increased interest in Stokkeby Nor in 1995/96. Old maps from the 18th century also show a dyke/stone bridge running from Stylteborg across the cove and on to the west (fig. 8). It was decided to make a trial excavation in 1996 under the direction of Langelands Museum.[17] On that occasion the remains were found, 100 m west of Stylteborg, of a dam-like structure with a reinforcement on the north side, consisting of large boulders and the remains of bricks, with a cladding layer of turf on the south side. In the other trial ditches no traces were found of the dam, which is thought to have been placed higher up on the large sandbanks which exist in that part of the cove. The use of the dam as part of a road cannot be determined. Further archaeological surveying of the Stokkeby Nor area would certainly provide more information about what is indicated by the place-names, and trial excavations at other points in the cove might produce evidence of a possible barrage.

Investigation of other naval structures

Archaeological and historical articles often mention naval structures which are difficult to identify: e.g. fleet-harbours or watch- and warning systems.[18]

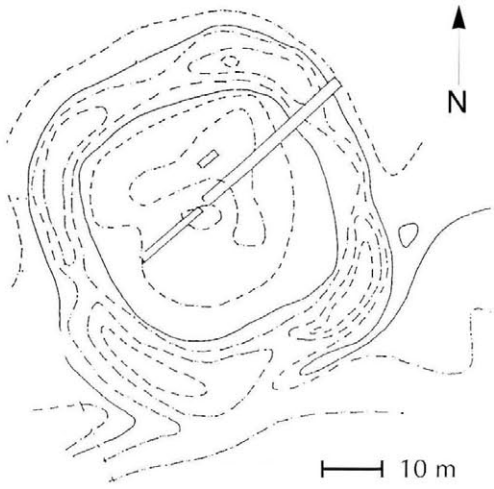


Fig. 9. *Borrebanken. Survey from 1961 by M. Brahde from the National Museum, and excavation areas from 1996.*

It is no easy task to trace and justify the theories put forward, but the attempt was made, within the coastal defence project, in one particular case, at Borrebanken on Isøre in north-western Sjælland. New investigations were also added to those previously undertaken at the well-known Kanhave Canal on Samsø.

Borrebanken on Isøre, Odsherred, North Sjælland

Borrebanken is a fortified site with four sides, situated on the Skansehage Bay about 100 m inland of the present shore. The mound measures about 40 x 40 m on the actual plateau, and is surrounded by a moat on all four sides. Borrebanken is situated in an area which is particularly interesting in the perspective of historical research; it is described in Saxo's account of the election of kings at the Landsting on Isøre.[19] The exact geographic situation of Saxo's Isøre is not known, however. In King Valdemar's Jordebog (register of estates) from 1231 *Ysør* is the isthmus which flanks the Isefjord to the west, the present-day parish of Rørvig.[20] The structure is mentioned by la Cour as possibly part of a watch- and warning-system, a socalled warth, inspired by the Carolingian and Ottonian defence systems which are known from written sources. This theory has since been expanded on by Crumlin-Pedersen, who suggests that there was a visual signal-system consisting of beacon-signals sent from Isøre through the Isefjord and Roskilde Fjord. This system should be seen in relation to the defence of Roskilde and the assembled *Leidang*. [21] After a preliminary soil-sample analysis in 1995, an actual excavation of the mound, the rampart and moat took place in 1996 in cooperation with the National Museum's Department of Archaeology and Early History (fig.9).[22] The purpose of the investigation was to confirm or counter the theory of Borrebanken as a warth structure. There can be no doubt that the structure is man-made, but no traces were found of a construction such as a tower. The mound is made entirely of soil and peat. The peat construction is most conspicuous in the central part of the structure and continues also into the moat, probably in order to retain the sandy soil. It is tempting to see the structure as a predecessor of the military structures situated on the Skansehage isthmus. Those structures are from the 1650s and were extended at the beginning of the 19th century. Rather than jumping to hasty conclusions about the age of the military structure on Borrebanken we now await the results of both pollen analysis and C-14 dating. The local historical interest in the Rørvig area is considerable and the investigation of the structure, which may be linked to the Landsting of the Viking Age and the early Middle Ages, continues indefatigably.

Kanhave, Samsø

The Kanhave canal consists of a dug trench which runs across Samsø at the island's narrowest point, from the Sælvig bay in the west to Stavns Fjord in the east. The channel is about 500 m long, 11 m wide and the banks in parts of the canal are clad with bulwarks consisting of 2-4 horizontal wooden planks. The stout timbers have square holes in them which allow them to be fastened in place with long wooden pegs, and they are reinforced by long, pointed, angled supports driven deep into the subsoil. The canal, which today is relatively dry and mostly grass-covered, is a conspicuous feature of the topography. The structure was investigated in 1960, 1977 and 1979.[23] As a result of extensive analysis of the year-rings in the samples of wood extracted from it, the structure has been dated to the year AD 726.[24]

The purpose - and result - of yet another investigation in 1995 was to provide documentation of the soil profile of a cross-section of the canal.[25] The profile was desirable chiefly for evaluation of whether there were other phases than the known one from AD 726. It has now been established with certainty that the period of functioning of the canal was quite short, that it was rapidly closed at the west end, and that the rampart on the north side of the canal belongs to the period of functioning in the 8th century. The rampart was not built using the 11,000 m≈ of soil which was dug up to make the canal, but was constructed of turf. There are a few signs of maintenance-work on the canal-bulwarks, but the construction clearly broke down; it is covered by material which can be dated to the late 8th century. The analyses of the complicated soil-profile are still in process. The 1995 excavation has earlier been discussed in this Newsletter.[26]

In addition to the sites discussed here, a trial excavation was carried out in the dried-up lake of Sundby Sø at Vilsund[27], as well as survey-work in a number of other dried-up areas which might potentially contain barrage-structures. In spite of the many new finds there is still extensive work to be done to locate barrages in the Danish coastal areas. By far the majority of finds registered to date come from the period of political instability in the 12th century when the country was plagued by internal conflicts and external threats from the Wends in the south.

As a result of the excavation work involved in this project there is comprehensive report-material and follow-up documentation available, including reports from the various participating parties. The following local museums have been involved in the project: Samsø Museum, Maribo Museum, Thy og Hanherred Museum, Langelands Museum, Odsherreds Museum and Vordingborg Museum. Those directly involved in the Coastal Defence project were Hugo Sørensen, Per Poulsen, Steen Ole Jensen, Lars Erik Skov Lassen, Line Dokkedal, Thorkild Thomasen, Nils Engberg and Bjarne Henning Nielsen. Cooperation with the National Museum's Scientific Investigations Unit was provided by Claus Malmros, Kjeld Christensen, Kaare Lund Rasmussen, Niels Bonde and Bent Aaby, among others, and by the National Museum's Wood Conservation Unit in Brede.

Anne Nørgård Jørgensen
& Ole Grøn

Notes:

1. 1995: 5; 1996: 7.
2. Nørgård Jørgensen 1997a.
3. Nørgård Jørgensen 1996b.
4. Nørgård Jørgensen 1993; 1995a; 1997b; 1997c; 1997d.
5. Grøn, et al. in press.
6. Report by Nørgård Jørgensen 22.8.1994; by Grøn 13.1.1996; by Jensen 30.6.1996.
7. Report by Grøn 7.1.1997.
8. Report by Grøn 19.1.1997.
9. Report by Grøn 7.1.1997.
10. Report by Dokkedal 1.10.1995.
11. Report by Grøn 9.4.1996.
12. Report by Grøn 18.3.1995.

13. Report by Grøn 6.1.1996.
14. Report by Nørgård Jørgensen 28.10.1996
15. Nørgård Jørgensen & Christensen 1996a; Nørgård Jørgensen 1996b.
16. Report by Sørensen 9.7.1996
17. Report by Sørensen, Langelands Museum, 11.11.1996.
18. Stiesdal 1964; la Cour 1972; Crumlin-Pedersen et al.1978.
19. Olrik's Danish translation of Saxo Danmarks Riges Krønike 1970, vol. I, 113, vol. II, 216, 253 and 285; vol.III, 103 ff and 180; Koch: Politikens Danmarkshistorie vol.3, 1963.
20. Trap Danmark III:2, 542; Kong Valdemars Jordebog II, 201.
21. Crumlin-Pedersen 1978.
22. Report by Nørgård Jørgensen 12.10.1995; Nørgård Jørgensen 14.3.1997.
23. Stiesdal. 1964.
24. Christensen 1995.
25. Report by Nørgård Jørgensen 31.5.1995; Nørgård Jørgensen 20.6.1996.
26. Nørgård Jørgensen 1995b.
27. Report by B. Henning Nielsen, Thy og Hanherred Museum, 1.8.1997.

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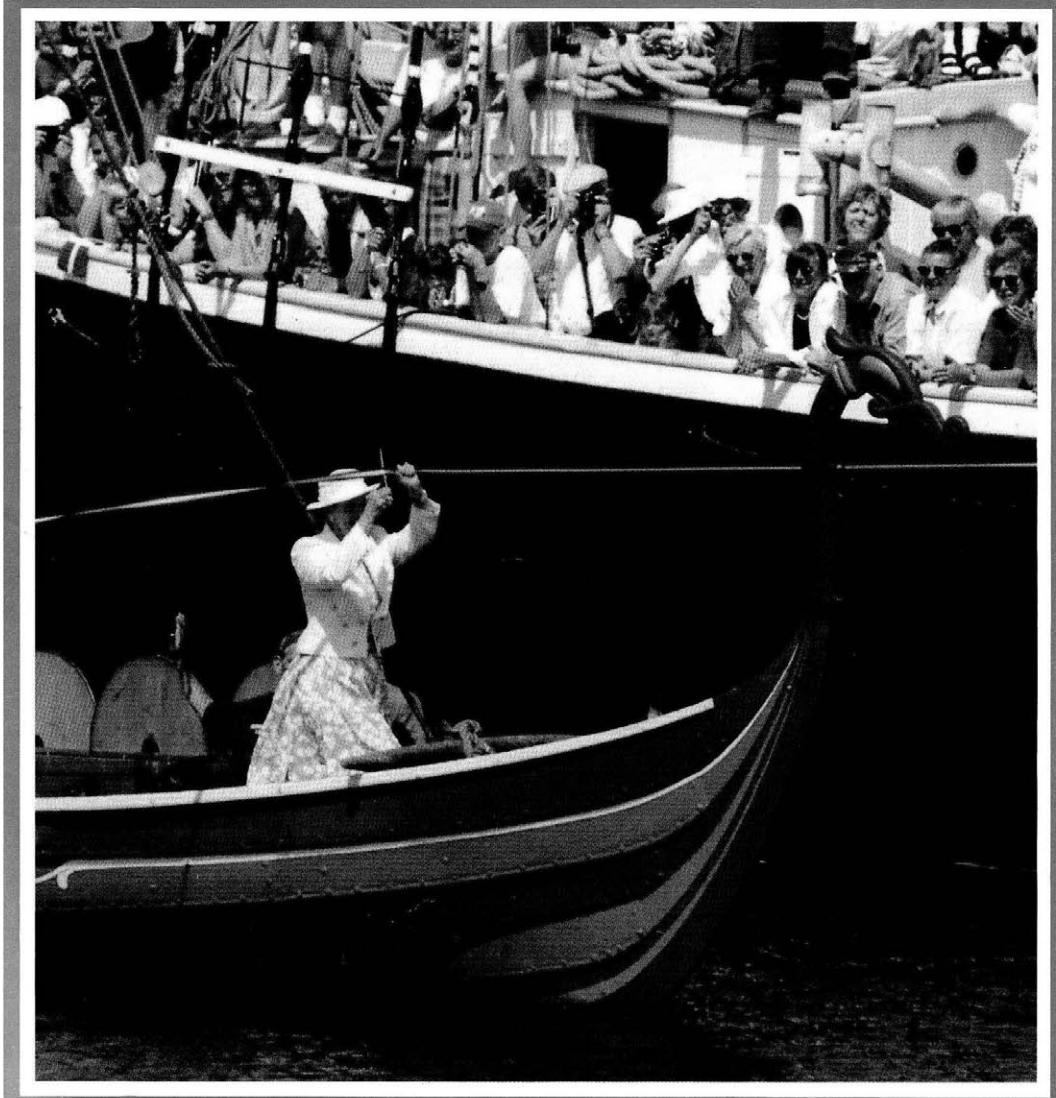
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Grønnegaard Harbour from a drawing from 1756, when the site was owned by the West India-Guinea Company, showing the positions of the ships in the find-complex. Drawing by Christian Lemée.

Datings:
1. 1584. Extended in 1608
2. 1606. Sheathed in 1622
3. 1607
4. 1582
5. 1644
6. Not dated
7. 1588
8. 1738
Slipway: 1744/1770/1821

Maritime Archaeology Newsletter *from Roskilde Denmark*

No. 9 · December 1997



Standing at the prow of the Viking ship Helge Ask, *Her Majesty Queen Margrethe II inaugurates the new museumsarea. Photo Benny Hansen.*