Harvesting underwater meadows, use of eelgrass (*Zostera* spp.) as indicated by the Dutch archaeological record

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JALC
JOURNAL OF ARCHAEOLOGY IN THE LOW COUNTRIES

Review data:
submission 11/12/2008
revision 19/1-2009
2nd submission 31/3/2009

available online at www.jalc.nl and www.jalc.be

Abstract

The main focus of archaeology and its derivative disciplines tends to be on the most common remains from the past. In archaeobotany, for example, there are ample opportunities to study food production and consumption. It is, however, rare that an opportunity presents itself to study different uses of vegetable material. From this perspective it should be interesting to present the case of a different kind of historically documented resource, namely eelgrass (Zostera spp.). Archaeological finds of eelgrass are indeed quite rare. This paper will present a summary of all the documented instances in which eelgrass was discovered in archaeological contexts in the Netherlands, on the basis of available literature and field research in which the author was involved.

Keywords: archaeobotany, eelgrass, *Zostera*, vegetable resources, Noord-Holland, Friesland

1 Eelgrass – a short description

All species within the genus *Zostera* are submerged, hydrophytic plants, growing in salty to brackish water. Only two species are endemic in the Netherlands: (common) eelgrass (*Zostera marina*) and dwarf eelgrass (*Zostera noltii*).

Even though not closely related to true grasses (Poaceae), eelgrass has some more or less similar morphological features, hence the name. Common eelgrass has leaves of about one metre long and roughly half a centimetre wide (Fig. 1). The leaves are connected to stems growing from a perennial rhizome. Like grass the species can easily propagate through its rhizome, forming extensive mats. Dwarf eelgrass is of similar shape, but smaller in every aspect (Fig. 2). The two species prefer a slightly different ecotope: common eelgrass appears in a zone between just above and up to several meters below low-water mark, while dwarf eelgrass grows in the zone between low and high- water mark (Hegi 1981, 203-213).

Fig. 1a: Dried common eelgrass (Zostera marina). (photo by author)

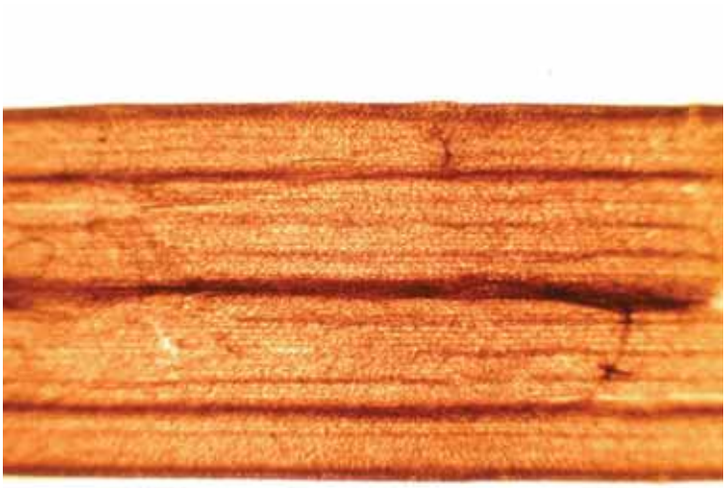

Fig. 1b: Picture of common eelgrass (Zostera marina) leaf. (magnification 40x, photo by author)

Fig. 1c: Picture of common eelgrass (Zostera marina) fruit. (photo by author)

Fig. 2: Picture of dwarf eelgrass (Zostera noltii) fruit. (photo by author)

2 Historical use of eelgrass

Nowadays eelgrass is rather rare in the Netherlands. Human activity and a wasting disease resulted in mass extinction around the 1930's. Before that time, however, large areas of the Dutch coastal waters were covered by extensive underwater 'meadows'. This was especially true for the many extensive shallow areas like the northern coast of the former Zuiderzee, the Wadden Sea and the many shallow coastal waters in Holland and Friesland that were later reclaimed on the sea (Weeda *et al.* 1991, 265-268). Of course, the dynamics of the Dutch coast mean that circumstances may have been favourable for eelgrass in one period, and less so in the next.[1] Nonetheless, the northern Dutch coast was probably increasingly favourable to eelgrass from the Bronze Age onwards, owing to the increasing area of tidal flats (Zagwijn 1986).

In autumn the eelgrass leaves die off and fall from their stems. As a result the many long and intertwining leaves of the plants in the meadows will form large floating islands. These islands can be netted and dragged ashore. Also, when washed ashore by itself, dying eelgrass can easily be gathered from the beach or from the slope of a dike. From 19th-century records it is known that eelgrass was also mown with scythes (Alan 1855, 14).

In recent times, eelgrass was an important source of supplementary income for the inhabitants of the former islands of Wieringen, Schokland, Urk, Texel, and Terschelling, as well as the town of Elburg. Its prime use was as stuffing in pillows, mattresses and furniture. Older sources also note other purposes for this abundance of long, springy leaves, not least of them the construction of medieval dikes.

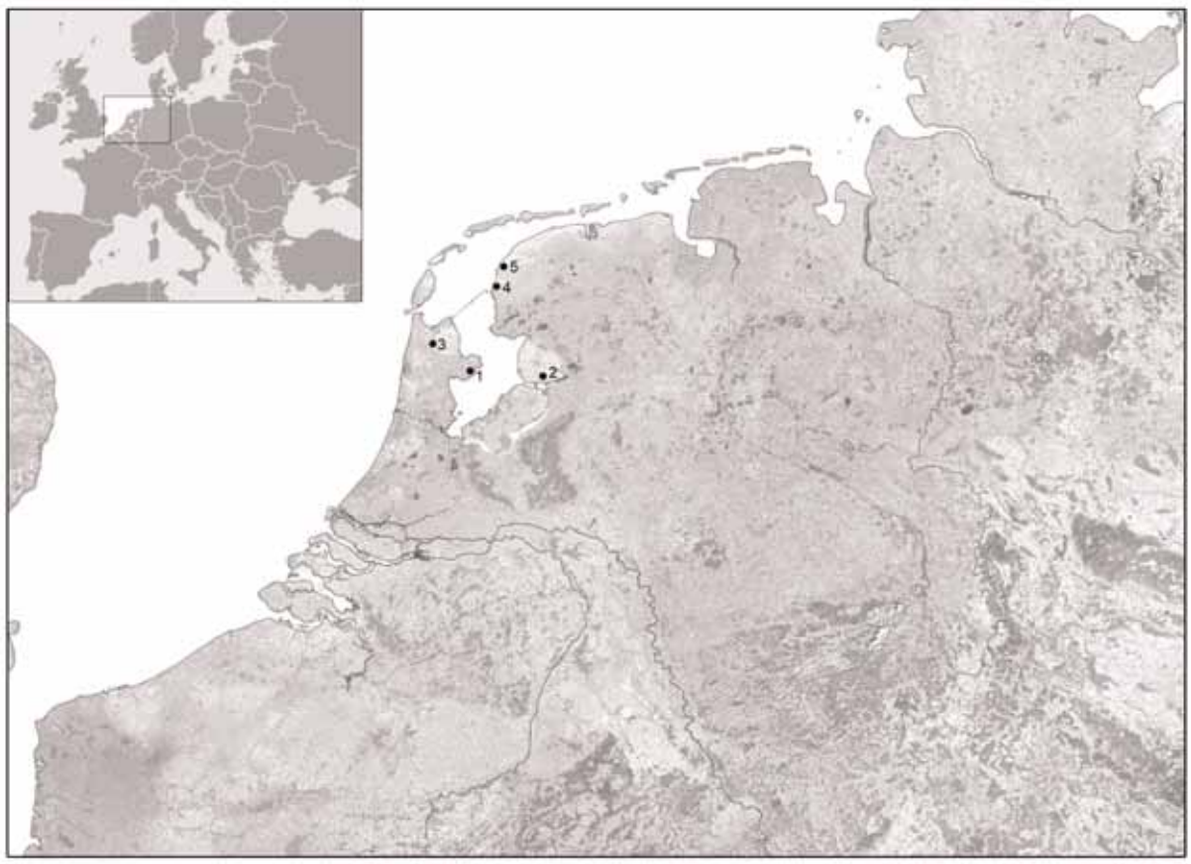

Fig. 3: Location of discussed sites: 1 – Southern part of Westfriese Omringdijk; 2 – Schokland; 3 – Kolhorn, Paludanus'road; 4 – Kimswerd, Zürich; 5 – Wijnaldum.

3 The dike of West Friesland – seaweed dikes (Fig. 3: 1)

It's a fairly well known fact that eelgrass was an important element in the construction of sea dikes in the Northern Netherlands. Dikes constructed this way were called 'seaweed dikes' (*wierdijken*) and they were the main line of defence against the sea for the coasts of West Friesland, Friesland and the islands of Wieringen and Schokland (Van der Heide 1992, 78). The first time eelgrass is mentioned in connection with a dike is in a text from AD1319 that deals with apportioning the liability of maintaining the dike that protected West Friesland: the Westfriese Omringdijk (Gottschalk 1971, II, 289; Borger & Bruines 1994, 21). The omission of any kind of technical detail on the use of eelgrass implies that it probably already was a well-known technique at that time: '*Every man in Frisia will make his [part of the] dike… with earth the earthen dike and with seaweed the seaweed dike.*' (Beenakker 1988, 191).

Many historical seaweed dikes are still preserved under modern dike bodies. There are, however, not many instances in which these dikes have been examined archaeologically and archaeobotanically. Yet on many occasions sections were made trough modern dikes (Van Geel *et al.* 1983; Danner *et al.*, 1994), and part of a seaweed dike was reconstructed recently in Wieringen. Also, in the recent project for the reinforcement of part of the Westfriese Omringdijk, strict archaeological supervision means that there will be plenty of opportunities for future research.[2]

A seaweed dike consists of an earthen body which is protected on the seaward side by a 'belt' of compacted eelgrass. This 'belt' is fixed to the earthen body by rows of posts and the base is further protected by bundles of brushwood. The intertwining eelgrass leaves protect the

earthen body, that forms the real barrier, from foundering (Blankaart 1698, 275-276). As such seaweed dikes took over the function of the foreshore, as the land available for this purpose was rapidly diminishing since the development of the Zuiderzee in the twelfth century AD (Danner *et al.* 1994). Large-scale use of eelgrass protection started only in the fifteenth and sixteenth century AD, when there was hardly any land left to be given up as foreshore. Still, even then only those segments of the dikes that were in immediate danger from the sea would be protected by an eelgrass belt. This use of eelgrass continued until 1730, shortly after the advent of the pile worm (*Teredo navalis*) which destroyed the posts fixating the eelgrass.

According to some sources, the belt of eelgrass could sometimes measure about seven meters high and four to seven meters thick (Schilstra 1974, 26-30). Sections, however, suggest an average of about four by two meters. Every two or three years the top layer of the belt had to be repaired, and once every century or so the entire belt had to be replaced. Also, the eelgrass that was to be used had to be freshly fished up, not gathered on the beach, and it could not be older than 4 days when used for construction.

Taking into consideration that we are speaking of several hundreds of kilometres of dike bodies in the northern Netherlands, and that every six cubic metres of fresh eelgrass yielded only one cubic metre of compressed eelgrass, the amount of eelgrass used must have been staggering, even if not all parts of the dikes were protected by a belt like this. It probably also means that from the 15th century onwards the gathering of eelgrass acquired commercial possibilities because of the rising demand, in combination with the outsourcing of construction work to contractors

4 Schokland – bottom or top? **(Fig. 3: 2)**

A second piece of evidence of eelgrass use comes from Schokland, before its incorporation into a large polder in the 1930's a small island in the Zuiderzee. During archaeological supervision of the reconstruction of a 16th/17th C. water well there, a layer of leaves of dwarf eelgrass was found on the bottom of the well (Brinkkemper 2007). Water wells are frequently found with a layer of plant material or coarse sand in them, probably for filtering. Eelgrass may have been used in this way. It is also possible that the eelgrass was part of a roof over the well. Linnaeus mentions that the 18th-century Dutch made almost indestructible roofs out of eelgrass (Houttuyn 1793, 245). This indestructibility can perhaps be attributed to its fire resistant qualities, as well as to its resistance to decay.[3] This last property can be attributed to the presence of Zosteric acid in the leaves, which inhibits the activity of micro-organisms (but apparently not the fermenting agent mentioned below) (Davies *et al.* 2007).

Earlier excavations on Schokland had also yielded a layer of eelgrass leaves. This was not documented during the excavation, but the layer seemed to date to the 16th or 17th century AD (Brinkkemper 2007, 83). The excavator interprets them as the remains of a seaweed dike (Van der Heide 1992, 78-79). The same excavator, incidentally, mentions eelgrass that was used as insulation in the walls of the 15th-century monastery of Elburg, a medieval city on the shores of the Zuiderzee, not far away from Schokland. The publication on the restoration, however, does not contain any information about the presence of this species (Jeletich-Visser *et al.* 2005).

5 Paludanus' Road – salt extraction **(Fig. 3: 3, Fig. 4)**

In 1995 excavations uncovered a strip of peat embedded in marine sediments at Kolhorn in the province of Noord Holland, just to the north of the northern part of the Westfriese Omringdijk. The strip of peat is the last remaining part of an extensive peat bog that was almost completely dug up. This 'road' was found to contain many pits along its surface, containing large amounts

of charred and waterlogged remains of eelgrass. Accurate dating of these pits proved to be impossible, but they must have been used somewhere between the 12th and 17th centuries AD. These particular remains are interpreted as remains of a salt extraction process that has been mentioned in the literature (Van Geel & Borger 2002; 2005).

Even though the exact method is not quite clear, it is known that in medieval times the inhabitants of the Dutch coast made salt out of peat that had become infused with seawater due to flooding. The peat was probably burned on the spot, the ashes were leached, and the resulting brine boiled down to extract the salt. Apparently this 'road' near Kolhorn served as a place where the diggers could burn their peat for its salt-containing ashes.

Presumably the peat digging turned the area surrounding the site into a lagoon, supporting a dense vegetation of eelgrass. Since no more peat could be dug up in the lagoon, the salt makers turned to the eelgrass, continuing the process with dried eelgrass instead of peat. The scale on which this was done seems to have been fairly large (Van Geel & Borger 2002).

The main historical source for this activity is Linnaeus, who discusses the uses of eelgrass in Denmark (Houttuyn 1793, 243-244, 704). The quality of the salt obtained this way was poor, but it could be used to preserve fish and meat. Salt was a very precious and vital commodity in the Middle Ages and Early Modern period, so the practice may have been economically viable or even necessary. Potash (potassium carbonate) could furthermore be obtained from the ashes, an important resource for glass and soap making.

Secondly, the burning of eelgrass may have served as a method to produce fertilizer. In Normandy washed up sea vegetation (called *warec*) used to be collected and applied either burned or fresh as a fertilizer rich in potash and other minerals (Van Ravelingen 1644, 780-782). Eelgrass would in this respect be inferior to true algae (*Laminaria* spp., *Fucus* spp., *Ascophyllum* spp.), which contain more potash. Yet there is evidence that coastal communities used eelgrass as fertilizer if there was no alternative, although there is no specific record of burning it (Wyllie-Echeverria & Cox 1999; Alm 2003).

Fig. 4: Ploughed up plaques of eelgrass from the area of the Paludanus' road. (photo by author)

6 Kimswerd – desalinating eelgrass? (Fig. 3: 4)

Samples from the excavation of an settled embankment along a tidal creek at Zurich (Friesland) that were examined by the author yielded a large number of waterlogged seeds from both eelgrass species as well as many eelgrass leaves (Van Haaster 2006; Waldus 2007). The samples were taken from a large rectangular pit (2x1.5x1.9 m) that had been dug into clay and was connected to a water supply system. This system consisted of small canals connected to water wells for fresh water, and a canal connected to the tidal creek for salt water or drainage. All features were contemporary and dated to the 12^{th}-13^{th} century AD.

The pit was filled with a compact mass of eelgrass leaves. Among the eelgrass were shells of different molluscs, seeds of local vegetation and 'settlement noise'. Many of the mollusc shells were eroded and belonged to subterraneous species (Kuijper 2007). This probably means that the leaves were gathered on the beach.

The eelgrass seems to have been purposely stacked below groundwater level. Taking the fresh water supply system into consideration, this might indicate a desalination process. If the sea salt is not removed from the eelgrass its hygroscopic properties will cause it to attract moisture and start fermenting, producing a very strong smell and rendering the leaves unfit for a number of purposes.

Desalinated eelgrass can be used in several ways such as thatch, stuffing and isolation. The way in which the leaves at Zurich were compressed, however, would make desalination difficult. Perhaps the material was just put there for storage. Storing underwater may have been a way to keep it fresh, for example to make it a more attractive fodder, as a kind of silage. Other known agricultural uses for eelgrass are: green fertilizer, bedding for livestock and mulch (Wyllie-Echeverria & Cox 1999; Alm 2003).

7 Wijnaldum – seaweed for cattle? (Fig. 3: 5)

During the excavation of the settlement mound (terp) of Wijnaldum in the province of Friesland, charred fruits of *Zostera marina* were encountered in a pit dated to the 6th-7th century AD. The same pit contained charred barley grains and many grass-stem fragments as well as some seeds and fruits from pioneer, grassland and saltmarsh vegetation (Pals 1999). Excluding fire accidents, charred seeds of eelgrass can only be the result of using the plants either as a source of minerals or as a fuel. However, eelgrass does not burn very well by itself, so it was probably not the first choice for fuel unless the aim was not warmth but, for example, smoke. In the treeless surroundings of the tidal flats, dried dung might, however, take over the role of firewood, and this dung might have contained eelgrass fruits, as is suggested by J.-P. Pals. And indeed, the other wild species present in this feature do summon up an image of a grazing meal on the high and low saltmarsh. It is furthermore documented that cows enjoy eelgrass, once they acquire the taste, walking into the sea to obtain it, and that Scottish farmers would use it as fodder (Houttuyn 1793, 245). In western Norway, eelgrass was fed to cattle, sheep and horses in winter. When dried, farmers cooked it into a swill, or mixed it with other fodder to make it more attractive to their livestock (Alm 2003).

8 Conclusion

Recent history shows that eelgrass was of some value to small coastal communities, providing them with an easily collectable vegetable resource that served different purposes in construction and agriculture. Contrary to many other natural resources, collecting drifting eelgrass had a minimal impact on ecosystems important to human society. Even though earlier use is very

likely, archaeological finds can only trace the use of eelgrass in the Netherlands as far back as the Early Middle Ages. One cannot argue from the absence of evidence, but it is possible that before the Early Middle Ages the ecologic requirements for eelgrass to flourish were not yet present in the Netherlands. The first real evidence for the processing of eelgrass comes from the High and/or Late Middle Ages, when it was apparently burned for mineral extraction, most likely its salt. At this time eelgrass could potentially be used to create a marketable commodity, but one of probably low quality and value. From the High Middle Ages onward its greatest value for the Dutch would be as a material for dike reinforcement. Suddenly eelgrass would be in great demand, probably stimulating the development of a sideline industry for fishing villages and other coastline communities. Even after eelgrass ceased to be used in dike construction, after the early 18th century, the industry continued when new applications were sought and found in connection with furniture making. When the eelgrass all but disappeared from the Dutch coast, the industry went with it. Excluding the fairly late large-scale application of eelgrass in dikes and, afterwards, furniture making, other uses of this plant remained very localized, finds being restricted to those areas where it occurred naturally. Its name seems to reflect the purposes it was used for. Like true sea algae, it was collected for manure, mulch or as a source of minerals, while on the other hand it could replace real grasses for thatching, cattle fodder or bedding for livestock.

Acknowledgements

The author would like to thank Dr. L. Kubiak-Martens, Dr. L.I. Kooistra, Dr. H. van Haaster, W. Kuijper and A. Brokke for their help during research and writing, and also G. van der Kleij for proofreading the resulting text.

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Notes

1. One of the most important changes in historical times must have been the development of the Lake Al (Almere) and later the Zuiderzee, which seriously enlarged the habitat for this species.
2. Under the direction of A. Brokke (Arcadis), the author participates in the project as an archaeobotanist.
3. US-patent 4016084 (1977) concerns compressed common eelgrass leaves as a fire retardant.

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