This thesis deals with faunal remains from Neolithic settlements in the Holocene sedimentation area of the western and central Netherlands. The aim of the study was to answer questions concerning the development of stock-keeping and hunting in an exceptional environment, the functional variability of settlements and the possible seasonality of their occupation. In this way it was hoped to obtain a better understanding of the function of the settlements within their societies, their adaptation to the environment over a period stretching from c. 4350 to c. 2000 cal BC and the process of transition from an economy of hunting and gathering to one of husbandry and crop cultivation.

The faunal material from three sites was studied: Swifterbant, Hazendonk and Kolhorn. As for the first site, the remains came from the site known as "S3", which was situated on a low-lying levee alongside a creek. A large single unit was excavated, representing more than half of the actual settlement. Most of the material came from the settlement itself, and was rather fragmented. A small number of well conserved bones were found during the excavation of a small section of the creek next to the site. Contrary to that of Swifterbant, the bone material from Hazendonk comes from dump areas in the margins of the settlement, along the slopes of the river dune. The remains would mainly have been thrown directly from the dune by the inhabitants. After its abandonment, the top of the dune was disturbed by bioturbation. The main part of the bone material comes from the third phase of habitation, the Hazendonk-3 phase (Middle Neolithic A) and from the fifth and the sixth phase, the Vlaardingen-1b and Vlaardingen-2b phases (Middle Neolithic B and Late Neolithic A, respectively). A smaller number of bones come from the earliest phases, Hazendonk-1 and -2 (Middle Neolithic A), while hardly any bone material from the fourth (Vlaardingen-1a) phase was recovered.

The site of Kolhorn (Late Neolithic A) can be divided into two subsites: the northern and the southern site. Until now it is not known whether these sites were contemporaneous or not, nor whether there are any other differences between the two. Because of the enormous amount of material, only samples were studied from parts of the various sectors that were excavated. Apart from this, the bone material from two series of samples from a well (situated in the southern site) was studied.

In order to obtain a more complete picture of the economy in the Dutch Neolithic, the results of these investigations were compared with the zoological, botanical and ecological data from fourteen other Neolithic sites in the same area.

In terms of environment, three different groups can be distinguished among the sites discussed in this thesis. One group was located in the freshwater marshland of the Holocene delta of the rivers Rhine and Meuse. The second and third groups were located in the coastal region: one in the Older Dunes, the other in the saline and brackish environments.

Both Swifterbant and Hazendonk belonged to the group of sites in the freshwater marshes, while Kolhorn was situated in the saline and brackish area on the coast.
One of the most striking aspects of the faunal spectra of Swifterbant and Hazendonk is the high frequency of remains of fur animals (mainly otter and beaver). In spite of this, pig and wild boar are the most numerous species in Swifterbant.

The faunal spectrum of Hazendonk fluctuates remarkably in the course of time. Not only does the ratio of domestic mammals (mainly cattle) to game species become smaller in the successive phases of habitation, also the proportions of the individual game species (such as red deer) vary considerably.

As for Kolhorn, one of the most striking differences compared to Swifterbant and Hazendonk is the far greater role of birds in the faunal spectrum, both in numbers of remains and in number of species. Other notable features are the high frequency of remains of small rodents, as well as the small number of bones of fur animals.

The fish remains, both in Swifterbant and Hazendonk, comprised mainly freshwater species, while in Kolhorn only marine species were present. Moreover, large amounts of mussel shells were found at Kolhorn.

Though not for red deer, aurochs, horse, elk and sheep/goat, the wet, wooded landscape in Swifterbant must have been very suitable for the species represented in the bone material.

The fluctuations in the frequencies of some of the species found in Hazendonk seem to be related to the changes in the landscape. In all phases the relatively low frequency of pig/wild boar, compared to Swifterbant, is remarkable, since at both sites the conditions seem to have been favourable for this species.

The environment at Kolhorn seems to have been suitable for sheep/goat and otter. Nevertheless, only a small number of remains of these species were found here. For the birds, rodents and some of the other mammals found in Kolhorn, the conditions must have been very favourable. Their remains point to an open, wet and treeless environment with a maritime influence. This roughly corresponds with the results of the study of mite remains from the well (Schelvis 1989).

It appears that at Swifterbant game species and domestic mammals played a more or less equal role in the meat supply. Pig, wild boar, cattle and beaver are the most important species in this respect. Other mammals as well as birds seem to have played only a minor role in the diet of the inhabitants of S3.

The role of the various species in the subsistence of the Hazendonk people varies considerably through time. In the earliest phases, Hazendonk-1 and -2, cattle seems to have been the most important species with regard to the meat supply. Notably in the Vlaardingen-1b phase, red deer seems to have gained predominance. Beaver is an important species in all phases. The role of roe deer becomes more important from the Hazendonk-3 phase onwards, while pig and wild boar seem to have made a smaller but fairly constant contribution to the meat supply in all phases. As at Swifterbant, birds seem to have played only a minor role in this respect. On the whole, the role of domestic mammals in the meat supply decreases in the course of time, while that of the game species becomes more important.

As for Kolhorn, cattle appears to have been by far the most important species for the meat supply. Pig and sheep, as well as wild mammals, seem to have played only a modest role. Both at Swifterbant and Hazendonk, marks or bones of fur and meat animals were found, as well as the remains of fish, shellfish and other species. The age structure of the bone material from the well at Hazendonk indicates that the population was more than one year old.

Although there are no indications of a special occupation at Hazendonk, the question of a special occupation cannot be excluded. In general, the occupation seems to have been at least in some phases, like a camp that was used for breeding stock and for hunting. At Swifterbant, the occupation continued through the centuries, and the Vlaardingen-1b phase seems to be an important occupation. At Swifterbant, the occupation seems to have continued from at least January. In the case of Swifterbant, the natural occupation seems certain. The occupation at Vlaardingen seems certain. In the case of Hazendonk, the occupation seems certain. In the case of Kolhorn, the occupation seems certain. In the case of Kolhorn, the occupation seems certain.
Birds probably were far more important for the meat supply here than at Swifterbant and Hazendonk.

Both at Swifterbant and at Hazendonk beavers and otters were hunted both for their fur and meat. The same probably applies to the Kolhorn animals, although no cutmarks or burning traces were found on the remains. The method of skinning otters at Swifterbant and Hazendonk, and polecat at Kolhorn, seems to have been the same as that described by Trolle Lassen for the Mesolithic otters and polecats of Tybrind Vig.

The age structures of the hunted populations of fur animals at Swifterbant and Hazendonk indicate selective hunting by the inhabitants of these sites of animals older than one year. The same seems to have been the case with the polecats at Kolhorn.

Although the faunal material from Swifterbant, Hazendonk and Kolhorn provides indications of the seasons in which the sites were occupied, the data do not answer the question of whether at the three sites we are dealing with seasonal or year-round occupation. Evidence of human activities in a specific season does not exclude occupation during the rest of the year.

In general, the presence of remains of domestic mammals in all three sites makes it clear that people were present over a longer period. Although it is evident that especially at Hazendonk the hunting of fur animals was an important activity or even, at least in some periods, one of the main activities, the site cannot be characterized as a camp that was used only for this purpose. In the earliest phases of habitation cattle breeding seems to have been even more important in terms of subsistence than hunting. Although in the course of time its role became less important, people continued to engage in cattle breeding. Moreover, not only fur animals were hunted on a large scale, but also other game species, as the large numbers of red-deer remains in the Vlaardingen-1b period indicate. In all phases fishing too seems to have been an important activity of the Hazendonk people.

At Swifterbant, it seems that the slaughtering of pigs took place mainly between spring and early autumn. The data on cattle with respect to the time of slaughtering, and the presence of sturgeon and thin-lipped grey mullet point to the same period. A small number of pig bones indicate slaughtering in autumn and winter, and the remains of swans point to human activities in the same seasons. Of the beaver remains, one indicates killing in midwinter. The age distribution based on the mandibles of beaver seems to point to their being caught on a year-round basis, but this is not certain. As for the otter, the few data available indicate catching between July and January.

In the case of Hazendonk the amount of data on age distribution of pig, cattle, beaver, red deer and roe deer is limited. Consequently, they do not provide a clear image of the nature of the habitation nor do they allow any conclusions about probable changes through time. In any case it can be concluded that in all phases the site must have been occupied between spring and late autumn or early winter. One roe deer from the Vlaardingen-2b phase probably was killed in midwinter. As at Swifterbant, the presence of swan bones (Hazendonk-3, Vlaardingen-1b & -2b) indicates human presence between late autumn and early spring, while remains of sturgeon point to a
period between spring and (early) autumn. At Kolhorn indications of seasonality are mainly provided by the bird remains. Three species point to catching in the period between spring and late summer or early autumn, as do the remains of thin-lipped grey mullet. Three other bird species indicate fowling between (late) autumn and early spring, while mussels must have been harvested in the same period. The presence of sturgeon at Kolhorn cannot be used as evidence of seasonality, owing to the site's location on the coast. In at least one case cattle was slaughtered in spring or summer.

The fact that at all three sites there are indications of human presence the year round, may lead to two different conclusions. Either people lived there throughout the year, or only between spring and autumn, bringing their livestock with them from a base camp and returning in winter only for hunting and fowling.

If one assumes that Swifterbant, Hazendonk and Kolhorn were occupied throughout the year, then the inhabitants could have practised different activities in different seasons. For instance, beavers could have been caught especially between late autumn and early spring, although at Swifterbant and Hazendonk the data on age distribution suggest a pattern of year-round catching. The fact that at Swifterbant the age data of the domestic mammals suggest that slaughtering took place also between late autumn and early spring seems to support the theory of permanent occupation. Yet this theory is doubtful, because the conditions for winter occupation in Swifterbant must have been unfavourable. The levee must have been quite wet. This is evident from the sections, showing thick layers of reed and willow wood that must have served to insulate the damp soil and to raise the ground level. The wood remains are well preserved, which also points to wet conditions. Furthermore there are indications that part of the site was washed away during the period of its inhabitation.

In general, one of the clearest indications of year-round occupation of a settlement is the presence of posts and postholes reflecting heavy structures, as well as distinct house plans. At Swifterbant the absence of sturdy dwellings argues against permanent occupation. However, it is clear from the small cemetery on the neighbouring site S2, which contained the burials of eight adults (four men and four women) and one child, that we are dealing with complete households. The fact that the hearths on the levee were renewed several times at the same spot indicates that the site was used on a regular basis over a prolonged period.

All in all, it seems most probable that the site of S3 was occupied from spring to autumn, and that the inhabitants visited it in winter only for hunting and fowling. Another possible scenario is that during some years conditions were more favourable, so that there was an alternation between seasonal and year-round occupation. This too could explain the data pointing to winter activities.

In view of the natural conditions, it is easier to imagine a permanent occupation of Hazendonk than of Swifterbant. Hazendonk was a permanently dry place in a wet landscape, unlike the levee of S3. This does not automatically mean that Hazendonk was permanently occupied. The absence of house structures of any kind argues against permanent occupation, although any traces could have been lost through bioturbation of the top of the dune. Moreover, recent excavations revealed the existence of more
Three early dunes indicate that the area has been inhabited throughout the Neolithic and Early Bronze Age; the case of Ewijk seems to support this. It is perhaps too early to draw a rounded, complete picture of an entire year, when there are no clear house plans. Nonetheless, there are indications of activities in the period between late autumn and early spring. Here too, the most probable explanation is that people were present between spring and autumn, bringing their livestock with them from their base camp and returning in winter only for fowling and harvesting mussels.

There seems to be a correlation between, on the one hand, the surface area of the sites and the natural conditions in the vicinity of the sites and, on the other, the type of economy. As for the settlements located in the freshwater marshes it seems that, if conditions were too wet and there was little available space, i.e. if there was no scope for crop cultivation, then people relied on both husbandry and hunting for their meat supply. The cereal pollen, chaff and grains found at these sites most probably come from imported, unthreshed ears. If, on the other hand, enough space was available and conditions were dry enough to allow crop cultivation, then hunting was almost completely abandoned, and people came to rely almost exclusively on husbandry for their meat supply. This change in subsistence is not only linked with chronological and cultural changes, but also with environmental conditions, as is shown most clearly by the case of Ewijk.

The data strongly suggest that if conditions were favourable both for the keeping of domestic stock and for crop cultivation - i.e. if enough pasture and arable land were available -., the people of the Vlaardingen culture switched to an economy based almost completely on husbandry and agriculture, even if other groups continued to rely to a great extent on hunting. This implies that they did possess knowledge of crop cultivation, but were able to put this knowledge into practice only if the environmental conditions enabled them to do so. The case of P14 indicates that this could have applied even to the Swifterbant culture. This change in subsistence must be explained not only from the environmental point of view, but also as a positive choice the people made to exploit certain ecological niches within their broad-spectrum subsistence.

The coastal settlements (in the Older Dunes as well as in the saline and brackish regions) seem to form a kind of intermediate group in this respect. This applies to the Hazendonk-3 sites such as Wateringen 4, as well as to those of the Vlaardingen culture - Voorschoten, Leidschendam and Zandwerven - and the Single Grave Culture, such as Kolhorn. In most cases evidence of local crop cultivation was found, but for their meat supply the inhabitants still relied both on stock keeping and hunting, fowling, fishing and harvesting molluscs. In the Older Dunes, game species such as red deer were important meat sources. Although also fowling played a role (especially in Wateringen 4), it was by no means as important here as it was in the saline and brackish regions in the northwestern part of the country. Here wild mammals only played a minor role in the economy; for their meat supply people depended mainly on cattle breeding, together with fowling, fishing and harvesting of molluscs.

river dunes in the vicinity of Hazendonk than was previously thought. The material found on these river dunes indicates occupation. This could mean that people moved from one river dune to another, which in its turn could explain the fact that Hazendonk was abandoned and recolonized several times.

Also at Kolhorn no clear house plans were found, which makes permanent occupation doubtful. Nonetheless, there are indications of activities in the period between late autumn and early spring. Here too, the most probable explanation is that people were present between spring and autumn, bringing their livestock with them from their base camp and returning in winter only for fowling and harvesting mussels.

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As for the domestic stock, cattle was by far the most important in all sites. Sheep and/or goat played only a minor role. In nearly all of the sites these species are represented only in (very) small numbers, and sometimes they are not even found at all, such as at Wateringen 4. Even at Aartswoud and Ewijk, the sites with the highest numbers of remains of sheep/goat, the proportion in the total bone weight is low: c. 3% at Aartswoud and at most 12% at Ewijk (layer A1). The fact that sheep/goat do occur in small numbers in the small sites in the freshwater marshes is not surprising, but it is striking that the same is the case in the saline and brackish areas, where natural conditions seem to have been more favourable. Prummel (1919) mentions that the numbers of sheep/goat are small also in the Bronze Age settlements in the northwestern part of the Netherlands (Andijk, Hoogkarspel and Zwaagdijk). Probably by then the environment was more brackish than saline, allowing the occurrence of liver-fluke. It is only from the Early Middle Ages onwards that sheep seem to have been kept in large numbers in this part of the country; goats were probably almost absent. This could be due to a salinization of the environment, but also to the greater role of wool production in the Middle Ages.

The question remains as to whether the inhabitants of the small and narrow levees and small river dunes in the marshes and those who inhabited the dry areas belonged to the same group, i.e. whether some of the occupants of the dry areas moved into the marshes for certain seasons and certain activities, bringing their livestock and grain with them. Another possibility is that the inhabitants of the small sites in the swamps constituted a separate community with a slightly different way of life from the inhabitants of the dry areas, with whom they however did maintain contacts. The archaeological evidence (similarities in material culture) seems to favour the first possibility. In spite of these similarities, it is evident that even during the Hazendonk-3 period there was a broad variation in terms of subsistence. This could mean that the economic diversity known from the Vlaardingen period may already have existed in the Hazendonk-3 period, and that the relatively well-known Vlaardingen settlement system may be similar to the settlement system of the Hazendonk-3 period.

If we assume that the inhabitants of the small levees and river dunes in the freshwater marshes did not constitute a community separate from that of the dry areas, and that the sites in the marshland only were indeed occupied from spring to early autumn, one important question remains: where did the "marsh people" stay during the winter? The same question can be asked with regard to the inhabitants of the sites in the saline and brackish area identified as seasonal settlements, such as Kolhorn and Mienakker. Even now, these questions must remain unanswered.

The transition from the Mesolithic hunter-gatherer economy to the production-based subsistence economy of the Neolithic did not take place at the same time in all parts of the Netherlands. Even at Late Neolithic sites such as Kolhorn, Zeewijk and P14, hunting, fowling and fishing still played a prominent role in people's subsistence. It is not until the Middle Bronze Age (c. 1650 cal BC) that the importance of hunting, fowling and gathering in the economy clearly becomes subordinate. In the freshwater tidal area
Sheep are among the species that have been found at the highest tide levels. C. 0.5 at the estuary, and at the marshy area of the central delta no small hunting or fishing camps are known from the Middle Bronze Age onwards. However, it is theoretically possible that even after the Middle Bronze Age there still were sites in the Netherlands where hunting played a role. This was indeed the case in Britain: the faunal spectrum from the Iron Age site of the Upper Delphs, Haddenham, U.K. (1st millennium BC) indicates that hunting still played a significant role, and that stock-raising was combined with exploitation of the wetlands in the vicinity of the site.