Mollusc Shells in Swedish Archaeology – Occurrence, Significance and Potentials

BY BIRGITTA M. JOHANSSON

Abstract

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The aim of this paper is to give a background and brief history of archaeomalacology - a new field of science in Swedish archaeology. The focus will be on the general pattern of shell-bearing evidence in different contexts. Molluscs live in a wide range of habitats both on land and in water. Subfossil evidence of mollusc shells is mainly restricted to areas with calcareous bedrock, and non-acid sediments and soils. Analysis and ecological interpretation of subfossil molluscs plays an important role as cultural and environmental evidence on many archaeological sites, particularly in Europe and the New World. Land snail analysis has not previously been used in Sweden in a specifically archaeological context. Since 1988 the author has been working with subfossil mollusc shells from sites in the provinces of Uppland, Gotland, Västergötland and Östergötland, southern Sweden. A survey of old excavation reports shows that mollusc shells occasionally have been found on archaeological sites. Some shells have been identified to species level and are included in the reports, whereas other shells have been neglected and are simply stored together with the artefacts in the museums. The author has identified and re-examined some of the older shell remains. Results from the author's own studies and from previous investigations, 241 direct and 16 indirect shell-bearing evidence, are discussed. Some shells have been used as personal objects, while other are used as technological tool or eaten as food. The future possibility of using archaeomalacology as a tool for palaeoecological reconstruction in Sweden is suggested.

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Introduction

Molluscs, and particularly the shells have been used by man in Europe, Africa, Asia and the Middle East since the Palaeolithic of the Late Pleistocene, 130,000 years ago (Volman 1978; Singer & Wymer 1982; James 1986; Mussi 1990; Taborin 1993; Stiner 1999). At Nice in southern France there is an even earlier anthropogenic and environmental mollusc shell evidence, the 400,000-year-old site of Terra Amata, from the Middle Pleistocene (de Lumley 1969, 1975). Depending on size, shape, colour, or some other properties, empty shells from snails, mussels and tusk shells were selected by man and slightly modified into personal ornaments, for example beads, pendants, bracelets and necklaces. Some shells have been utilised as money, containers or tools, whilst other shells were used when decorating pottery.

Crushed shells have also at times been used to temper the clay prior to making ceramic vessels (Jackson 1917; Clark 1977; Hulthén 1977, 1984; Doluchanov 1979; James 1986; Lindqvist 1993; Kriiska 1996; Triossi & Mascetti 1997).

Shell mounds, sometimes of enormous size, both coastal (Madsen *et al.* 1900; Bailey 1978; Burenhult 1984; Cesi 1984; Waselkov 1987; Larsson 1993; Sørensen 2000; Jaksland 2001; Mannino & Thomas 2002), or inland (Parmalee & Klippel 1974; Lubell *et al.* 1976; Noe-Nygaard 1995, pp. 39 ff.; Andersen 1998), are taken world-wide as evidence of man's use of molluscs as food, but this is not always true (Brothwell & Brothwell 1969; Meighan 1969; Claassen 1998; Milner 2002). In some cases it can be difficult to distinguish between shell deposits accumulated naturally (de Geer 1910; Antevs 1917; Hägg 1924; Odhner 1918, 1927; Asklund 1936; Hessland 1943; Fredén 1988) and shell heaps of anthropogenic origin, for example in western Sweden (Frödin 1907; Alin 1935, 1955; Janson 1936; Jonsäter *et al.* 1995; Schaller-Åhrberg *et al.* 1996; Nordqvist 2000).

Subfossil mollusc assemblages from Denmark (Madsen *et al.* 1900, Petersen & Rasmusen 1995; Petersen 1987), Sweden (Frödin 1907; Munthe 1910a, 1910b, 1940; Waldén 1986a, 1986b; Fredén 1988), England (Sparks 1961; Evans 1969, 1972; Kerney 1977; Preece & Bridgland 1999), France (Limondin 1995), Central Europe (Lozek 1964, 1986) and North America (Evans 1969; Parmalee & Kippel 1974; Bobrowsky 1984) have been studied for more than 100 years. The first large shell mounds of anthropogenic origin, *i.e.* shells found together with bones and artefacts were discovered in 1837 at Krabbesholm, near Limfjorden in Denmark. In 1848, the Royal Danish Academy of Sciences formed an interdisciplinary commission, which was to investigate the nature and origin of the Danish shell mounds. The commission consisted of the geologist G. Forchhammer, the zoologist J. Steenstrup and the archaeologist J. J. A. Worsaae. It was Japetus Steenstrup who coined the expression *kjøkkenmøddinger* (kitchen middens) in the middle of the 19th century (Steenstrup 1851, p. 11). Eight Danish shell mounds were investigated, with attention focused on the site at Ertebølle. Thirteen marine one limnic and twelve terrestrial mollusc species were identified from Ertebølle (Petersen & Winge 1900, pp. 80 f.; Petersen 1987). The kitchen middens have since then mostly been interpreted as accumulated food remains (Frödin 1907; Lubbock 1913; Andersen & Johansen 1987; Andersen 1991; Schaller-Åhrberg *et al.* 1996; Milner 2002), although Tilley (1996), Carlsson (1998) and Strassburg (2000) focus on the symbolic meaning of these sites.

Subfossil molluscs are used as palaeoclimatic indicators and to reconstruct past local environments (Lozek 1964; Gould 1969; Kerney 1977; Lowe & Walker 1984, pp. 187 ff.; Limondin & Rousseau 1991; Craighead 1999; Gedda 2001). The ecological information gained from mollusc studies alone has been used for this kind of reconstruction, but land snail remains are now increasingly being used as an adjunct to pollen and other palaeoecological analyses to contribute to a clearer picture of past local environments (Dimbleby & Evans 1974; Kerney *et al.* 1980; Bottema & Ottaway 1982; Stead 1991; Dockrill *et al.* 1994; Gedda *et al.* 1999; Preece & Bridgland 1999; Kelso *et al.* 2000). Since 1988 mollusc analysis has been applied in Sweden by the author on shells from the provinces of Gotland, Uppland, Västergötland and Östergötland (Johansson 1989a, 1989b, MS, 1990a, 1990b, 1992 MS), and since 1990 it has been systematically applied in the interdisciplinary Birka Project (Johansson 1995a, 1997). In order to reconstruct the environmental history of the Viking Age settlement of Birka on Björkö in Lake Mälaren and its hinterland subfossil mollusc shells were studied together with plant macrofossils, pollen and diatoms (Miller *et al.* 1995, 1997; Risberg *et al.* 2002), coprolites (Karlsson 2000, MS) and animal bones (Lõugas 2001; Wigh 2001).

Basic mollusc data

Molluscs are invertebrates, *i.e.* animals without backbones. At present there are seven major classes of molluscs – solenogasters (Aplacophora), monoplanctophorans (Monoplacophora), chitons (Polyplacophora), tusk shells (Scaphopoda), snails and slugs (Gastropoda), clams, scallops and mussels (Bivalvia), nautili, cuttlefish, squids and octopuses (Cephalopoda) most of them having an external skeleton, *i.e.* the shell. The first three classes and the last one will not be discussed in this paper. Molluscs have a soft unsegmented body mostly with an outer skeleton, the shell. Some slug species, however, have a small and rudimental internal shell at the end of the body, which can be difficult to recover or overlooked in the samples. Molluscs live in the sea - marine species, in fresh and brackish water - limnic species, and on land - terrestrial species. Most of the molluscs feed on plant material or detritus, although a few species in each ecological group are carnivores.

The recent fauna

The Swedish mollusc fauna includes at present 656 taxa: 435 Gastropoda, 174 Bivalvia, and 5 Scaphopoda. The remaining 44 taxa belong to the four classes, mentioned above, which will not be discussed in this paper. (Gärdenfors 2000, p. 33). Man has introduced eight of the 85 limnic and several of the 121 terrestrial snail species into the Swedish fauna. Further anthropochorus species, *i.e.* molluscs spread into the area by man are to be expected in the future (Waldén 1984; von Proschwitz 1993, 2001b, 2001c).

Ecological classification

Molluscs live in a wide range of habitats on and within the soil and sediment. Most species are stenotopic - able to tolerate only a narrow range of environmental change, which makes them excellent paleoenvironmental indicators. Aquatic snails move slowly on rocky shores browsing for food and some shelter. The marine gastropods, for example limpets and periwinkles, move between the tidal zones. Not all molluscs move around, however. The limnic mussels, for example, spend most of their lives sitting on the bottom, on stones or in loose sand, filtering the water for food. Most molluscs inhabit marine or freshwater environments but some are terrestrial.

Marine (saltwater) molluscs can be divided into three major groups: littoral species – living on the seashore, benthic species - living on the sea bottom, and pelagic species - attaching to vegetation in open sea water or free-swimming (Thorson 1971).

Limnic (freshwater) molluscs can be divided into four ecological groups: slum species, catholic (or intermediate), ditch species and moving water species. Limnic molluscs are also littoral, benthic or pelagic (Sparks 1961; Lozek 1986).

Terrestrial (land) molluscs can be grouped into four main categories: woodland (or shadeloving), catholic (or intermediate), grassland (or open country) and marsh (or wetland) species (Lozek 1964; Evans 1972). At least four other sub-groups of terrestrial snails can be recognised depending on the nature of the environment and the purpose of the studies: burrowing, alien, synanthropic and anthropochorus species (Lozek 1964, 1986; Waldén 1955, 1981; von Proschwitz 1993, 1994, 2001b).

By assuming that the subfossil mollusc species had the same or very similar environmental requirements as the recent ones, a mosaic picture can be built up of the local environmental conditions at various stages of a depositional sequence. Marine molluscs occupy a great range of habitats from small pools and rock outcrops in the inter-tidal zone to the deeper waters off the edge of the continental shelf. Limnic molluscs and terrestrial snail species have a wide distribution and can be preserved in a variety of deposits. The large freshwater mussels and land snails are sensitive to polluted and acid environments and they are extremely useful palaeoecological tools (Carell *et al.* 1987, 1995; Gärdenfors *et al.* 1988; von Proschwitz 2001a, 2001c with further references).

Preservation

Terrestrial snails, in particular, need lime-rich environments in order to build up their shells and to lay their eggs. The shell consists mainly of aragonite, a crystalline form of calcium carbonate, although some are of calcite. Aquatic molluscs also need lime for their shells and reproduction but to a lesser extent. Molluscs are found in all parts of Sweden, even at high altitudes in northern Sweden (Lundqvist 1917; Waldén 1971; Nilsson 1984; von Proschwitz 1985, 1996), but as subfossil evidence they are mostly restricted to areas with calcareous bedrock, non-acid sediments and soils. Soils suitable for mollusc preservation are found on the islands of Öland and Gotland, in southern Skåne, in the region of Falbygden in Västergötland and in parts of Östergötland, Närke, Uppland and Gästrikland (Fig. 1). The central part of Dalarna, Jämtland and some areas in Lappland along the mountain ridge should also be considered in this respect (Lundqvist 1959; Fredén 1994). Some pioneering sites, where subfossil mollusc studies have been carried, out are in tufa deposits located in Närke (Kjellmark 1897), Skåne (Kurck 1901), Jämtland (Kjellmark 1904), Östergötland (Odhner 1910a) and in Västergötland (Odhner 1910b). The most important malacological investigations were done on Gotland (Halle 1906; Munthe 1910a, 1940). Impressions of mollusc shells have also been preserved in gyttja sediments from Blekinge (Liljegren 1982, p. 33). Mollusc remains can also be preserved on archaeological sites where the sediments and soils contain large quantities of bones or wood ash particles, which creates suitable pH conditions for the surviving shells. Most of the mollusc occurrences discussed in this study are from these calcareous regions.

It is essential to understand how the ecological and archaeological contexts were formed, and how and when the shells came to be included in these contexts. Subfossil molluscs are zoological macrofossils and in Sweden they can be from 1.5 mm to 200 mm in size, according to species. The preservation of molluscs in archaeological contexts is very often closely related to the type and degree of human past activities at a site. Shell preservation is generally very poor in the plough soil horizon due to burial, mixing and sorting processes caused by the soil fauna (Carter 1990). On-site deposits, or archaeological contexts, can be severely damaged for various reasons, *e.g.* constructing of large burial mounds,

Fig. 1. Calcareous bedrock and soils in Sweden (from G. Lundqvist 1959, p. 77).

digging of graves and pits or ditched enclosures (Evans 1972; Thomas & Johansson 1988; Evans & O'Connor 1999). Off-site deposits, for example, tufa deposits (Gedda 2001) and lake sediments are less disturbed (Johansson 1989a, MS). Well preserved molluscs can also be found in sediment cores taken for pollen analysis (Johansson 1991a, MS) or in individual soil samples collected for plant macrofossil analysis (Johansson 1995b) and they can give a record of the climate and the natural local environment at a site.

Archaeomalacology

Definitions and background

Archaeomalacology is the field of science interpreting the interrelationships between people and subfossil mollusc shells based on evidence in the archaeological record. Mollusc findings, or the shell-bearing evidence from archaeological contexts, have principally been discussed previously from a site perspective. Subfossil shells and the number of shells found at the sites were recorded without being identified as to taxon. Shells have been found in settlements, graves and other contexts of anthropogenic origin. This study will focus on the shell-bearing evidence, *i.e.* the identified mollusc taxa found in different anthropogenic and environmental prehistoric contexts, rather than on the individual sites. The shell-bearing evidence will be divided into two categories: direct and indirect evidence.

Direct shell-bearing evidence can be found as actual shells in pits, wells or ditches. Subfossil shells are recovered from either inside or outside houses within a settlement, in hill-forts and in graves. Shells can also be found *in situ*, in buried soil horizons beneath a grave mound or under a stone wall. Personal decorative ornaments made from shells, along with food offerings are other forms of direct mollusc evidence and the shells can be found both in inhumation and cremation graves. The shell middens provide other direct mollusc evidence.

Indirect shell-bearing evidence, in this study, is when the mollusc shell itself cannot be seen with the naked eye, *e.g.* impressions in pottery made by shell. Crushed molluscs, recognised as shell temper in ceramics are also regarded as indirect shell-bearing evidence, since the shell debris is not seen unless the pot is broken into potsherds. Likewise, pearls are regarded as indirect evidence, because the actual shells are absent and also because pearls are not seen as shell remains in an archaeological sense, they are commonly treated as beads.

To illustrate the potential of molluscs in archaeological contexts the direct and indirect shell-bearing evidence will attempt to address the following questions:

* In which contexts are molluscs preserved: in settlement deposits, graves or others?

* Which mollusc groups are present: marine, limnic, terrestrial or undetermined?

* What is the provenance of the molluscs: local, regional or exotic?

* Where is the shell-bearing evidence located: in a coastal area or inland?

* What kind of evidence are the molluscs: natural occurrence or anthropogenic?

* When were the molluscs incorporated into the context: subfossil or recent origin?

* How have the molluscs been used: as food, personal objects, as technological tool or other?

The direct and indirect shell-bearing evidence will be presented below according to species or taxon and chronologically, from the Mesolithic to the medieval period, starting with the oldest findings in the excavated records from each period. Moreover, the molluscs are divided into three ecological groups: marine, limnic and terrestrial snail species. In this study brackish water molluscs are included in the limnic group.

The presentation gives a review of subfossil shells found in Sweden, including some studies by the author (printed in bold in Table 1-4, cf. Appendix). The author has re-examined older shell-bearing evidence in the Museum of National Antiquities in Stockholm (hereafter abbreviated to SHM) and at local museums, mainly in Visby. The author has to rely on shell identifications given in the original publications since it was not possible to retrieve all old samples. In spite of insufficient data on stratigraphy, context and dating for the older evidence it has been included in this study. The nomenclature used in the text follows le Renard (2002) for marine molluscs and Falkner, Banks & von Proschwitz (2002) for limnic and terrestrial molluscs. In this study the revised, scientific (Latin) names are given first, followed by the earlier names (the synonyms), which appear in the publications. This means, for example, that the revised name for the common cockle is *Cerastoderma edule,* while the earlier name (syn.) was *Cardium edule.* The radiocarbon dates presented are calibrated and shown with two sigma errors as suggested by Olsson (1999), following Stuiver *et al.* (1998) and using the OxCal Program, version 3.5 (Bronk Ramsey 1995, 2001). The maps in the text, illustrating the shell-bearing sites, are one way of illustrating that subfossil shells can be found all over Sweden, but this presentation does not give a general pattern of mollusc species distribution. Very often the shell-bearing evidence also has a mixed ecological origin. To avoid confusion the dominating ecological taxa in the evidence have been decisive for the heading under which the shell-bearing evidence was placed in this study.

Shell morphology and modification

The snail shell has a spiral shape, either flat or high and elongated. The highest point of the shell, as in for example the orchard snail (*Arianta*

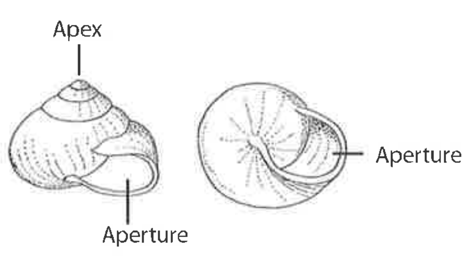

Fig. 2a-b. Land snail shell (*Arianta arbustorium*), lateral and ventral view (Drawing by Rita Larje).

arbustorum, Fig. 2a-b) is the *apex* (pl. *apices*) and the largest shell whorl ends in the *aperture,* or the mouth of the snail. For some gastropods (Prosobranchia), *e.g.* the limnic species *Bithynia tentaculata* (Fig. 3), a disc called the *operculum* seals the *aperture* when the animal retracts into its shell. The Latin terms *apex, aperture* and *operculum* of the snail shell are used for taxonomic interpretation and in quantifying different subfossil mollusc taxa. The shell height of terrestrial and limnic snails varies from 1.5-50 mm (Kerney *et al.* 1983; Pfleger & Chatfield 1983), whereas marine gastropod shells are 5-100 mm high (Abbot & Dance 1986).

Mussels have symmetrical or asymmetrically paired shells, *e.g.* the valves of the common cockle (*Cerastoderma edule,* Fig. 4a-b) are joined together at the upper end by a ligament and sometimes also by one or several teeth. The *apex* or the beak of the mussel is called the *umbo* and the edge of the shell is called the margin. Both the *umbo* and the marginal region of the shell are important for taxonomic studies and for quantifying different subfossil mussel taxa. The length of the limnic mussel shells is 2-150 mm (Pfleger & Chatfield 1983), whereas the marine mussels are 5-200 mm in size (Abbot & Dance 1986).

Subfossil cowries and porcelain shells occur also in the Swedish archaeological record. The shells from this Indo-Pacific genus (*Cypraea* spp.) have very often been modified, either pierced for suspension, cut into segments or thin discs. The upper surfaces of the small shell taxa are occasionally being ground down. The shell of cowries and porcelain snails is unusual among the marine shells because of the domed, bilaterally symmetrical shape and the glossy outer surface. The back or the upper part of the shell is the *dorsum* (Fig. 5a, 6a). The lower side of the cowrie and porcelain shells is called the ventral side. On the ventral side is the opening of the shell, the *aperture* (Fig. 5b, 6b). On each side of the *aperture* is a lip or *labium.* The left lip is the outer lip and to the right of the aperture is the inner lip. The *dorsum* was sometimes ground

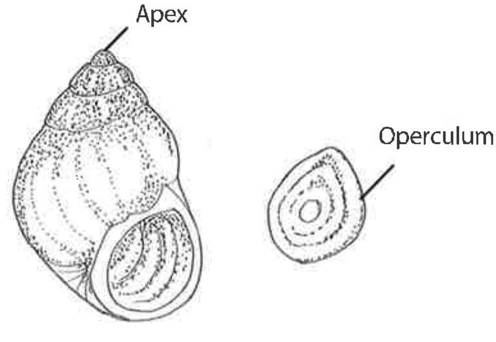

Fig. 3. Freshwater shell (*Bithynia tentaculata*), lateral

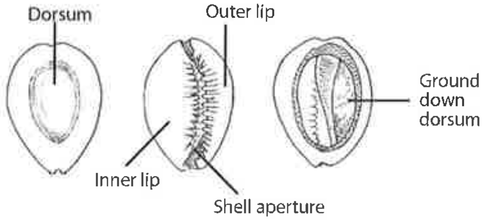

Fig. 5a-c. Cowrie shell (*Cypraea annulus*) in dorsal and ventral view and modified (Drawing by Rita Larje).

down on some cowrie shells (Fig. 5c) in order to make the shells flat. When the shells are modified in this way the ventral side of the cowries can be exposed, resembling an eye. There are numerous teeth on both the inner and the outer lip and some snail species have more prominent teeth on the outer lip, *e.g.* most of the porcelain shells. The *labium* area of these subfossil shells has been cut into thin discs or larger segments. These shell segments, including the characteristic teeth, have been modified into disc-shaped beads or larger shell segments, which could be used as beads, or as tools. In this paper the name cowrie shell is strictly attributed to the two species: the money cowrie (*C. moneta*) and the ringed cowrie (*C. annulus*). Other species of the genus *Cypraea* are referred to as porcelain shells (*cf.* Johansson 1990a, p. 43). The length of the intact cowrie shell is 10-40 mm and the length of the porcelain shells (*Cypraea* spp.) ranges from 10-153 mm (Allan 1969; Walls 1979).

Shell-bearing evidence

A total of 257cases of shell-bearing evidence from 104sites will be presented below. Only fifteen of these, from ten sites, could be identified as indirect shell-bearing evidence.

Direct evidence

The 241cases of direct shell-bearing evidence from 94 different sites will be discussed below, starting with indigenous marine Swedish taxa, followed by European and Indo-Pacific taxa, the limnic taxa and finally the terrestrial species.

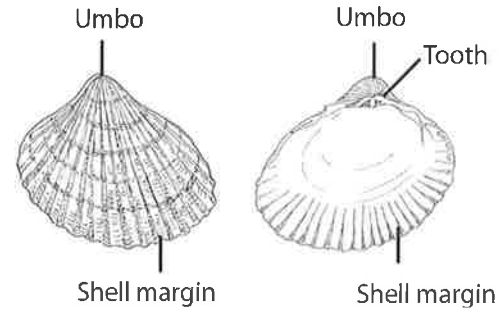

Fig. 4a-b. Mussel shell (*Cerastoderma edule*), dorsal and ventral view (Drawing by Rita Larje).

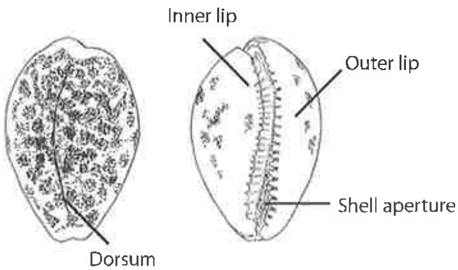

Fig. 6a-b. Porcelain shell (*Cypraea pantherina*), dorsal and ventral view (Drawing by Rita Larje).

Marine indigenous species

Remains from two human skeletons were found 1843 whilst quarrying gravel in a shell deposit at Dammen on the Röe estate, Bro parish in Bohuslän. No artefacts were found associated with the skeletons. On the basis of how the skeletons were situated in the shell mound, the bodies must have drowned at sea, and then become incorporated into the shell deposit during the accumulation of the shells (Fürst 1926). These skeletal remains are known as *Stångenäskraniet* and have been very much disputed since Sven Nilsson published them in 1868. The mollusc fauna from Dammen at Röe was, however, not investigated until 1903 when the malacologist Richard Hägg visited the site. He identified 22 marine shell species but no oysters were present, and this naturally accumulated shell deposit at Röe was dated to the Ancylus Sea stage (Hägg 1924, p. 429). Munthe (1940, p. 163 f.) was very sceptical of this remarkably old find, dating from *c.* 7500-7000 BC. A new excavation in the Röe area was carried out in 1989-90 at the site of Dammen. This time the study included pollen, diatom and osteological analysis. Human bone remains, from two post-cranial skeletons, were also recovered from the site. The osteologist Leif Jonson was able to relate these bones to the cranial bones from the previous excavation. Four radiocarbon samples were obtained, one from a hazelnut shell 7860±85 (7050-6500 cal. yrs. BC), two from unburned bone, 7645±80 (6650-6260 cal. yrs. BC) and 8065±85 (7350-6650 cal. yrs. BC), and one from an oyster shell 8600±80 ^{14}C years BP (7920-7520 cal. yrs. BC), indicating that the sample from the oyster shell was *c.* 500 years older than the other samples partly due to the marine reservoir effect. The molluscs found in the shell midden were: oysters, periwinkles, blue mussels, cockles and limpets, all edible species (Schaller-Åhrberg *et al.* 1996, p. 27 f.).

Marine molluscs, bones from mammals, birds and fish were found together with flint objects and ceramics in some of the caves at Kullaberg, western Skåne, originally dated to the Stone Age. The mollusc species found are: Iceland cyprina (*Arctica islandica* syn. *Cyprina islandica*), blue mussel (*Mytilus edulis*), whelk (*Buccinum undatum*), scallop (*Pecten* sp.) and Neptune shell (*Neptunea antiqua*) (Bruzelius 1851; Retzius & Wallgren 1903). Later, contextual studies on these cave site remains have indicated a mixed Stone Age inventory (Munthe 1940; Althin 1954). Burned bones, several shells of blue mussel and periwinkles were recovered inside the chamber of a passage grave from Berg, Bokenäs parish in Bohuslän (Gustafson 1890, p. 31). Blue mussels (*Mytilus* sp.) and large land snails (Helicidae syn. *Helix* spp.) were reported from the gallery grave at Söndrum in Halland (Arne 1907). A close examination of these shells by the author at SHM resulted in a re-identification of the large terrestrial snails, which turned out to be common periwinkles (*Littorina littorea*). One fragment of a mussel shell was found together with flint flakes, hammer stone, slate and quartz fragments in the chamber of the Neolithic passage grave at Sjöbol 1.3 (no. 7), Lye parish in Bohuslän (Särlvik *et al.* 1979, p. 122).

European tusk shells (*Dentalium entalis*) have been found at six Neolithic sites in Sweden: Ånneröd in Bohuslän, Siretorp in Blekinge and Visby, Västerbjers, Ire and Ajvide on Gotland. The first tusk shells were found together with 14 other marine and 3 terrestrial mollusc species in a shell midden at Ånneröd in northern Bohuslän. The malacologist Richard Hägg identified the shells and the results are included in the archaeological text (Frödin 1907, p. 20). The marine shells found were: *Ostrea edulis, Mytilus edulis, Cerastoderma edule, C. echinatum* (syn. *Cardium echinatum*), *Venerupis decussata* (syn. *Tapes decussatus*), *V. aureus* (syn. *T. aureus*), *Arctica islandica, D. entalis, Patella vulgata, Littorina littorea, L. rudis, L. obtusata, Rissoa* spp, *Nassa reticulata,* and *Cerithium reticulatum.* Three different species of terrestrial snails (Helicidae) were also found at the site. In all, 18 different taxa were identified. Numerous bones from mammals, birds and fish were also recovered together with potsherds, flint and rock artefacts in the archaeological deposits. The marine mollusc *V. decussata* is of special interest since this species today occurs in a warmer environment along the coasts of France and Britain (Frödin 1907, pp. 17 ff.). New excavations at Änneröd were carried out from 1977-1991, but there is no mentioning of molluscs in the report (Jonsäter *et al.* 1995). Some 50 tusk shells were found in grave 2, a female burial from the excavations in Visby 1924. The shells were located to the skull region of the skeleton (Nihlén 1927, p. 171). Tusk shells were also found at the settlement Siretorp in Blekinge, but unfortunately these shells were thrown away during the excavation (Bagge & Kjellmark 1939, p. 101). One tusk shell was found together with bone beads made from bird metatarsals in grave 62, a female burial from Västerbjers on Gotland (Stenberger *et al.* 1943, p. 59, p. 96; Johansson 1991a, p. 84). Tusk shells were also recovered from two male graves at Ire on Gotland (Johansson 1991b, p. 84, *cf.* Fig. 3). Grave 4 contained as many as 210 fragments, while grave 6:B contained some 20 fragments (Janzon 1974, pp. 68 ff.; Johansson 1991a. p. 84 f.). Twelve fragments of tusk shell, 11 fragments of common periwinkle, 2 common cockles, 2 Baltic macoma (*Macoma balthica*) and some 20 fragments of mother-of-pearl (*cf. Anodonta* sp.) were identified by the author from grave 20, a Neolithic infant burial from Ajvide on Gotland. The shells were located to the abdominal region of the child where some bone beads made from bird metatarsals, amber and bone beads also were found (Larje & Johansson 1997, p. 208). Tusk shells (Scaphopoda) appear world wide in marine environments, and are found offshore on sandy or muddy bottoms on the West Coast of Sweden and in Öresund.

Common cockles (*Cerastoderma edule*) have been found at three Neolithic sites on Gotland; Visby, Ire and Ajvide. Some 10 cockles were recovered in grave 2 in Visby. The shells were located in the pelvic region of the female skeleton (Nihlén 1927, p. 171). Three male burials, grave 2, 5, 7C and a female, grave 6A, from Ire also contained cockles. Most of the shells are perforated or abraded in the *umbo* region (Johansson, 1990a, p. 41, *cf.* Fig. 4). Two shell-bearing graves from Ire have been radiocarbon dated: burial 2 to 4025±100 BP, (2900-2250 cal. yrs.), and burial 5 to 3850±100 BP or (2600-1950 cal.yrs. BC) (Janzon 1974, pp. 99 ff.). Cockles, sporadic shells from periwinkle, Baltic macoma and fragments of blue mussels were found in archaeological deposits at Ajvide during excavations in May 1992. Some shells were collected and identified by the author (Johansson 1992, MS). These shells were found at the bottom of the excavated strata, in the glaciofluvial gravel. Cockles occur naturally in marine and brackish environments, on sandy bottoms in the inter-tidal zone along the entire Swedish coast.

Shells of the Baltic macoma (*Macoma balthica*, syn. *Tellina baltica*) have been found at two Neolithic sites on Gotland: Ire and Ajvide. One Baltic macoma was found together with the cockles in grave 7C from Ire (Janzon 1974, p. 283; Johansson 1991a. p. 85, *cf.* Fig. 5), two from grave 20 at Ajvide, but some shells were also recovered from the settlement at Ajvide, mentioned above. This mussel is naturally occurring on sandy or muddy bottoms in the Baltic Sea.

European oysters (*Ostrea edulis*) have been found at fourteen Stone Age sites: the harbour at Limhamn, Fjärrestad and Elinelund in Skåne, and Rottjärnslid, Svartetjärn, Rörvik, Dafter, Uteby, Svenseröd, Sötorp, and Huseby klev, all in Bohuslän. Oysters have also been found at the Viking Age settlement Birka on Björkö and in several medieval towns, for example Old Lödöse in Västergötland and at "Bryggaren" in Uppsala.

Two oyster shells were discovered in 1891-92 among the dredged material from the harbour of Limhamn. This material consisted of flint implements, pecked axes and animal bones, a mixed Mesolithic assemblage (Althin 1954, p. 32). Nine oyster shells were found in a passage grave at Fjärrestad, southern Skåne. Almgren (1910) excavated the site, but the shells found have not been mentioned in any report. The author has studied and identified the shells at SHM. Large oysters, common and flat periwinkles, blue mussels, cockles and reticulated nassa shells were found in a Mesolithic shell midden at Rottjärnslid in Dragsmark parish (Alin 1935, p.11, 1955, p. 298 f.). Another shell mound was found at Svartetjärn in Tossene parish. The midden contained 12 marine species of molluscs: oysters, common, flat and rough periwinkles, limpets, blue mussels, cockles, reticulated nassa shells (*Nassa reticulata*), *Gibbula cineraria, Lucinoma borealis, Venerupis pullaster* and *V. decussata* (Alin 1935, p. 29 f.). Oysters, periwinkles, limpets, blue mussels, cockles, *L. borealis* and *V. decussata* were identified in a Neolithic settlement at Rörvik in Kville parish (Janson 1936, p. 59 f.). Oyster shells, animal bones, pottery and stone artefacts were also noted in a gravel pit at Dafter in Skee parish (Fredsjö 1950, p. 112). The oyster shell midden at Uteby in Bro parish contained stone artefacts, potsherds and remains from fireplaces (Alin 1955, p. 78). Shells from *Ostrea edulis, Aporrhais pespelicani, Pecten septentrionalis, Patella vulgata, V. decussata, Nassa reticulata* and *Littorina littorea* were found together with some stone and flint artefacts at Svenseröd on the Nyborg estate, Bokenäs parish. This shell deposit had been damaged and was finally completely destroyed by agriculture (Alin 1955, p. 149). A shell midden at Sötorp in Bro parish was investigated in 1943. The shell deposit was 3x1 m and 20 cm thick. Stone, flint, slate and quartz artefacts together with shells from *O. edulis, L. littorea, Cerastoderma edule* and *Mytilus edulis* were found at the site. Human bones were also recovered 2 m north of the shell deposit (Alin 1955, pp. 286 ff.). An oval shaped structure, consisting of crushed oyster shells was found at the Mesolithic site of Huseby klev in Morlanda parish. This possible hut construction contained bone tools, mostly fishhooks and carbonised hazelnut shells. Several radiocarbon dates from the carbonised hazelnut shells were obtained from Huseby klev, dating the construction to *c.* 7100-7000 BP (Nordqvist 2000, p. 213 f.). Some molluscs and fossils have recently been recovered at Elinelund, a re-investigated Neolithic site outside Malmö. Six fragments of oyster shell, six freshwater snails and two brachiopods were noted in the cultural layer mixed with potsherds, flint tools, hazelnut shells and animal bones. One hazelnut shell, found at the bottom of the cultural layer, was radiocarbon dated to 5275±70 BP (4320-3960 cal. yrs. BC) and a food crust from the inner surface of a Funnel Beaker pot, from the upper part of the cultural layer, was dated to 5030±85 BP (3980-3650 cal. yrs. BC) and with a ^{13}C-value -29,35 (Jonsson 2002).

Fragmented oysters have been found, scattered in the archaeological deposits, at the Viking Age settlement Birka on Björkö. Oysters were found in the Black Earth by Hjalmar Stolpe already in 1874, but he interpreted the shells as recent refuse from restaurants in Stockholm, dumped on the arable fields as manure during the late 19th Century. Numerous oyster shells were recovered at Birka in 1970-71 (Danielsson & Warén 1973) and in 1990-95, together with 12 marine mollusc species, 3 Indo-Pacific, 3 limnic and 12 terrestrial species. These shells, including the oysters, are not believed to be of recent origin since they occur not only in the upper layer of the "Black Earth" (Johansson 1995a, 1997). Oysters, periwinkles, blue mussels, horse mussels, whelks and limpets were found in the cultural layers from the medieval town of Lödöse in Västergötland (Lepiksaar 1965, p. 40 f.). Oyster shells and freshwater molluscs (*Unio* spp., *Anodonta* spp., *Viviparus viviparus, Bithynia tentaculata, Planorbidae* spp. and *Lymnaeidae* spp.) were identified by the author together with animal bones, bird egg shell and insect remains at the medieval site of Bryggaren in Uppsala (Johansson 1991b, p. 219 f.). Oysters occur naturally in marine environments on sandy or muddy bottoms in the North Sea, in Skagerack and Kattegatt.

Shells of blue mussels (*Mytilus edulis*) have been found at several sites, dating from Mesolithic to the medieval period. A concentration of 26 subfossil blue mussels and 19 pieces of barnacle (*Balanus* spp.), contemporary with burned animal bones, was noted in the plough soil at the Stone Age settlement of Lundfors in Västerbotten. Seal bones dominate in the marine faunal evidence from Lundfors. In the discussion on shells Broadbent (1979, p. 177) suggests that the blue mussels and barnacles found in the cultural layer "came to the sites as the contents of seal stomachs". Another possible explanation for to the occurrence of mussels and barnacles in the cultural layer at Lundfors is the well-known use of ancient local shell deposits as soil improvement (Halden 1921, p. 5). This suggestion is, however, ruled out by Broadbent (1979, p. 177) since the old farmers in the area deny this practice. Several fragments of blue mussel were found in a Neolithic grave at Fridtorp, Västerhejde parish on Gotland. The shells were located between a pair of boar tusks, which were placed near the lower jaw of the male skeleton in grave 15 (Englund 1982, p. 31). A small fragment of blue mussel was found in a Bronze Age burial at Barkåkra in Skåne (Rausing 1949, p. 67). Holmqvist (1956, p. 24) found one mussel shell in grave 65, an Iron Age inhumation at Barkarby in Uppland. The shell is most probably a horse mussel (*Modiolus modiolus*), a species naturally occurring on the West Coast of Sweden. A small collection of blue mussels, cockles, periwinkles and freshwater nerite shells (*Theoduxus fluviatilis*) were found in an Iron Age construction, feature 4 at cementary 8 in Vårby, Huddinge parish south of Stockholm. Neither bones nor artefacts were found in the "grave". The shells were of fossil origin and taken from a nearby shell deposit dating from the Litorina Sea stage (Iregren 1972, p. 84 f.). Blue mussels occur naturally in marine and brackish environments on rocks and stone shores in the inter-tidal zone, along the entire Swedish coast.

Marine European species

Scallop shells (*Pecten* spp.) have mostly been found in medieval grave contexts in western Europe, including the Scandinavian countries. Scallops occur naturally in marine environments, on sandy bottoms in the Atlantic and the North Sea, in Skagerack and Kattegatt. There are 74 complete and at least 3 fragmens of scallop shells from 19 localities, mainly graves, recorded in Sweden. From Lund 45 shells, Malmö 3, Helsingborg 5, Lemmeströ church ruin in Börringe parish 1, Skanör 1, Helgeandshuset in Vä parish 1, Voxtorp church 1, Old Lödöse 3, Skara 2, Dverstorp church ruin in Dimbo parish 2, Varnhem monastery 1, Alvastra monastery 3, Linköping 1, Sigtuna 1 and at the abandoned chapel of Västerhus in Jämtland 2 shells were recovered (Andersson 1989, pp. 105 ff.). One scallop shell with two significant holes in the *umbo* region was found together with a modified mussel shell in the medieval phase of the settlement at Eketorp on Öland (Borg 1998, p. 316). One scallop shell has also been found in the medieval town Visby on Gotland (Engeström 1989, p. 264). Two fragments of scallop shell were recovered at the Viking Age settlement of Birka, but these shells are regarded as food remains and have no symbolic meaning (Danielsson & Warén 1973). Fragments of scallop have also been found together with the bone remains at the medieval site Ny Varberg in Halland (Jonsson 1992, p. 101)

Scallop shells were used as a sign of pilgrimage, from *c.* AD 1100 until *c.* AD 1400, by people returning from the Holy shrine of St. James at Santiago de Compostela in northwestern Spain. An attribute of St. James could be worn on the hat, on the mantle or placed on the walking stick or on the bag (Fig. 7). Mostly shells from St. James' scallop (*Pecten jacobaeus*) were used, but at times shells from the great scallop (*P. maximus*) and also other mollusc species, *e.g.* limpets and oysters have been used for the same purpose (Eriksson, 1984; Andersson 1989, p. 118, 2002; Dunn & Davidsson, eds. 1996). The other mussel shell from Eketorp is most probably an Iceland cyprina (*Arctica islandica*), a species naturally occurring in the southern part of the

Fig. 7. Scallop shells used as a sign of pilgrimage (from Eriksson 1984).

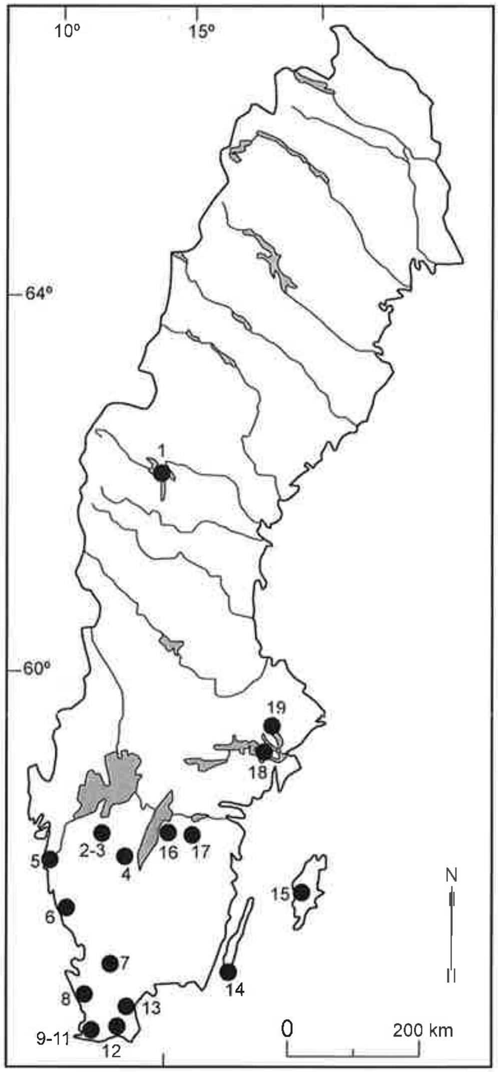

Fig. 8. Scallop shells found in Sweden. 1. Västerhus (Jä.) 2. Skara (Vg.) 3. Varnhem (Vg.) 4. Dimbo (Vg.) 5. Gamla Lödöse (Vg.) 6. Ny Varberg (Ha.) 7. Våxtorp (Ha.) 8. Helsingborg (Sk.) 9. Malmö (Sk). 10. Lund (Sk.) 11. Skanör (Sk.) 12. Börringe (Sk.) 13. Vä (Sk.) 14. Eketrop (Öl.) 15. Visby (Go.) 16. Alvastra (Ög.) 17. Linköping (Ög.) 18. Björkö (Up.) 19. Sigtuna (Up.)

Baltic Sea, and this shell might be a replacement or substitute for a scallop shell. The scallop shells found in Sweden are located at early medieval churches or monasteries in southern Sweden. The two shells found at Västerhus in Jämtland are from burials, while the shells from Visby on Gotland, Birka on Björkö and Eketorp on Öland are from settlements (*cf.* Fig. 8).

Marine Indo-Pacific species

Shells of Indo-Pacific origin reached Sweden during the Roman Iron Age. Three major groups can be distinguished; cowrie shells (*Cypraea moneta* and *C. annulus*), porcelain shells (*Cypraea* spp.) and olive shells (*Oliva* spp.). These exotic shells have been found in graves and settlements mainly on Gotland, on Björkö in Lake Mälaren and in a few sites from Öland and the mainland of Sweden, in all 24 sites.

A total of 56 cowries (*C. moneta* and *C. annulus*), from 13 different sites have been found in Sweden. From Björkö in Uppland 17 (Arbman 1943; Selling 1945; Jansson 1988; Johansson 1990a, 1991 a, 1995a, 1997; Reese 1991); Fjäle

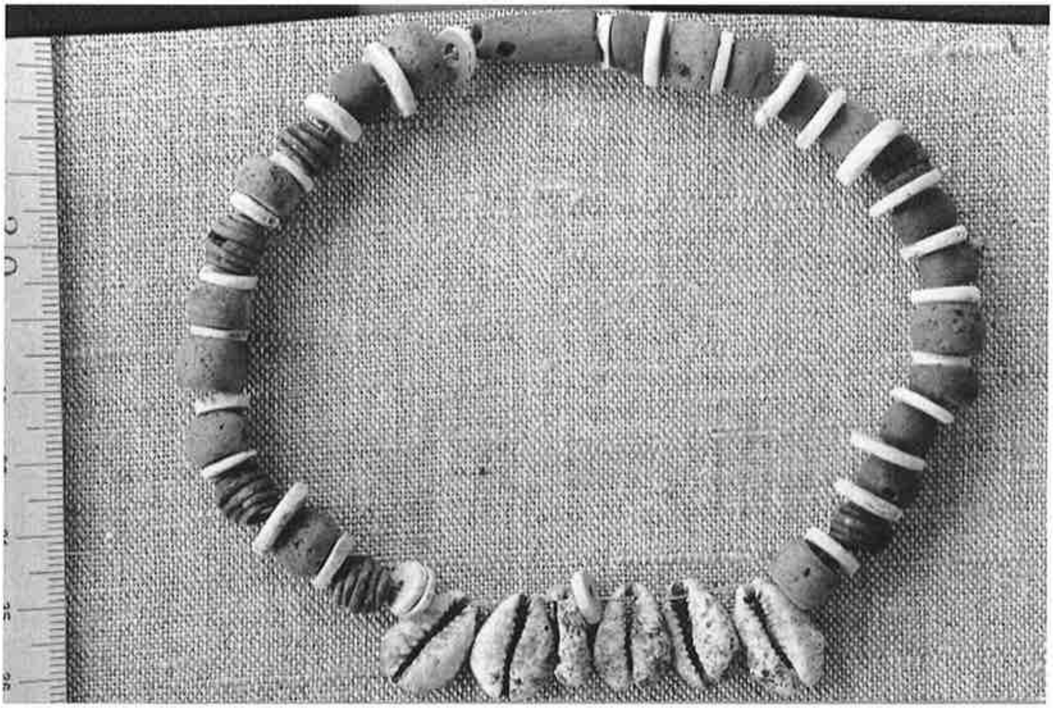

Fig. 9 Necklace from Källa, Öland with cowrie shells and shell beads. Photo: ATA, Stockholm.

11, Bjästavs 3 (Johansson 1991a, p. 87, *cf.* Fig. 10), Slite 1, Stora Hallvards 1, Ire 1, Fröjel 10 all on Gotland; grave 303a from Källa on Öland 6; Djuped in Ångermanland 1 (Jansson 1988; Johansson 1995c; Reese 1991; Thunmark-Nylén 1995, 1998, 2000; Carlsson 1999; Holgersson & Schultze 2001), at "Kransen" in medieval Uppsala 1 (Mogren 1984), from Fjälkinge in eastern Skåne 2 (Helgesson 1996) and one unpublished shell from Björkå bruk, Överlännäs parish in Ångermanland. These 55 shells are unburned, whereas one unpublished cowrie shell from Viggbyholm, Täby parish, north of Stockholm, was found in a cremation grave (Johansson, MS).

Seventeen porcelain shells or fragments of shells (*Cypraea* spp.) from 10 different sites have been found in Sweden. From Björkö in Uppland 6 larger fragments (Selling 1955; Jansson 1988; Johansson 1990a, 1995a; Reese 1991) and 1 *C. mauritina* (Johansson 1997); Vallstenarum 1, Grötlingbo 1, Endregårda 1, Kylver 1, Hallvede 1, Kvinnegårda 1 (Johansson, 1991a, p. 86, *cf.* Fig. 8), Ire 1, Häffinds 1, all on Gotland (Hildebrand 1883; Nerman 1955; Jansson 1988; Reese 1991; Johansson 1995c; Thunmark-Nylén 1995, 1998, 2000). These 16 shells or fragments of shells are unburned, whereas 1 shell from Valbo in Gästrikland is damaged by fire (Appelgren & Broberg 1996). This porcelain shell was found by the author in SMH and was identified as *C. ventriculus* (Johansson, MS).

Porcelain shells (*Cypraea* spp.) have also been cut up into larger segments or very thin discs and used as beads. Shell beads occur mostly on Gotland, with two sites Källa and Eketorp on Öland, one from Djuped in Ångermanland and one from the Black Earth in Birka, Uppland. These shell beads are mainly recovered in connection with other intact cowries or porcelain shells. Nerman (1919), Jansson (1988), Trotzig (1988), Reese (1991), Thunmark-Nylén (1995, 1998, 2000) and Johansson (1999) have published some shell-bearing evidence of this

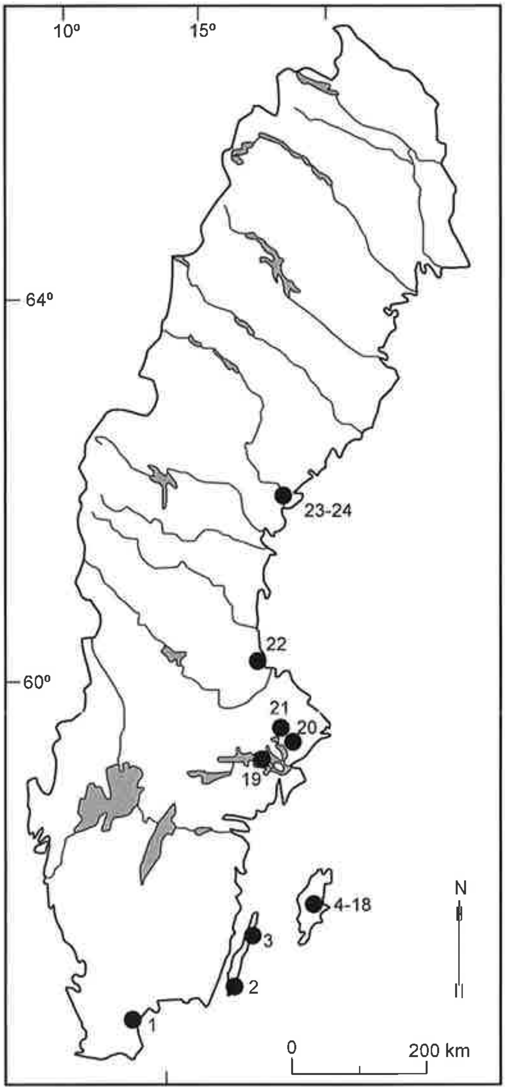

Fig. 10. Indo-Pacific shells found in Sweden
1. Fjälkinge (Sk.) 2. Eketorp (Öl.) 3. Källa (Öl.) 4. Grötlingbo (Go.) 5. Hallvede (Go.) 6. Endregårda (Go.) 7. Kvinnegårda (Go.) 8. Stora Hallvards (Go.) 9. Känne (Go.) 10. Häffinds (Go.) 11. Kylver (Go.) 12. Fröjel (Go.) 13. Bjästavs (Go.) 14. Fjäle (Go.) 15. Vallstenarum (Go.) 16.Slite torg (Go.) 17. Ire 18 (Go.) 18. Tingstäde (Go.)19. Björkö (Up.) 20. Viggbyholm (Up.) 21. Uppsala (Up.) 22. Valbo (Gä.) 23. Djuped (Ån) 24. Björkå bruk (Ån.)

kind. Shell beads have been neglected and a survey of this category is in progress by the author (Johansson, MS). Only five examples will be given to illustrate these findings: 24 disc-shaped shell beads found together with a porcelain shell from a female burial at Kylver, Stånga parish on Gotland (Johansson, 1991a, p. 86, *cf.* Fig. 9), 29 shell beads found together with 6 cowries and beads of glass and bronze from grave 303a, an infant burial, Källa parish on Öland (Fig. 9). The 35 shell beads from Eketorp on Öland were found without other shell-bearing evidence (Iversen & Näsman 1978; Borg 1998). One shell segment from the Black Earth in Birka, 15,4x10,5x6 mm long and with a drilled hole 3 mm in diameter, has been modified into a shell bead. This porcelain shell fragment was found together with several Indo-Pacific shells during the Birka excavations in 1990-95. The 26 shell beads from Smiss1:3, a female grave, in Tingstäde parish on Gotland, were found without any other shell-bearing evidence. These shell beads, measuring from 7,0x4,3 mm to 11,0x6,3mm, were studied by the author in the museum at Visby (Johansson 1999).

One unmodified olive shell (*Oliva bulbosa*) was noted in an ancient refuse heap outside one of the Iron Age houses at Känne, Burs parish on Gotland. Arabic coins, several Roman denarii and potsherds from *terra sigillata* vessels were among the very diverse artefacts and household objects found at this site (Nihlén 1932, pp. 86 ff.). The shell was identified by the author in SHM (Johansson 1991a, p. 86, *cf.* Fig. 7). Olive shells occur naturally in the Indian Ocean.

At least five taxa of exotic marine shells have been found and identified by the author from 24 sites. The majority of these sites are located in the coastal area of eastern Sweden and the shell-bearing evidence derives mainly from female, inhumation graves (*cf.* Fig. 10). Though the map presently shows a strongly eastern Swedish bias for these finds of exotic shells, and thus suggests *eastern trade links*, this is probably a result of lack of knowledge amongst archaeologists and museum personnel. The lack of *exotica* from other parts of Sweden is not a result of poor preservation conditions, such as acid soils, as these shells are very resistant, and survive even in cremation burials. Two new shell species

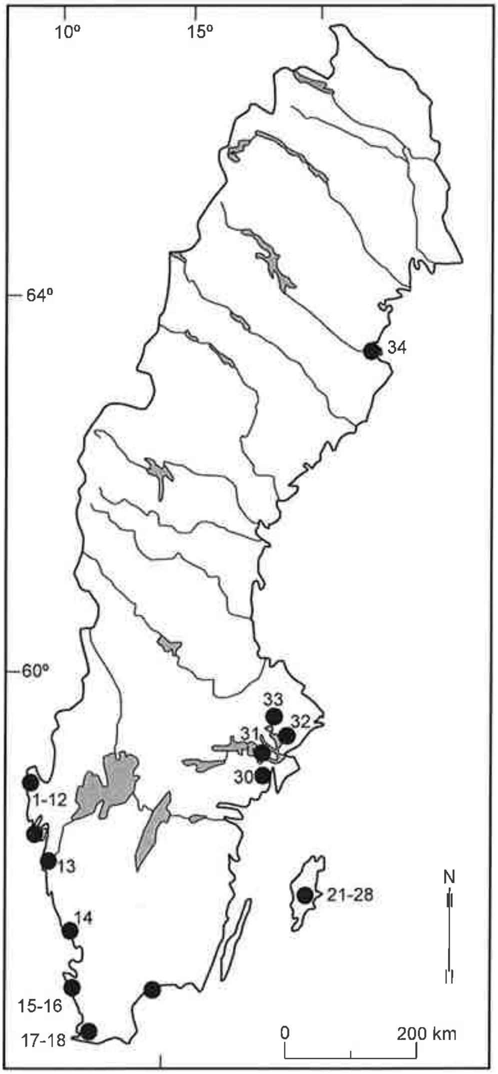

Fig. 11. Direct evidence – marine indigneous species 1. Röe (Bo.) 2. Dammen (Bo.) 3. Berg (Bo.) 4. Sjöbol (Bo.) 5. Ånneröd (Bo.) 6. Rottjärnslid (Bo.) 7. Svartetjärn (Bo.) 8. Rörvik (Bo.) 9. Dafter (Bo.) 10. Uteby (Bo.) 11. Svenseröd (Bo.) 12. Sötorp (Bo.) 13. Huseby klev (Bo.). 14. Lödöse (Vg.) 15. Söndrum (Ha.) 16. Kullaberg (Sk.) 17. Fjärrestad (Sk.) 18. Limhamn (Sk.) 19. Barkåkra (Sk.) 20. Elinelund (Sk.) 21. Siretorp (Bl.) 22. Ajvide (Go.) 23. Fridtorp (Go.) 24. Visby (Go.) 25. Västerbjers (Go.) 26. Ire (Go.) 27. Vårby (Sö.) 28. Björkö (Up.) 29.

Cypraea ventriculus and C. *mauritina* have been identified the first was preserved in the female cremation grave from Valbo and the other from

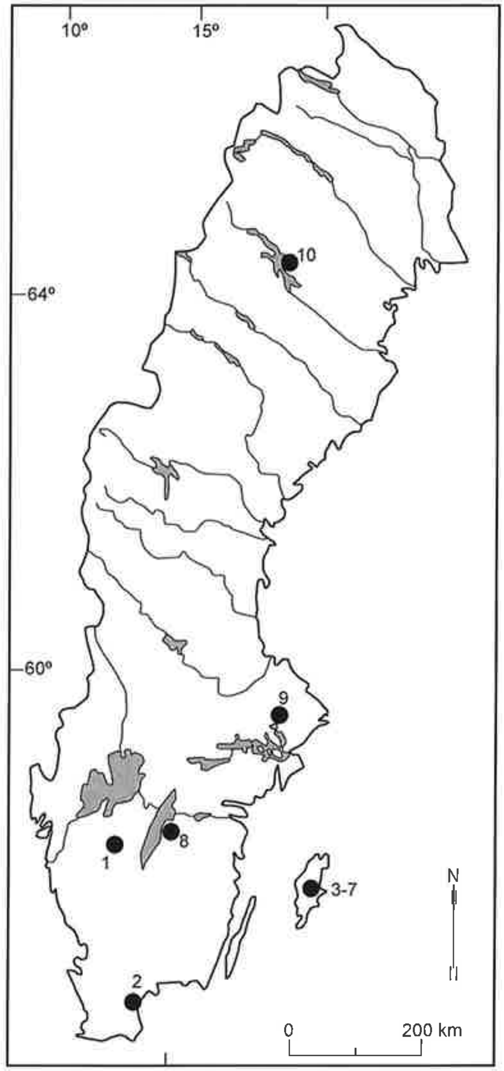

Fig. 12. Direct evidence – limnic species 1. Luttra (Vg.) 2. Torseke (Sk.) 3. Ajvide (Go.) 4. Vallhagar (Go.) 5. Svalings (Go.) 6. Gislause (Go.) 7. Tingstäde (Go.) 8. Alvastra (Ög.) 9. Kransen (Up.) 10. Kakel (La.)

the Viking Age settlement on Björkö. The four settlements, Känne, Häffinds, Eketorp and Kransen, have little shell-bearing evidence, whereas the Viking Age site on Björkö and the cemeteries on Gotland have more diversified evidence.

Limnic species

Shells from large freshwater mussels were found at the bottom of the two chambers of the gallery grave at Torseke, Fjälkinge parish in Skåne. The painter's mussel (*Unio pictorum*) and the thick-shelled river mussel (*U. crassus*) were recovered among unburned bones, pottery, flint and slate objects in the grave (Hildebrand 1870, pp. 25 ff.). Limnic molluscs (*Limnaea* spp., *Bithynia* spp., *Planorbidae* and *Sphaerium*) were recovered by the geologist Hjalmar Olsson in the Ancylus gravel at the bottom of the cultural layer from the Stone Age settlement of Svalings, northern Gotland. Further up in the stratigraphy, in the Litorina gravel, some fresh and brackish water taxa (*Neritina*, *Cardium*, *Mytilus*, *Tellina* and *Hydrobia*) were identified (Nihlén 1927; Munthe 1940). Fresh and brackish water shells (*Theodoxus fluviatilis* forma *littoralis* syn. *Neritina fluviatilis* forma *litoralis*, *Radix balthica* syn. *Limnaea ovata* forma *baltica*), some operculae from *Bithynia tentaculata* and two land snail species (*Cepaea hortensis* and *Fruticicola fruticum* syn. *Bradybaena fruticum* syn. *Eulota fruticum*) were recovered among the artefacts and animal bones from the Stone Age settlement of Gisslause, northern Gotland (Munthe & Hansson 1930; Munthe 1940). One fragment from a thick-shelled freshwater mussel (*Unio* sp. or *Margaritifera margaritifera*) was found at the Stone Age settlement of Kakel, at Lake Hornavan, Arjeplog parish in Lappland (Hallgren 1959, MS). This fragment was studied by the author at SHM and is not mentioned in the later archaeological investigations from this region (Bergman 1995, Bergman *et al.* 2003).

Molluscs, insects and a fossil brachiopod were found together with unburned bones, flint and potsherds in a Neolithic grave at Alvastra in southwestern Östergötland. The site is a damaged megalithic grave dated by radiocarbon to 4490±95 BP (3500-2900 cal. yrs. BC) (Janzon 1984). One small and thick mollusc fragment, slightly bluish in colour, is most probably from a freshwater mussel (cf. Unio). There are significant rodent cuts on one of the shells of the garden snail (Cepaea spp.). The apex of the shell is gnawed off. The land snail (Euomphalia strigella) and the garden snail are both regarded as recent shells, while the freshwater fragment is of subfossil origin. The fossil brachiopod (Dalmanella testudinaria) originates from the local limestone bedrock in the Alvastra region and it resembles a small cockle both in size and in shape (Johansson 1989b, MS).

Limnic snails (*Planorbidae* spp. and *Bithynia* spp.) were found in the clay floor inside house 20 at the Iron Age settlement of Vallhagar, Fröjel parish on Gotland (Thorvildsen & Voss 1955, p. 239). Both freshwater and land snail species were found outside house 7 at Vallhagar. The botanist Bengt Pettersson identified the following species: *Bithynia tentaculata*, *Arianta arbustorum* (syn. *Helicigona arbustorum*), *Oxychilus allarius* (syn. *Hyalina allaria*), *Pupilla muscorum*, *Catinella arenaria* (syn. *Succinea arenaria*) and *Zonitoides nitidus*. The shells were located in the calcareous patches of a deposit outside the house (Klindt-Jensen 1955a, p.141). Limnic and terrestrial snails were found under a stone wall (Gotlandic *vast*, part of a field boundary) within the settlement of Vallhagar. The identified species are: *Cochlicopa lubrica*, *Galba truncatula* (syn. *Lymnaea/Limnea truncatula*), *Planorbis planorbis*, *Pupilla muscorum*, *Catinella arenaria* (syn. *Succinea arenaria*), *Oxyloma pfeifferi* (syn. *S. pfeifferi*), *Succinea putris*, *Vallonia pulchella* and *Vertigo alpestris*. The shells were preserved in a layer of "stone free soil" (Klindt-Jensen 1955b, p. 259). The freshwater snails must have been brought to the settlement together with the clay from a nearby lake, whereas the land snails most probably are from the remains of an ancient buried soil. Two freshwater snail taxa (*Valvata piscinalis* and *Radix balthica* syn. *R. ovata*), and some freshwater pea mussels (Sphaeriidae) were identified by the author in samples taken from Lake Tingstäde träsk, a shallow lake on northern Gotland. The shells indicate a shallow limnic environment, with still or slow-floating water (Johansson 1989a, MS). The samples were taken from an early medieval wooden construction with houses, a "bulwark", situated in the lake (Rönnby 1995). Some additional freshwater mollusc species and two land snail taxa (*Cepaea* spp. and *Cochlicopa lubrica* syn. *Cionella lubrica*) were identified from Lake Tingstäde träsk, in connection with construction work for protection of ground water along the main road close to this shallow lake. The shells were found in a context radiocarbon dated to 8180-9200 BP (Eliason 1999).

Some 30 fragments of a limnic mussel, most probably the swan mussel (cf. *Anodonta cygnea*) were recovered from a damaged double grave at the Stone Age site Ajvide on Gotland. The mother-of-pearl like shell fragments were located in the skull region of the female in grave 62, where a bone comb also was found (Österholm 1999). Large freshwater mussels (*Anodonta* spp. and *Unio* spp.), one cowrie shell and several land species were recovered at the medieval site of Kransen in Uppsala (Jonsson 1984, p. 94). Several small and very fragile limnic molluscs were preserved in the peat deposits around a Neolithic skeleton found 1943 at Rogestorp, Luttra parish in Västergötland. The skeleton was carefully examined and excavated in the laboratory by the osteologist Nils-Gustaf Gejvall and other scientists, who found well-preserved raspberry seeds (*Rubus idaeus*) both in the stomach region of the young female and in the surrounding peat. Since then the skeleton has been known as "the Raspberry girl" from Rogestorp. The palynologist Carl Larsson, Geological Survey of Sweden, carried out a pollen investigation from different parts of the peat surrounding the skeleton, but the molluscs were neglected at that time (Gejvall *et al.* 1952, pp. 410 ff.). The author has studied some of the peat samples, which have been kept since the excavation and the mollusc species identified are: *Succinea* cf. *putris*, *Bithynia tentaculata*, *Planorbis planorbis*, *Physa fontinalis*, *Valvata cristata*, *Stagnicola palustris*, *Radix labiata* (syn. *R. perega*) and some small freshwater mussels (Sphaeriidae). The molluscs indicate a marshy environment, a shallow lake or weedy pond with

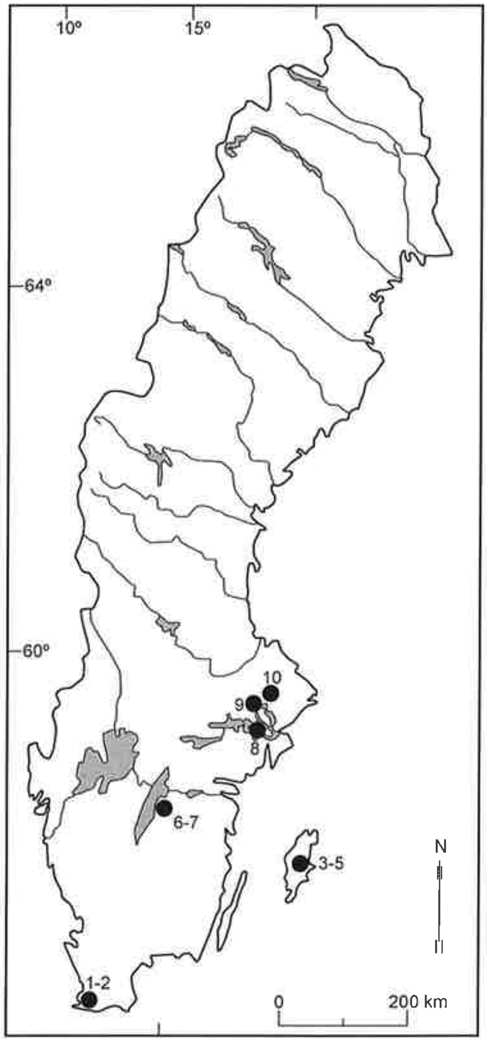

Fig. 13. Direct evidence – terrestrial species
1. Kvarnby (Sk.) 2. Sallerup (Sk.) 3. Hemmor (Go.) 4. Stora Förvar (Go.) 5. Ajvide (Go.) 6. Alvastra (Ög.) 7. Nässja (Ög.) 8. Björkö (Up.) 9. Apalle (Up.) 10. Håga (Up.)

still, or slow-moving water (Johansson 1995, MS). When the skeleton was examined again in 1995 a small bone sample was accelerator dated and the age of the Raspberry girl was determined to 4360±65 BP (3330-2870 cal. yrs. BC). Some mollusc shells were also picked out from the peat samples by staff from SHM. These shells were analysed by the malacologist Anders Warén, Swedish Museum of Natural History, and the taxa were almost identical with the author's identifications above. Warén, however, identified no freshwater mussels and his data are included in the archaeological text (Ahlström & Sten 1995).

Terrestrial species

Land snails were found in the Neolithic flint mines at Kvarnby and Sallerup near Malmö in Skåne, together with antler axes, pottery, flint axes and animal bones. The shells are reported as *Helix* species or as "snails", interpreted by Schnittger (1910, pp. 20 ff.) as food remains. In later geological investigations a study of the provenance of the calcareous bedrock erratics, foraminiferal palynomorphs and diatoms were also included (Ringberg *et al.* 1984). The living mollusc fauna has recently been documented by the malacologist Ted von Proschwitz (2002). Shells from large terrestrial snails (Helicidae syn. *Helix hortensis* and *H. arbustorum*) were found together with flint and bone artefacts potsherds, charred hazelnut shells and animal bones from the Stone Age settlement Hemmor, När parish on southern Gotland (Munthe 1910a, 1940, Nihlén 1927). Eelgrass and large land snails (Helicidae) were found at the Stone Age site of Stora Förvar, a cave on the island of Stora Karlsö, west of Gotland (Schnittger & Rydh 1940). Many of these shells are perforated in the aperture area (Johansson 1991a, p. 84, *cf.* Fig. 2.). When a small soil sample, preserved since the excavation, was dry sieved in the laboratory by the author fragments of large land snails and even small blue mussels (*Mytilus edulis*), eelgrass (*Zostera marina*) and lots of bones from small fish and seal were identified. The land snail taxa are: orchard snail (*Arianta arbustorum*), garden snail (*Cepaea hortensis*), bush snail (*Fruticicola fruticum*) and amber snail (*Succinea putris*) indicating an open, slightly moist and anthropogenic environment (Johansson & Larje 1993, p. 295 f.).

One terrestrial snail shell was recovered in a sediment core taken for pollen analysis at Nässja, a kettle hole site in western Östergötland, not far from Alvastra. The shell is most probably a rayed glass snail *(cf. Nesovitrea hammonis)*, today a very common and eurytopic species, widely distributed throughout western, central and northern Europe. This species has a very wide ecological range, up to the province of Lappland, and is today the most abundant land snail in Sweden (Nilsson 1984; von Proschwitz 1985; Johansson 1991a, MS). The severely damaged shell, however, was found in a sediment sample which was radiocarbon dated to 4750±60 BP (3650-3370 cal. yrs. BC), in connection with a pollen analytical study (Göransson 1991). Terrestrial snails and some limnic molluscs were found together with charred seeds, hazelnuts and subfossil insect remains in the Neolithic pile dwelling at Alvastra in Östergötland (Göransson 1995). There were 10 land snail species and 5 genera of molluscs preserved on the site. The identified taxa are: amber snail (*Succinea* spp.), rayed glass snail (*Nesovitrea* sp.), hairy snail (*Trichia hispida*), slippery moss snail (*Cochlicopa lubricella*), whorl snails (*Vertigo pygmaea, V. substriata, V. genesii*), moss snail (*Pupilla muscorum*), grass snails (*Vallonia pulchella, V. excentrica*), *Carychium tridentatum, Spermodea lamellata,* ramshorn snail (*Planorbis* sp.), *Bithynia* sp. and pea cockles (*Sphaerium* spp.) The shell bearing-evidence indicates an open landscape with anthropogenous impact on the vegetation, but *S. lamellata* mainly occurs in old deciduous woods, for example, beech forests with high moisture in the ground litter (von Proschwitz 1996; Johansson 1995b). Some 15 fragments from the orchard snail (*Arianta arbustorum*) were found in grave 7, at the Neolithic site of Ajvide, Eksta parish on Gotland. The land snail fragments were located in the chest region of the adult man, and no modification was noticed on these fragments (Johansson 1991a, p. 85).

Subfossil land snails have been found at Håga and Apalle, two Bronze Age sites in Uppland. Two terrestrial species, garden snail (*Cepaea hortensis)* and bush snail (*Fruticicola fruticum*), were found in the burial mound at Håga in Uppland. Rutger Sernander regarded the shells to be contemporary with the construction of the Bronze Age grave, archaeologically dated to Montelius period IV (Almgren 1905, p. 25). According to Munthe (1910b, p. 144) it is very likely that man used both the garden snail and the bush snail since both species are edible. The malacologist Henrik Waldén has interpreted these shells as subfossil environmental evidence from the Subboreal climatic period (Waldén 1986a, p. 108). The same two terrestrial species, *C. hortensis* and *F. fruticum* have also been found in the clay floors in some of the houses at the Bronze Age settlement Apalle in Uppland (Johansson 1990b). The shells from the garden snail and the bush snails found inside the houses are most probably a result of human activity, and as such to be regarded as possible food remains.

Subfossil land snails were first recorded on Björkö in 1988 in a house foundation situated near the town rampart. The species found are: amber snail (*Succinea* cf. *putris*), *Euomphalia strigella* and fragments of larger land snails (Helicidae) (Johansson 1990a, 1995a, p. 124 f.; Holmquist Olausson 1993). A soil sample from the site was also dry-sieved in the laboratory and some more mollusc taxa were identified: moss snail (*Pupilla muscorum*), grass snails (*Vallonia* spp.) and whorl snails (*Verigo* spp.). Fragments of mother-of-pearl were also recovered in the soil sample, most probably originating from a large limnic mussel (Johansson 1993).

Indirect evidence

There are sixteen cases of indirect evidence from ten different sites, mainly identified in ceramic vessels. The sites are: Lake Ringsjön, Jonstorp, Carlshögen, Ablahamn and Bulltofta in Skåne, Sjöbol 1:3 (no. 13c.) in Bohuslän, Alvastra pile dwelling in Östergötland, Ajvide on Gotland, Apalle and Björkö in Uppland (cf. Fig. 15).

Marine species

Impressions of the shells of the common pelican's foot snail (*Aporrhais pespelecani*) were identified by Reventlow (1890, p. 96) in potsherds from the Stone Age settlements at Lake Ringsjön in central Skåne. The pointed *apices* of common periwinkles (*Littorina littorea*) were used when decorating some of the pottery at the Neolithic settlement Jonstorp in western Skåne (Lidén 1938, p. 26 f.). In potsherds from the passage grave Carlshögen (Hagestad 14:4), Lödde-köpinge parish in Skåne, Hulthén has (1977, pp. 144 ff.) identified "nail impressions" which can be interpreted as impressions made with shells of the blue mussel. Three potsherds from the Stone Age settlement Ablahamn in western Skåne were decorated with impressions made with shells of the common periwinkles (Askman & Skön 1980, p. 42). From the Neolithic settlement of Ajvide on Gotland potsherd impressions made by shells of the common cockle (*Cerastoderma edule*) were recorded by Österholm (1989, pp. 105 ff., *cf.* Fig. 48, no. 30-32). Shells of the common cockle were used when decorating Neolithic pottery from the pile dwelling at Alvastra in Östergötland (Hulthén 1998, pp. 39 ff.).

Fragments of eelgrass (*Zostera marina*) were found in a Bronze Age barrow at Bulltofta in Skåne, indicating that marine material had been incorporated during the construction of the grave mound (Peterson 1950, p. 50). In contrast to the Barkåkra site discussed above, no mussel shells were, however, recovered during the excavation of this grave (Rausing 1949).

There are shell impressions, or wavy incised lines (Lüdtke & Schietzel 2001, p. 986) in some of the Iron Age pottery found in graves on Björkö in Uppland. Erik Sörling made Dagmar Selling (1955, p. 33, *cf.* note 14) aware of one fragment from a porcelain shell (*Cypraea spp.*) when he was compiling a catalogue of Hjalmar Stolpe's finds from the "Black Earth" of Birka. It is most probably from this kind of exotic shell species that the wavy incised lines, in German called *Wellenlinien*, were made (Johansson, 1995, p. 228, cf. Fig. 6). These wavy lines occur mostly on Selling's ceramic groups AII:1a-1b (Selling (1955, pp. 33 ff.), which today are called Slavonic and Baltic ware (Roslund 2001; Lüdtke & Schietzel 2001).

Limnic species
Reventlow (1887, p. 191 f.) identified impressions made by shells of the freshwater river snail (*Viviparus viviparus* syn. *Paludina viviparus)* in potsherds from Stone Age settlements at Lake Ringsjön in Skåne.

One real pearl was found among the grave goods in a female cremation grave, Bj. 29, on Björkö (Arbman 1943, p. 11 f.; Johansson 1997, p. 219). Another pearl was found among the *c.* 180 glass beads from the same Iron Age burial when Greta Arwidson (1989, p. 51) re-investigated some particular artefacts from the cemeteries on Björkö. The size of the two pearls is 4 and 8 mm respectively. Ten small pearls, 1-3 mm in diameter, have been perforated and placed on a silver ring. The ring was made into a pendant and placed among the glass beads on a necklace found in the female chamber grave, Bj. 854, on Björkö (Arbman 1943, pp. 328 ff.; Arwidson 1989, p. 51).

Terrestrial species
One burnt clay fragment, 16x15x3 mm in size, was found at the Bronze Age settlement of Apalle in Uppland. There is a small, but distinctive flat shell impression on this clay fragment, made with the *apex* of a large land snail species. It is not possible to determine from which mollusc species the impression has been made.

Undetermined species
Crushed molluscs or shell debris have also been used to temper some of the clay prior to making the pot in grave Bj. 369 from Björkö (Selling 1955, p. 60 f., p. 249). Hulthén has identified aragonite, a crystalline form of calcium carbonate, as temper in the same ceramic vessel from grave, Bj. 369 on Björkö. The aragonite is most likely to derive from mollusc shell (Hulthén 1984, pp. 257 ff.; Lüdtke & Schietzel 2001). From excavations during the Birka Project 1990-95 there are another 21 potsherds of shell-tempered ware, representing 2-5 vessels (Bäck 1995, Bäck, MS; Lüdtke & Schietzel 2001). Fourteen potsherds with snail impressions were identified from the Stone Age, (Pitted Ware) settlement at Jonstorp RÄ in western Skåne (Malmer 1969, pp. 55 ff.). Some potsherds with snail impressions were also recorded from Sjöbol 1:3 (no. 13c.), a settlement in Lyse parish, Bohuslän, dating from Stone-Bronze Age (Särlvik *et al.* 1979, p. 344 f.).

Discussion and Conclusions

It is difficult to trace and reconstruct the daily use of molluscs from the archaeological record. In the ethnographic records, however, the use and the role of molluscs can be traced. Mostly, the marine shells are used as personal ornaments, for example, beads, arm rings, necklaces and pendants (Taffinder 1998, pp. 28 ff.). Marine shells have also been used as money (Jackson 1917, pp. 123 ff.; Clark 1963; Lindqvist 1993; Nuytten 1993), as containers (Meehan 1982, pp. 61 ff.), as spoons and as nacre ornaments (Reese 1987, pp. 125 ff.). Some shells can even be used as fishhooks, net sinkers and bait (Claassen 1998), whereas others are used as musical instruments (Janzon 1974, p. 77 f.; Feld 1985, pp. 171 ff.). Toth and Woods (1989) have made experiments on modern oyster and mussel shells and they suggest that the sharpened edges on shells from both oysters and mussels could have been used as shell knives in prehistoric time.

Grouping the shell-bearing evidence
The 87 direct and 16 indirect cases of shell-bearing evidence discussed so far can be considered in various ways. However, in order to meet the seven questions raised earlier the following division will be used in Tab. 1-4 (*cf.* in the Appendix).

* Context - settlement, grave or other.
* Mollusc groups - marine, limnic, terrestrial or undetermined.
* Provenance - local, regional or exotic.

* Location - coastal or inland.
* Environment - natural or anthropogenic.
* Archaeological dating - Stone Age, Bronze Age, Iron Age or medieval period.
* Function - food, personal object, technological tool or unknown.

Direct evidence

Eighty-seven of the 241 cases of direct shell-bearing evidence will be more thoroughly discussed (*cf.* Figs. 11-13 and Tab. 1-3 in the Appendix). Sites with the occurrence of scallops and Indo-Pacific shells were illustrated by maps (*cf.* Fig. 8 and 10) and are not discussed below.

Context, location and origin

Fifty-two cases come from 27 settlements: Dammen, Ånneröd, Siretorp, Ajvide, Rottjärnslid, Svartetjärn, Rörvik, Dafter, Uteby, Svenseröd, Sötorp, Huseby klev, Elinelund, Björkö, Lödöse, "Bryggaren", Lundfors, Svalings, Gisslause, Kakel, Vallhagar, "Kransen", Hemmor, Stora Förvar, Alvastra pile dwelling, Apalle and the "Black Earth" of Birka.

Twenty-five cases come from 22 graves: Berg, Söndrum, Sjöbol 1:3 (nr. 7), Visby grave 2, Västerbjers grave 62, Ire grave 2, 4, 5, 6A-B and 7C Ajvide grave 7, 20 and 62, Fjärrestad, Fridtorp, Barkåkra, Barkarby, Vårby, Torseke, the Alvastra megalithic grave and Håga. Ten cases come from 8 other contexts: Röe, Kullaberg, Limhamn harbour, Tingstäde, Rogestorp, the flint mines Kvarnby and Sallerup and the kettle hole from Nässja.

The majority of the direct shell-bearing evidence can be located in a marine coastal environment except 20 cases which are regarded to be located inland, *i.e.* those from: "Bryggaren", Kakel, the Alvastra megalithic grave, Vallhagar, Tingstäde "bulwark", Lake Tingstäde, Kransen, Rogestorp, Nässja and Alvastra pile dwelling.

Fourty-eight of the occurrences have clearly marine origin 20 are mostly limnic, whereas 19 have a terrestrial origin. Eight of the marine occurrences are mixed with limnic shells, whereas two are associated with terrestrial species. Gisslause and the Black Earth of Birka and "Kransen" are the only threesites where all three ecological categories occur together. The majority of the direct shell-bearing evidence has a local provenance. Only 13 cases can be regarded as regional, *i.e.* Visby, Siretorp, Västerbjers, Ire, Ajvide, the Black Earth of Birka, Barkarby, Torseke, the Alvastra grave, "Bryggaren" and "Kransen" in Uppsala. There are four exotic finds from the "Black Earth" of Birka and "Kransen".

Archaeological dating and function

Fifty-eight occurrences can be dated to Stone Age: Röe, Dammen, Kullaberg, Berg, Söndrum, Ånneröd, Visby, Siretorp, Västerbjers, Ire graves 2, 4, 5, 6A-B and 7C, Ajvide grave 7, 20 and 62, Ajvide, Limhamn harbour, Fjärrestad, Rottjärnslid, Svartetjärn, Rörvik, Dafter, Uteby, Svenseröd, Sötorp, Huseby klev, Elinelund, Lundfors, Fritorp, Torseke, Svalings, Gisslause, Kakel, the Alvastra megalithic grave, Lake Tingstäde, Rogestorp, Kvarnby and Sallerup, Hemmor, Stora Förvar, the kettelhole at Nässja and the Alvastra pile dwelling.

Five can be dated to Bronze Age: Barkåkra, a stone wall from Vallhagar, Håga, and Apalle. Sixteen can be dated to Iron Age: the "Black Earth" of Birka, Björkö, Barkarby, Vårby, house 7 and 20 from Vallhagar. Eight can be dated to medieval period: Lödöse, "Bryggaren", and "Kransen" in Uppsala, and Tingstäde "bulwark". Thirty-seven cases are regarded evidence of food: 19 marine, 4 limnic and perhaps also 4 terrestrial finds. Nineteen are regarded as personal objects: 16 marine, 1 limnic and 2 terrestrial evidence. Eight are regarded as technological tools: 3 marine, 3 limnic and 2 terrestrial. Thirty-three cases are regarded as having unknown function being or part of the natural fauna: 13 marine, 14 limnic and 6 terrestrial evidence.

From several of the earlier archaeological investigations there are only single cases of shell-bearing evidence, but this does indicate that the responsible archaeologists were conscious that subfossil shells could occur in archaeological contexts. It is lucky that not all archaeologists did as Axel Bagge did at Siretorp. Through lack of knowledge, he threw away the Dentalium shells (Bagge & Kjellmark 1939).

It is very possible that few mollusc shells occurred on, for example, the large settlements of Eketorp and Vallhagar. Both sites lie in alkaline environments, and the excavations were carried out with modern techniques, including sieving of excavated soils. Sometimes the shells are recorded among the animal bones in the publications, but this is not true for the sites of Eketorp or Vallhagar. The author has carefully searched for shells from these two sites in the museums in Stockholm and Visby, where most of the artefacts from the sites are stored, but without any result yet.

There is only one site, the "Black Earth" of Birka that provides evidence from all shell categories discussed in this review. There are marine indigenous species, scallop fragments, Indo-Pacific taxa, limnic and terrestrial species as well as indirect shell-bearing evidence. During the Birka Project 1990-95 special attention was given to the occurrence of molluscs and effort was spend by the author to carefully examine the shells during the excavation or very soon after each field season.

International and ethnographic evidence

Marine shells often have an interesting shape and the shells are mostly very brightly coloured. They also have a robust exterior with a smooth, almost polished surface. The white, thin and elongated tusk shells (*Dentalium* spp.), which are open at both ends, make excellent beads. The thick and elongated olive shells (*Oliva* spp.) can easily be turned into pendants. The money cowries (*Cypraea moneta* and *C. annulus*) have been modified into beads and pendants. The large, brightly coloured porcelain shells (*Cypraea* spp.) can be used as pendants, cut up into segments or very thin discs the shells are used as beads. The latter were previously "hidden" within the group of the white so-called limestone beads, which are mostly found in graves on Gotland (Nerman 1919, p. 66 f.). Limnic and terrestrial snail shells are often smaller in size, more fragile and less colourful. The large limnic mussels, except the swan and duck mussels (*Anodonta* spp.), have a very thick shell with an attractive inner surface of mother-of-pearl, which was used as nacre ornaments.

Barter or a local and regional trade and exchange of molluscs can be illustrated by the subfossil occurrence of tusk shells, oysters, limpets, periwinkles and mussel shells in several coastal sites in eastern Sweden. Shells from St. James' scallop occur naturally in the Atlantic Ocean. Scallop shells became a symbol of people who returned from the shrine of Santiago de Compostela in northern Spain. The distribution pattern of St. James' scallop is connected to the pilgrim routes of medieval Europe (Köster 1983; Eriksson 1984; Andersson 1989, 2002; Dunn & Davidsson, eds. 1996; Vunk 2002). Patterns of distribution for the Indo-Pacific species: olive, cowrie and porcelain shells are much more complicated to interpret (Jackson 1917; Reese 1991; Johansson 1995c; Kovács 2000; Vellanoweth 2001; Valk 2002).

From ethnographic records it is known that tusk shells were used as money by Northwest Indian tribes in America (Clark 1963; Nuytten 1993). Cowries, to some extent also olive shells and the porcelain shells, have been circulating in complex, European or worldwide system of trade and exchange. Cowrie shells were used as money in China, India, Africa and in the Middle East region. On some islands in the Pacific Ocean this currency was still in operation even at the beginning of the 19th century (Jackson 1917, pp. 123 ff.; Schilder 1952; Clark 1977; Reese 1991; Lindqvist 1993; Johansson 1995c).

Horse trappings decorated with cowrie shells, doubtless with the object of averting the evil eye, were used in Persia, Egypt, Hungary, Norway and Sweden. In India elephants carry such ornaments. This custom has also been mentioned in the ethnographic records (Jackson 1917, p. 140; Johansson 1990, p. 40 f.). The author has studied a set of horse trappings (headstall) with

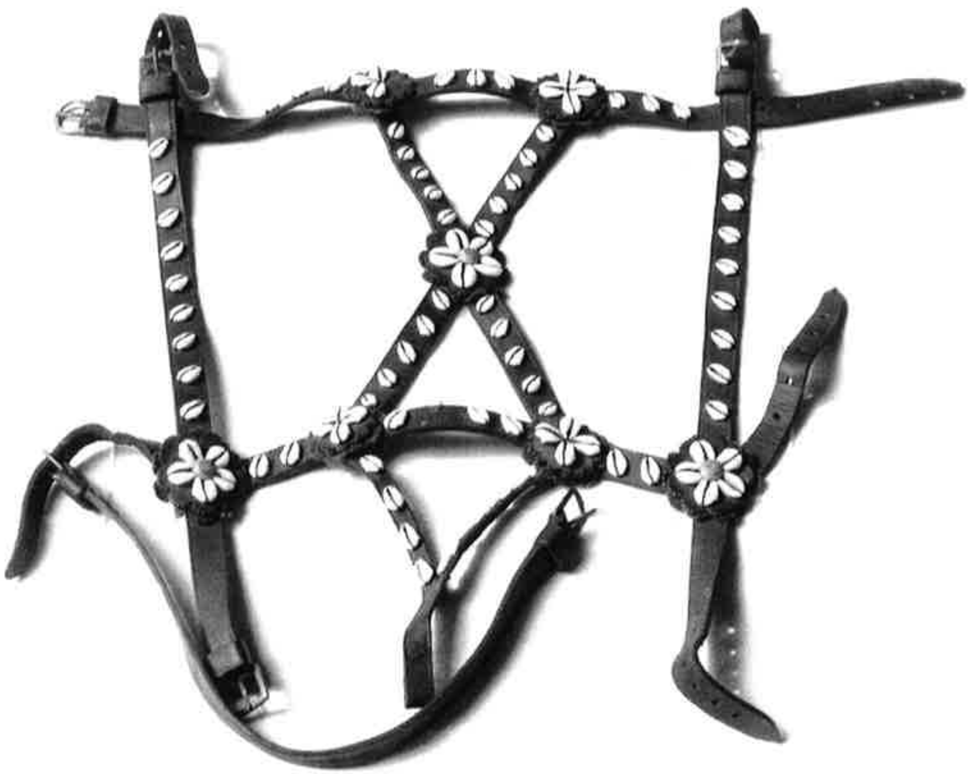

Fig. 14. Headstall decorated with cowrie shells from Haverö parish, Medelpad. Photo: B.M. Johansson.

cowries from Haverö parish in Medelpad, dating from the middle of 19th century AD. There were originally 89 cowries on the headstall, but two are missing. The smallest shell is 14x10 mm and the largest 20x15 mm long (Fig. 14). The *dorsum* had deliberately been ground down on all shells. This modification of the cowries is necessary in order to attach the shells to the leather straps. Four sets of horse trappings decorated with cowries are kept at the National Museum of Cultural History in Stockholm. These were used by members of the Hussar regiment at, *e.g.* the regiments in Skåne and Närke in Stockholm. One set of horse trappings is however, from Nederkalix parish in northern Sweden, where there has been no Hussar regiment. The four items date from the middle of the 19th century (Johansson 1991, MS; Braunstein, pers. com. 2002). The members of the "Brygger regiment", on eastern Gotland, decorated their horses with cowrie headstalls according to Säve (1978, p. 210).

Marine molluscs have been harvested or collected for food or other purposes since the Pleistocene. The oldest Swedish shell deposits are Dammen, Huseby klev and Rottjärnslid, all Mesolithic sites on the West Coast. Historic and ethnographic sources give examples of people eating blue mussels, cockles, limpets, oysters, periwinkles and scallops (Linnaeus 1747; Olsson 1958, pp. 22 ff.; Pettersson 1953, p. 232 f.; Berg 1967, 1968). In the circumpolar area the Eskimos and Saami have eaten mollusc flesh both as a delicacy and as emergency food (Eidlitz 1969, p. 34 f.), while the shells have been used as medicine (Tunón 2000, p. 138), bait or as toys for the children (Anderson 2000, p. 121). The poor people ate limnic molluscs, *e.g.* duck mussels, on

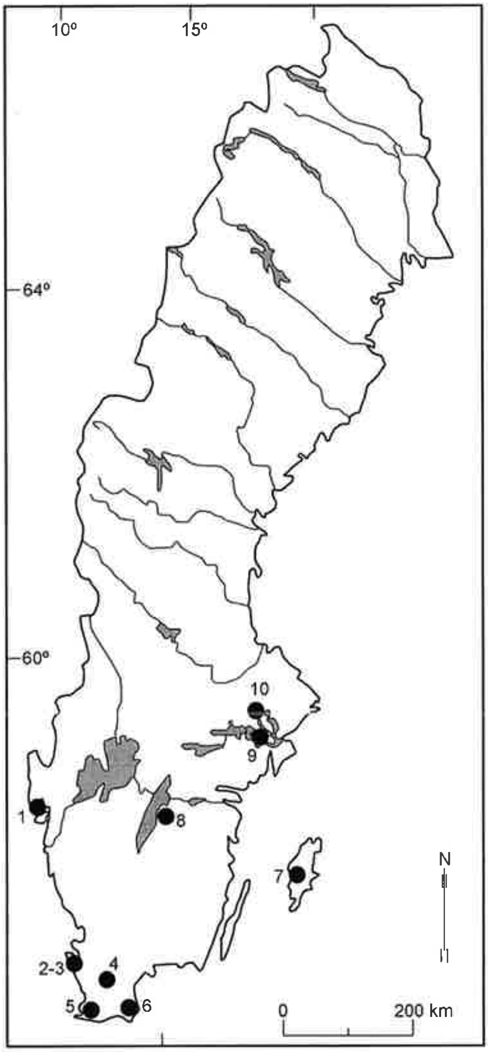

Fig. 15. Indirect shell-bearing sites in Sweden
1. Sjöbol (Bo.) 2. Jonstorp (Sk.) 3. Ablahamn (Sk.) 4. Lake Ringsjön (Sk.) 5. Bulltofta (Sk.) 6. Carlshögen (Sk.) 7. Ajvide (Go.) 8. Alvastra pile dwelling (Ög.)9. Björkö (Up.) 10. Apalle (Up.)

Gotland in historic time (Säve 1979, p. 8). Terrestrial molluscs, *e.g.* bush snail, garden snail and orchard snail, recovered at the flint mines Kvarnby and Sallerup in Skåne, and the molluscs from Håga and Appalle in Uppland are all edible species. Trace element analysis and stable isotope analysis on human bone and teeth have also been conducted, aiming to provide information about patterns of prehistoric diet in Sweden (Arrhenius 1985, 1990; Lidén 1995; Eriksson 2003).

Indirect evidence

Sixteen occurrences of indirect shell-bearing evidence from ten sites will be discussed below (*cf.* Fig. 15 and Tab. IV in the Appendix).

Context, location and origin

Eleven cases come from settlements: Lake Ringsjön, Jonstorp, Jonstorp RÄ, Ablahamn, Sjöbol 1:3 (no. 13c.), Ajvide, Alvastra pile dwelling, Apalle and the "Black Earth" on Björkö, whereas five comes from graves at Carlshögen, Bulltofta and Björkö (Bj. 29, Bj. 363, Bj. 854). Local marine indirect evidence is found at six sites: Jonstorp, Carlshögen, Ablahamn, Ajvide, Alvastra pile dwelling and Bulltofta. Regional marine evidence comes from Lake Ringsjön and exotic marine shell-bearing evidence from Björkö. Local, limnic evidence was found at Lake Ringsjön and regional limnic evidence in two graves, Bj. 29 and Bj. 854, from Björkö. The provenance of the evidence from Jonstorp RÄ in Skåne, Sjöbol 1:3 (no. 13c.) in Bohuslän and grave Bj. 363 and the shell tempered pottery from the "Black Earth" on Björkö cannot be identified. The evidence from Apalle might derive from a local terrestrial mollusc species. All sites except Lake Ringsjön and the Alvastra pile dwelling were located in a coastal area.

Archaeological dating and function

Nine finds can be dated to the Stone Age:Sjöbol 1:3 (no. 13c), Lake Ringsjön, Jonstorp, Jonstorp RÄ, Ablahamn, Carlshögen, Ajvide and Alvastra pile dwelling. Two are from the Bronze Age: Apalle and Bulltofta, whereas the five Björkö finds date from the Iron Age. The shell-bearing evidence for tools and technology dominates in the settlements of Lake Ringsjön, Jonstorp, Jonstorp RÄ, Ablahamn, Sjöbol 1:3 (no. 13c.), Ajvide, Alvastra pile dwelling, Apalle and the Black Earth on Björkö and in the graves from Carlshögen and Bulltofta. Personal objects are found in two graves, Bj. 29 and Bj. 854, from

Björkö. All indirect shell-bearing evidence, except three from Björkö (the freshwater pearls from Bj. 29 and Bj. 854, but also the wavy incised lines in ceramics from Birka) and the evidence from Bulltofta can originally derive from food remains. The food debris has later been re-used by local people, for tempering the clay or decorating the pottery.

The local Swedish marine shells, for example oysters, blue mussels, cockles, periwinkles and limpets, are less colourful and smooth than the exotic shells. Yet the shells are quite robust and as such they have been suitable for making decorative impressions in ceramics from the settlements at Lake Ringsjön, Jonstorp, Ablahamn, Ajvide and from the passage grave at Carlshögen. The three mollusc species identified in the impressed potsherds from Lake Ringsjön and Jonstorp were confirmed by Reventlow (1887, pp. 191 ff.) and Lidén (1938, p. 26 f.) experimentally, by making negative mollusc impressions in plastic clay.

The grave mound at Bulltofta contained eelgrass, which is interpreted as indirect evidence of blue mussels, similar to finds in the grave from Barkåkra. Eelgrass has been found in two Danish Bronze Age mounds, wrapped around the grave urns (Broholm 1946, p. 85). Some pottery at the Alvastra pile dwelling was decorated with impressions made with the common cockle, a regional species in relation to this inland site. The wavy incised lines found on pottery from Björkö were made by a shell fragment of an exotic marine species. The porcelain shell fragment, recovered by Stolpe in the "Black Earth" of Birka, is 24x23x4 mm in size and was illustrated by author (Johansson 1997, p. 227 f.).

The freshwater pearls found in two graves, Bj. 29 and Bj. 854, on Björkö are most probably of regional origin. The two larger pearls from Bj. 29 are probably from the pearl mussel (cf. *Margaritifera margaritifera*), an indigenous Swedish species. It is important to note that the large freshwater pearls are still preserved, even though they were cremated along with the body prior to burial in the soil. Small sized pearls can occasionally also be found in the large freshwater mussels (*Unio* spp. and *Anodonta* spp.), species that have been identified among the subfossil molluscs from Björkö (Johansson 1997, pp. 219 ff.).

The shell impression on the burned clay piece from Apalle cannot be identified as to taxon, but it is probably derived from a large terrestrial snail. Clay-rich areas were found both inside and outside the houses within this Bronze Age settlement and two zoomorphic miniatures of clay, one pig and one sheep figurine, have also been recovered from Apalle (Ullén 1994, 1999). How this clay fragment was made, or why it has been preserved at Apalle is not possible to tell without further studies. Burned clay beads with impressions have been recorded from the Stone Age settlements of Ire, Hemmor and Gullrum on Gotland (Nihlén 1927). Deliberately crushed shells or shell debris have also been used, mixed in the clay as temper. The shell debris that was found in the pot from grave Bj. 369 on Björkö is not possible to identify either to taxon or to origin (Hulthén 1984; Lüdtke & Schietzel 2001). The snail impressions in the potsherds from Jonstorp RÄ in western Skåne and those recovered at Sjöbol 1:3 (nr. 13c) in Bohuslän have not been studied in detail and remain undetermined.

Both direct and indirect shell-bearing evidence is found at the settlements of Ajvide, Apalle, in the Black Earth on Björkö and in some of the graves from Björkö (cf. Fig. 16). The indirect mollusc evidence is limited, compared to the direct evidence, but some indirect mollusc evidence, *e.g.* that found in potsherds, is very significant in the archaeological record. The zoologist Herluf Winge identified some impressions in potsherds from the Danish shell middens as deriving from common cockles (Müller 1888, pp. 277 ff.). This was, however, not confirmed by practical experiments as later was done by Reventlow (1887) and Lidén (1938). The Quaternary geologist Ronnie Liljegren has identified impressions of cockle and blue mussel

CORRELATION BETWEEN DIRECT AND INDIRECT EVIDENCE		
Direct shell-bearing evidence	Site	Indirect shell-bearing evidence
Common cockle (*Cerastoderma*) - Blue mussel (*Mytilus*) Baltic macoma (*Macoma*) Swan mussel (cf. *Anodonta*) Tusk shell (*Dentalium*)	**AJVIDE**	- shell impressions in potsherds made from common cockle
Garden snail (*Cepaea*) - Bush snail (*Bradybaena*) —	**APALLE**	- shell impression in a clay piece made from land snail
Swan mussel (*Anodonta*) - Freshwater mussel (*Unio*) - Freshwater pearl-mussel (*Marg.*) - Shells from undetermined taxa - Porcelain snail (*Cypraea* spp.) —	**BJÖRKÖ**	- small size, real pearls, in grave, Bj. 854 - large size, real pearls, in grave, Bj. 29 - shell temper in a pot, in grave Bj. 369 - shell temper in potsherds, in Black Earth - ware-lines in pottery from Indo-Pacific shell

Fig, 16. Correlation between direct and indirect evidence (Evidence studied by the author is printed in bold).

in algae-rich clayey fine detritus gyttja sediments from Spjälkö, a coastal site in southern Blekinge (Liljegren 1982, p. 82, *cf.* Fig. 1-2). There was nothing left of the calcareous shells. Only the thin outer surface layer of the shells, the *periostracum,* occurred occasionally in the stratigraphy (Liljegren 1982, p. 33). Clark (1977) has discussed the world- wide occurrence of "Cardium ware" pottery, whereas Dolukhanov (1979) illustrate the findings in eastern and southeastern Europe. Tilley (1996) has also discussed "Cardium impressions" in Neolithic European ceramics, but from a symbolic perspective.

Future possibilities

The author's own studies on subfossil mollusc shells from sites in the provinces of Uppland, Gotland, Västergötland and Östergötland, discussed in this paper, have revealed that mollusc analysis is applicable to calcareous Swedish soils. Examples of the application of mollusc analysis to archaeological contexts, and the future potentials for archaeomalacology in Sweden, will be given here.

Pollen analysis gives a general view of the regional vegetation environment over wide areas of the landscape, whereas macroscopic plant remains are more suitable for detailed reconstruction of local habitats, giving a good record of the microclimatic conditions of the site. Subfossil mollusc and insect remains are zoological macrofossils and are best used as indicators of local environment, but like the plant macrofossils, they can also be applied to reconstruct former climates. Pollen grains and diatoms do not preserve very well in lime-rich environments, whereas the molluscs do and they can be numerous. Molluscs are even favoured by the lime-rich environment and in such deposits they are sometimes the only source of palaeoenvironmental evidence.

The analysis and ecological interpretation of subfossil shells from archaeological contexts, both in Europe and North America, have been of great importance when reconstructing prehistoric climatic conditions and local environments. It has also been possible to trace man's impact and behaviour in past landscapes by using land snail analysis. Not only calcareous soils, but also shelter and a damp environment, make it possible for land snails to survive. Clearance of the forests makes living conditions more favourable for the open country species, while breaking up the soil for agriculture makes the living conditions more suitable for other land snail species.

Environmental indicators - Studies of the trace-element content in large freshwater mussel shells (Carell *et al.* 1987, 1995) and similar investigations on shells from recent land snails (Gärdenfors *et al.* 1988) have revealed new environmental mollusc data. A pilot study on archaeological source material, a subfossil *Mytilus edulis* from the Birka Project in 1990-95, indicates an increased eutrophication of the environment already during the Viking Age (Westermark *et al.* 2004). The Particle-Induced X-ray Emission method, or the PIXE-method, has been applied on oyster shells from the shell midden at Cullenamore, Co. Sligo on Ireland. This nuclear method was developed during 1960-70 as a quantitative, non-destructive analysis of various materials. Kuisma-Kursula *et al.* (1995) used the PIXE-method to determine and compare the elemental composition of both recent and subfossil oysters from Ireland, thereby tracing present and prehistoric environmental pollution of the environment.

Climatic conditions - The marine mussel *Venerupis decussatus* recovered in shell deposits from Ånneröd, Svartetjärn, Rörvik and Uteby in western Sweden, discussed above, has a more southern pattern of distribution today, thereby indicating that warmer climatic conditions occurred in Sweden at that time (Hägg 1911; Munthe 1940). A classification of marine molluscs, based on the zoogeographical division of the European seas into an Arctic, Boreal and Lusitanian zone, was first used by Antevs (1917) and further improved by Hessland (1943, p. 273). Feyling-Hansen (1982) applied this method to the marine molluscs, extracted from three cores taken in the province of Bohuslän, in order to distinguish the boundary between the Pleistocene and the Holocene epochs. The colonisation of the terrestrial Swedish mollusc fauna has been correlated to palynological biostratigraphical and chronstratigraphical data by Waldén (1986a). The land snail *Spermodea lamellata* recovered at the Alvastra pile dwelling is a stenotopic species with a mainly Atlantic distribution today. This species is at present, a rare and red-listed woodland taxa and a good indicator of unaltered conditions and long continuity in Sweden (von Proschwitz 1996; Gärdenfors 2000). Oxygen isotope analysis is another valuable method, which can be applied on marine molluscs in order to establish climatic conditions (*cf.* Lowe & Walker 1984, pp. 187 ff.; Classen 1998).

Ancient land use – Subfossil terrestrial molluscs can be preserved in buried soils under stonewalls or under grave mounds. Baudou (1978), Thomas (1985) and the author (Johansson 1990a) have made Swedish archaeologists aware of land snail analysis, used both in Europe and in the New World, for the interpretation of different kinds of ancient land use, *e.g.* gracing and cultivation.

Fishing and collecting patterns - Fishing and collecting patterns on a settlement can be estimated by identifying and quantifying the different species of shells and by estimating the composition of the shell assemblage on the site (Meehan 1977, 1982; Classen 1998; Milner 2002).

Seasonality studies - Growth ring analysis of shells to determine when the shells where collected has been applied to the large freshwater mussels (Carell *et al.* 1987, 1995). This method has also been used on marine shells, *i.e.* common cockle and oysters, when studying the Danish shell middens (Broch & Bourget 1991; Milner 2002).

Dating evidence - The lack of dating evidence in connection with mollusc remains can be solved by radiocarbon dating of shells. It was possible to date marine shells, from several Holocene deposits in Sweden (Feyling-Hansen (1982; Fredén 1988), and Denmark, using the conventional radiocarbon method (Petersen 1987; Petersen & Rasmussen 1995). The Accelerator Mass Spectrometry (AMS) method can date single shells and also shell beads. Direct AMS radiocarbon dating was applied to subfossil olive shell fragments recovered in southern California and fragments of the same type of shell beads found in western Nevada and southern Oregon. Results from the study indicate that this method can be used to test artefact typologies and even confirm trade in shells (Vellanoweth 2001). The Electron Spin Resonance (ESR) and the AMS method has been applied in Estonia to date ancient Baltic Sea deposits and shorelines containing subfossil shells (Molodkov & Raukas 1996; Raukas 1999). Dating shells by applying the AMS-method will make it possible to distinguish mollusc assemblage zones (MAZ) in the same way as the pollen assemblage zones (PAZ) are used today (Sparks 1961; Lozek 1964; Kerney 1977; Waldén 1986a, 1986b; Limondin & Rousseau 1991; Preece & Bridgland 1999; Gedda 1999).

Dietary indicators – Analysis of species composition, so called quantitative shell midden studies, has been conducted more or less successfully to sites, *e.g.* California, Oronsey in Scotland (Meighan 1969; Claassen 1998) and Ertebølle in Denmark (Madsen *et al.* 1900; Andersen & Johansen 1987). The nutritional value of mollusc meat can vary tremendously, depending on the season in which the molluscs have been harvested, but also depending on which mollusc species have been selected. Molluscs are available and can be collected all year around in most parts of the world. The ice covering of lakes, rivers and the Baltic sea during the winter season is a limiting factor for the Scandinavian peninsula. However, a detailed ethnographic study by Meehan (1977, 1982) among the Aborigines in Australia has clearly shown that the people of Arnhem Land visited the shell beds when they felt like doing so and not because of lack of food.

Trade, gift exchange and barter - Every type and occurrence of shell-bearing evidence is important and by accurate scientific determinations of the mollusc taxa a local, regional or worldwide network of shell trade and exchange can be visualised. The tusk shell evidence in the Baltic Sea is an example of a local network, the pattern of shell distribution in Europe for the scallop shells a regional network and finally the pattern of cowrie shell distribution is a world-wide or inter-regional pattern of trade and exchange routes (Jackson 1917; Schilder 1952; Reese 1991). The *kula* exchange system of valuable marine shell objects among the islanders in the Western Pacific is well known and discussed by archaeologists (Tilley 1996, pp. 248 ff., Taffinder 1998, pp. 40 ff.) and anthropologists (Malm 1999, p. 36), just to mention a few.

Shells used in daily life - Shells can, for example, be used as cutting tools, containers, and net sinkers, as fish bait and as personal objects (Meehan 1982; Toth & Wood 1989; Malm 1999). Shells were used as tools for making impressions in pottery, and shell debris can also be used to temper clay (Clark 1977; Dolukhanov 1979; Kriiska 1996). X-ray diffraction analysis has been applied to Neolithic ceramics from sites in Estonia, identifying the content of the clay and temper, for example shell, used in the making of ceramic vessels (Kalm 1996).

Shells used for dyeing - Purple or red colour can be extracted from several species of the *Murex* snail. Tyrian purple was produced at several Mediterranean sites and crushed *Murex* shells dating from *c.* 1500 BC have been found in northern Syria. The Atlantic dog whelk (*Thais lapillus*) has been used in France, Ireland, England, Scotland and Norway as a source of dye since the eight century BC (Reese 1980).

Social studies (Gender and age) - Woman and children are mostly the collectors of molluscs in Ghana (Noe-Nygaard 1967), in Arnhem land as described by Meehan (1977, 1982), in the Kingdom of Tonga illustrated by Malm (1999) and recognised by Bird (2000) among the Meriam children of the Eastern Torres Strait. Other ethnographic records reported by Waselkov (1987) and Claassen (1998) have indicated a similar pattern of collecting shells.

Ceremonial use - In Hindu rituals shells from the great Indian chank (*Turbinella pyrum*) are used as trumpets. Ceremonial trumpets made from triton shells (*Charonia tritonis, C. nodifera*) are found in Neolithic context in Italy and in Bronze Age contexts on Cyprus and at other Mediterranean sites (Jackson 1917; Reese 1982; Skeates 1991).

Symbolic use - Cowries, porcelain and scallop shells, shell beads, "Cardium ware" pottery, perhaps also the Slavonic and the Baltic ware, and the use of real pearls are some of the symbolic uses of shell, discussed in this paper.

Concluding remarks

This paper focuses on shell evidence rather than on sites. It is the author's hope that both field archaeologists and curators in museums will observe and look for mollusc shells in their future work. The use of various molluscs is a matter of taste and choice, when it comes to food, as well as their use as personal objects or as tools. This is as valid for modern man as for our ancestors. It is a striking observation that not a single shell was found, either in the graves or at the Mesolithic settlement of Skateholm (Jonsson 1988, p. 78 f.; Larsson 1988), whereas at Vedbaek in Denmark some 200 perforated shells from a local species, the freshwater nerite (*Theodoxus fluviatilis*) were found in grave 8 (Knutsson 1995: 174; Larje & Johansson 1997:218-219; Taffinder 1998:55-72). Neither have shells been recovered from the recently published sites at Tågerup (Karsten & Knarrström 2001) nor at Bökeberg in Skåne (Karsten 2001), even though the soils and preservation conditions must have been excellent. Is this due to the fact that shells have been overlooked as insignificant evidence, or could there be other reasons for the absence of shell-bearing evidence from these sites in Skåne?

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Appendix

DIRECT EVIDENCE - MARINE SPECIES

Site	Context	Mollusc group	Provenance	Location	Environ-ment	Archaeological dating	Function
1. R e	Other	Marine	Local	Coastal	Natural	Stone Age	Unknown
2. Dammen	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
3. Kullaberg	Other	Marine	Local	Coastal	Natural	Stone Age	Unknown
4. Berg	Grave	Marine	Local	Coastal	Natural	Stone Age	Food ?
5. **Söndrum**	Grave	Marine	Local	Coastal	Natural	Stone Age	Food ?
6. Sj bol 1:3 (nr. 7)	Grave	Marine	Local	Coastal	Natural	Stone Age	Unknown
7. n ner d	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food
	Settlement	Terrestrial	Local	Coastal	Natural	Stone Age	Unknown
8. Visby, grave 2	Grave	Marine	Local	Coastal	Natural	Stone Age	Personal object
	Grave	Marine	Regional	Coastal	Anthrop.	Stone Age	Personal object
9. Siretorp	Settlement	Marine	Local ?	Coastal	Anthrop.	Stone Age	Personal object ?
10. **Västerbjers, 62**	Grave	Marine	Regional	Coastal	Anthrop.	Stone Age	Personal object
11. Ire, 4	Grave	Marine	Regional	Coastal	Anthrop.	Stone Age	Personal object
12. Ire, 6B	Grave	Marine	Regional	Coastal	Anthrop.	Stone Age	Personal object
13. **Ajvide, grave 20**	Grave	Marine	Local	Coastal	Natural	Stone Age	Unknown
	Grave	Marine	Regional	Coastal	Anthrop.	Stone Age	Personal object
14. Ire, 2,	Grave	Marine	Local	Coastal	Natural	Stone Age	Personal object
15. Ire, 5	Grave	Marine	Local	Coastal	Natural	Stone Age	Personal object
16. Ire, 6A	Grave	Marine	Local	Coastal	Natural	Stone Age	Personal object
17. Ire, grave 7C	Grave	Marine	Local	Coastal	Natural	Stone Age	Personal objekt ?
18. **Ajvide**	Settlement	Marine	Local	Coastal	Natural	Stone Age	Unknown
19. Limhamn	Other	Marine	Local ?	Coastal	Natural	Stone Age	Unknown
20. **Fjärrestad**	Grave	Marine	Regional	Coastal	Anthrop.	Stone Age	Food ?
21. Rottj rnslid	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
22. Svartetj rn	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
23. R rvik	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
24. Dafter	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
25. Uteby	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
26. Svenser d	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
27. S torp	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
28. Huseby klev	Settlement	Marine	Local	Coastal	Natural	Stone Age	Food ?
29. Elinelund	Settlement	Marine	Local ?	Coastal	Anthrop.	Stone Age	Food ?
	Settlement	Limnic	Local	Coastal	Natural	Stone Age	Unknown
30. Lundfors	Settlement	Marine	Local	Coastal	Natural	Stone Age	Unknown
31. Fridtorp	Grave	Marine	Local	Coastal	Natural	Stone Age	Personal object
32. Bark kr a	Grave	Marine	Local	Coastal	Natural	Bronze Age	Unknown
33. Barkarby	Grave	Marine	Regional	Coastal	Anthrop.	Iron Age	Personal object
34. V rby	Grave	Marine	Local	Coastal	Natural	Iron Age	Unknown
35. **Birka**, 1870-74	Settlement	Marine	Local	Coastal	Natural	Iron Age	Food ?
Black Earth	Settlement	Limnic	Regional	Coastal	Anthrop.	Iron Age	Personal object
	Settlement	Exotic	Exotic	Coastal	Anthrop.	Iron Age	Technology
36. **Birka**, 1970-71	Settlement	Marine	Regional	Coastal	Natural	Iron Age	Food ?
Black Earth	Settlement	Limnic	Local	Coastal	Anthrop.	Iron Age	Personal object
	Settlement	Marine	Exotic	Coastal	Anthrop.	Iron Age	Technology
37. **Birka**, 1990-95	Settlement	Marine	Regional	Coastal	Anthrop.	Iron Age	Food ?
Black Earth	Settlement	Limnic	Local	Coastal	Natural	Iron Age	Personal object
	Settlement	Terrestrial	Exotic	Coastal	Anthrop.	Iron Age	Technology
38. L d se	Settlement	Marine	Regional	Coastal	Natural	Medieval period	Food
	Settlement	Marine	Local	Coastal	Anthrop.	Medieval period	Unknown
39. **Bryggaren**	**Settlement**	**Limnic**	**Local**	**Inland**	**Anthrop.**	**Medieval period**	**Unknown**
	Settlement	Marine	Regional	Inland	Anthrop.	Medieval period	Food

Table I. Direct evidence – Marine species (Evidence studied by the author is printed in **bold**).

DIRECT EVIDENCE - LIMNIC SPECIES

Sites	Context	Mollusc group	Provenance	Location	Environ-ment	Archaeological dating	Function
1. Torseke	Grave	Limnic	Local	Coastal	Anthrop.	Stone Age	Food ?
2. Svalings	Settlement	Limnic	Local	Coastal	Natural	Stone Age	Unknown
	Settlement	Marine	Local	Coastal	Natural	Stone Age	Technology ?
3. Gisslause	Settlement	Limnic	Local	Coastal	Natural	Stone Age	Unknown
	Settlement	Marine	Local	Coastal	Anthrop.	Stone Age	Technology ?
	Settlement	Terrestrial	Local	Coastal	Natural	Stone Age	Unknown
4. **Kakel**	Settlement	Limnic	Local	Inland	Anthrop.	Stone Age	Food ?
5. **Alvastra, grave**	Grave	Limnic	Local	Inland	Anthrop.	Stone Age	Food ?
	Grave	Terrestrial	Local	Inland	Natural	Stone Age	Unknown
6. **Rogestorp**	Other	Limnic	Local	Inland	Anthrop	Stone Age	Unknown
7. Ajvide, grave 62	Grave	Limnic	Local	Coastal	Anthrop.	Stone Age	Technology ?
8. Lake Tingst de tr sk	Other	Limnic	Local	Inland	Natural	Stone Age	Unknown
	Other	Terrestrial	Local	Inland	Natural	Stone Age	Unknown
9. Vallhagar, vast	Settlement	Limnic	Local	Inland	Anthrop.	Bronze Age	Unknown
	Settlement	Terrestrial	Local	Inland	Natural.	Bronze Age	Unknown
10. Vallhagar, house 7	Settlement	Limnic	Local	Inland	Anthrop.	Iron Age	Unknown
	Settlement	Terrestrial	Local	Inland	Natural	Iron Age	Unknown
11. Vallhagar, house 20	Settlement	Limnic	Local	Inland	Anthrop.	Iron Age	Unknown
12. **Tingstäde bulwark**	Other	Limnic	Local	Inland	Natural	Medieval period	Unknown
13. Kransen, Uppsala	Settlement	Limnic	Local	Inland	Anthrop.	Medieval period	Food ?
	Settlement	Terrestrial	Local	Inland	Natural	Medieval period	Unknown
	Settlement	Marine	Exotic	Inland	Anthrop.	Medieval period	Personal object

Table II. Direct evidence – limnic species (Evidence studied by the author is printed in **bold**).

DIRECT EVIDENCE - TERRESTRIAL SPECIES

Sites	Context	Mollusc group	Provenance	Location	Environ-ment	Archaeological dating	Function
1. Kvarnby	Other	Terrestrial	Local	Coastal	Natural	Stone Age	Food ?
2. Sallerup	Other	Terrestrial	Local	Coastal	Natural	Stone Age	Food ?
3. Hemmor	Settlement	Terrestrial	Local	Coastal	Natural	Stone Age	Technology ?
4. **Stora Förvar**	Settlement	Terrestrial	Local	Coastal	Natural	Stone Age	Personal object?
5. **Stora Förvar**	Settlement	Terrestrial	Local	Coastal	Natural	Stone Age	Unknown
	Settlement	Marine	Local	Coastal	Anthrop.	Stone Age	Unknown
6. **Nässja**	Other	Terrestrial	Local	Inland	Natural	Stone Age	Unknown
7. **Alvastra pile dwell.**	Settlement	Terrestrial	Local	Inland	Natural	Stone Age	Unknown
	Settlement	Limnic	Local	Inland	Natural	Stone Age	Unknown
8. **Ajvide, grave 7**	Grave	Terrestrial	Local	Coastal	Natural	Stone Age	Personal object?
9. H g a	Grave	Terrestrial	Local	Coastal	Natural	Bronze Age	Food ?
10. **Apalle**	Settlement	Terrestrial	Local	Coastal	Natural	Bronze Age	Food ?
11. **Björkö, 1988-93**	Settlement	Terrestrial	Local	Coastal	Natural	Iron Age	Unknown
	Settlement	Limnic	Regional	Coastal	Anthrop.	Iron Age	Technology ?

Table III. Direct evidence – terrestrial species (Evidence studied by the author is printed in **bold**).

INDIRECT EVIDENCE

Sites	Context	Mollusc group	Provenance	Location	Environ-ment	Archaeological dating	Function
1. Lake Ringsj n	Settlement	Marine	Regional	Inland	Anthrop.	Stone Age	Technology
2. Lake Ringsj n	Settlement	Limnic	Local	Inland	Anthrop.	Stone Age	Technology
3. Jonstorp	Settlement	Marine	Local	Coastal	Anthrop.	Stone Age	Technology
4. Jonstrp R	Settlement	Undetermined	Local?	Coastal	Anthrop.	Stone Age	Technology
5. Carlsh gen	Grave	Marine	Local	Coastal	Anthrop.	Stone Age	Technology
6. Ablahamn	Settlement	Marine	Local	Coastal	Anthrop.	Stone Age	Technology
7. Sj bol 1:3 (no. 13)	Settlement	Undetermined	Local?	Coastal	Anthrop.	Stone Age	Technology
8. Ajvide	Settlement	Marine	Local	Coastal	Anthrop.	Stone Age	Technology
9. Alvastra pile dwelling	Settlement	Marine	Local	Inland	Anthrop.	Stone Age	Technology
10. Bulltofta	Grave	Marine	Local	Coastal	Anthrop.	Bronze Age	Unknown
11. **Apalle**	Settlement	Terrestrial ?	Local ?	Coastal	Natural	Bronze Age	Unknown
12. Bj r k , Black Earth	Settlement	Marine	Exotic	Coastal	Anthrop.	Iron Age	Technology
13. Bj r k , Bj. 29	Grave	Limnic	Regional	Coastal	Anthrop.	Iron Age	Personal object
14. Bj r k , Bj. 854	Grave	Limnic	Regional	Coastal	Anthrop.	Iron Age	Personal object
15. Bj r k , Bj. 363	Grave	Undetermined	Local?	Coastal	Anthrop.	Iron Age	Technology
16. Bj r k , Black Earth	Settlement	Undetermined	Local?	Coastal	Anthrop.	Iron Age	Technology

Table IV. Indirect evidence (Evidence studied by the author is printed in **bold**).