DATES FOR ORIGIN AND DIFFUSION OF THE EUROPEAN LOGBOAT

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ABSTRACT: More than 600 radiocarbon and dendrodates for European logboats are presented. The progressive but surprisingly slow adoption of the logboat from two core areas (?) is documented.

KEYWORDS: Europe, prehistory, history, logboats, skin/barkboats, paddles, radiocarbon dating, dendrodating.

1. INTRODUCTION

Logboats have an almost world-wide distribution. It is hardly likely that they have a single common origin, however. More likely is that the logboat was invented in different places, at different times. The basic idea is rather simple, after all. Even within Europe several centres of development cannot be excluded beforehand. Only a large series of dates can show where the European logboat was introduced first.

According to our information more than 3500 'archaeological' finds of logboats are documented in Europe. This paper will not deal with the development of the logboat through time, or with technical details and performance. In fact the monograph in two volumes on Central-European logboats by Arnold (1995; 1996) gives all necessary information. Some general trends in development and the introduction of technological improvement are noticeable over large areas. Side by side with more sophisticated logboats more primitive looking vessels were produced, however. That makes it very difficult to date a logboat just by its appearance. Only occasionally the combination of shape and wood species used may give clues to the dating. The Late Mesolithic canoes in Denmark, for example, are clearly recognizable by the use of soft wood species like alder and lime, the long and slender shape, the U-shaped cross-section and some technical details (Andersen, 1994: p. 10). But as a rule dating a logboat is only possible through archaeological association, or by scientific dating methods like radiocarbon or dendrodating, or indirectly through pollen analysis.

Dating by association with archaeological objects is rare. Objects are seldom found in logboats. Occasionally artefacts are found outside, but near logboats, but the actual association remains to be proven in such cases. Near one of the Ukrainean logboats (see 6.4) 15 bronze vessels of the 5th century BC are said to be found. The boat itself turned out to be considerably younger.

Sometimes logboats are found in an archaeological context, mostly in the form of discarded ones, used secondarily in foundations etc. Archaeological dating is possible in such cases, but surprises are possible. Part of a logboat of the Younger Ertebølle culture, according to its ^{14}C-date of c. 5400 BP, was found standing upright in settlement layers of the Older Ertebølle culture, dated to c. 5800 BP, at Maglemosegårds Vaenge (Rieck & Crumlin-Pedersen, 1988). Some Swiss logboats were found in stratified lakeside settlements, and could be dated fairly accurately by dendrodating the layers above and below. Caution is needed, however, in case of logboats found near settlements, or on top of submerged settlements. A good example is the medieval logboat found in front of the Early Bronze Age settlement Ezerovo III in Lake Varna, Bulgaria (see 6.2).

In most cases radiocarbon and/or dendrodating are the only way to get an accurate date. Radiocarbon dating is almost always possible, provided the wood has not been treated with chemicals. Recently large numbers of logboats from Ireland and Poland, and smaller numbers from Scotland, the Netherlands and Slovenia were dated in the radiocarbon laboratory of Groningen at our request. In addition we collected radiocarbon dates carried out by other laboratories, and dendrodates for European logboats. At the moment we have 551 radiocarbon en 58 dendrodates at our disposal, but we realize that this figure will have been exceeded by the time this paper is published. Nevertheless, the publication of these dates presents a clear picture of the areas where the logboat was used first, and of its diffusion across Europe. These dates are presented here by country, after a short introduction in which the most recent numbers of documented finds, and published and unpublished studies are mentioned. No distinction has been made between simple logboats, and paired, expanded and/or extended ones (cf. McGrail, 1987: pp. 66-75).

2. IRELAND AND BRITAIN

2.1. Ireland

An attempt to catalogue Irish logboats was undertaken by U. MacDowell who in an unpublished MA thesis

Table 1. Dated logboats of Ireland.[1]

Radiocarbon dates		
Bond's Bridge, Cos Armagh/Tyrone	GrN-14741	245±15
The Argory, Co. Armagh	UB-3871	272±35
Derrygally 2, Co. Tyrone	GrN-16868	287±16
Drumnacor 1, Co. Longford	GrN-18757	290±25
Northern Ireland	GrN-14744	305±30
Urney Glebe, Co. Tyrone	GrN-16865	310±30
Clooncunny 2, Co. Sligo	GrN-18750	330±20
Cloongee B, Co. Mayo	GrN-18752	335±20
Drumnacor 2, Co. Longford	GrN-18758	340±20
Fossa More, Co. Clare	GrN-18760	375±20
Fahy, Co. Leitrim	GrN-18759	385±30
Cavan, Co. Leitrim	GrN-18748	385±25
Carr, Co. Fermanagh	GrN-14739	395±25
Derryloughan B, Co. Tyrone	GrN-14738	410±35
Rosserk, Co. Mayo	GrN-18762	410±30
Derrybroughas, Co. Armagh	UB-2397	420±45
Castledargan, Co. Sligo	GrN-18747	430±30
Leamore, Co. Roscommon	GrN-18761	515±25
Co. Leitrim ('Cambridge')	Q-1364	535±45
Derryloughan A, Co. Tyrone	GrN-14737	570±25
Copney, Co. Armagh	GrN-16866	585±30
Maghery, Co. Armagh	GrN-14742	590±20
Derrygally 1, Co. Tyrone	GrN-16867	840±20
R. Foyle 2, Co. Tyrone	GrN-16872	880±20
Templemoyle A, Co. Galway	GrN-18763	925±20
Church Island, Co. Derry	GrN-16870	942±17
Clooncunny 1, Co. Sligo	GrN-18749	990±20
R. Foyle 3, Co. Tyrone	GrN-16873	1070±30
Derrygally 3, Co. Tyrone	GrN-16869	1140±20
Inch, Co. Down	UB-3651	1188±22
Callow, Co. Roscommon	GrN-18746	1195±25
Levaghery, Co. Down	UB-3549	1197±33
Lough Neagh, Co. Armagh	GrN-17241	1245±30
R. Foyle 1, Co. Tyrone	GrN-16871	1410±30
West Ward 1, Co. Tyrone	GrN-16863	1440±30
West Ward 3, Co. Tyrone	GrN-19282	1440±30
West Ward 2, Co. Tyrone	GrN-16864	1470±30
Corlummin 2, Co. Mayo	GrN-18755	1520±20
Corlummin 1, Co. Mayo	GrN-18754	1590±20
Collenstown, Co. Westmeath	GrN-18753	1590±20
Curragh, Co. Cork	GrN-19693	1605±35
Drummans Lower, Co. Leitrim	GrN-18756	1630±30
Crevinish Bay 1, Co. Fermanagh	HAR-1969	1860±70
Gortgill, Co. Antrim	UB-2681	2060±60
Ballinphort, Co. Westmeath	GrN-20551	2100±20
Eskragh, Co. Tyrone	GrN-14740	2165±25
Kilraghts, Co. Antrim	GrN-14743	2405±20
Derrybrusk 1, Co. Fermanagh	UB-3846	2876±34
Derrybrusk 2, Co. Fermanagh	UB-3848	2912±38
Tonregee, Co. Mayo	Beta-78159	3080±60
Curraghtarsna, Co. Tipperary	GrN-12618	3120±35
Cloongalloon, Co. Mayo	GrN-18751	3265±30
Ballyvoghan, Co. Limerick	GrN-18361	3300±30
Teeronea, Co. Clare	GrN-15968	3310±35
Cuilmore, Co. Mayo	Beta-83891	3410±80
Carrowneden, Co. Mayo	Beta-85979	3890±90
Lurgan, Co. Galway	GrN-18565	3940±25
Ballygowan, Co. Armagh	GrN-20550	4660±40
Carrigdirty, Co. Limerick	GrN-21936	5820±40

Table 1 (Cont.).

Dendrodates (site, age of youngest ring, corresponding ^{14}C-age)		
Mullynascarty, Co. Fermanagh	1520 AD	330 BP
Strabane, Lifford Br. Co. Derry	1393 AD	580 BP
Unprovenanced, NMI	1273 AD	730 BP
Summerville, Co. Galway	1001 AD	1050 BP
Oxford Island, Co. Armagh (Kinnegoe)	492 AD	1590 BP
Strabane, Co. Derry	431 AD	1610 BP
Ballagh Lough, Co. Monaghan	999 BC	2830 BP
Inch Abbey, Co. Down	2771 BC	4140 BP

entitled 'Irish logboats' (University College, Dublin, 1983) listed 283 possible logboats, based partly on actual remains and recently inspected but not curated finds, but largely on old and often inadequately reported finds. She illustrated fifty-four specimens and referred to two radiocarbon dates and two dendrodates. At present, N. Gregory is working on a comparison of Irish and Scottish logboats (University of Edinburgh). An important contribution to Irish logboat studies was made by Lucas (1963) who showed on the basis of literary evidence, that logboats were in widespread use until the late 17th century and probably well into the 18th century. Recently Fry (1995) found evidence for the use of logboats in Ulster as late as 1796. In the intervening years, many new finds of logboats have been reported, especially from Northern Ireland. The total number of logboats is now approximately 350. Of these 59 have been dated by radiocarbon and 8 by dendrochronology. The following datelist is largely based on unpublished material. Detailed information on find circumstances, present whereabouts, etc. are presented elsewhere (Lanting & Brindley, 1996). All dated logboats were made of oak, with the exceptions of Derrybrusk 1 and 2, which were made of alder, and Carrigdirty, made of poplar.

The datelist, table 1, presents the dates in order of age. It includes both radiocarbon dates and dendrodates for Irish logboats. To make the dendrodates more easily comparable, they have been translated into radiocarbon years, using the calibration curve published by Pearson et al. in *Radiocarbon* 28/2B, 1986 (for the rejection of the 1993 curve, see McCormac et al., 1995). This may seem unusual, for normally these curves are used to convert radiocarbon dates into calendar years. This procedure has one advantage, however; each dendrodate has only one corresponding radiocarbon age whereas a radiocarbon date usually has several ranges of calendar years. It is assumed that the radiocarbon dated samples contained the youngest rings present. An unknown number of year and sapwood rings will have disappeared, however. To make radiocarbon and dendrodates more comparable, the radiocarbon date of the youngest ring present in the dendrosample has been calculated, not of the possible felling date of the tree in question. Where

Table 2. Dated logboats of Britain.

Radiocarbon dates				
	Weybridge		HAR-4996	410±60
104	Oakley Park	Q-3135	470±50	505±35
		Q-1398	525±40	
127	Smallburgh	Q-3130		520±45
66	Hulton Abbey	Q-3137		545±40
105	Oakmere	Q-1495		560±40
79	Llyn Llydaw (W)	Q-1243		640±50
49	Giggleswick Tarn	Q-1245	615±40	650±30
		Q-3049	690±40	
70	Kentmere 1	D-71	650±120	730±65
		Q-3126	740±35	
73	Kew	Q-3038	720±40	740±30
		Q-1453	770±45	
146	Warrington 1	Q-1390		760±60
M21	Closeburn	GrN-19279		810±50
M49	East Green/Forfar 2	Q-3143		860±50
152	Warrington 7	Q-1395		860±60
69	Irlam	Q-1456		865±40
103	North Stoke	Q-3127	860±40	880±35
		Q-1387	915±50	
149	Warrington 4	Q-1393		880±60
M64	Springfield 1	GrN-19280		885±50
79	Llandrindod Wells (W)	Q-3136		915±40
11	Barton	Q-1396		920±65
147	Warrington 2	Q-1391		930±50
156	Warrington 11	Birm-269		950±90
31	Chirbury 1	Q-3051	930±40	960±35
		Q-1247	1000±50	
132	Stanley Ferry	HAR-2835		960±70
6	Astbury	Q-1457		980±50
150	Warrington 5	Q-1394		990±65
M14	Cambuskenneth	GrN-19281		1035±45
148	Warrington 3	Q-1392		1075±60
123	Sewardstone	Q-3052	1070±45	1100±35
		Q-3040	1130±45	
9	Banks	Q-1386		1120±45
78	Llyn Llangorse (W)	Q-857		1135±60
M118	Loch of Kinnordy	Q-3142		1215±45
23	Burpham 1	Q-1455	1200±40	1220±30
		Q-3139	1245±45	
129	South Stoke	Q-1454	1150±90	1255±50
		Q-3128	1275±35	
137	Thornaby	Q-3132		1265±40
74	Knockin	Q-1248		1270±45
141	Walthamstow	Q-3041	1255±40	1290±30
		Q-1388	1335±45	
1	Amberley 1	Q-3140		1290±50
3	Amberley 3	Q-828		1310±70
118	Ryton	Q-3131	1340±50	1380±35
		Q-1379	1410±40	
M96	Loch Doon 1	SRR-501		1441±110
M38	Errol 2	Q-3121	1465±40	1490±30
		Q-3141	1520±45	
-	Mattersea Thorpe	HAR-4997		1490±80
54	Hardham 1	Q-3138	1530±45	1550±35
		Q-1244	1575±50	
142	Walton	Q-3042		1585±50
55	Hardham 2	Q-827		1655±50
122	Seasalter	OxA-1054		1740±80
168	Wisley	Q-1399		1780±45
7	Baddiley Mere	Q-1496		1980±50

Table 2 (Cont.).

M44	Erskine 6	GU-1016		1995±50
170	Woolwich	Q-1389	1990±50	2035±35
		Q-3039	2070±45	
M92	Loch Lotus/Arthur 1	SRR-403		2051±80
50	Glastonbury 1	Q-3125	2095±45	2105±35
		Q-1563	2120±50	
57	Holme Pierrepont 1	Birm-132	2180±110	2210±60
		Q-1473	2220±55	
41	Clifton 2	Q-1375	2175±50	2235±35
		Q-3134	2270±50	
112	Poole Harbour	Q-821		2245±50
40	Clifton 1	Q-1374	2250±45	2275±35
		Q-3048	2310±50	
47	Ellesmere	Q-3050	2260±45	2285±35
		Q-1246	2320±50	
124	Shapwick	Q-357		2305±120
14	Blae Tarn	Q-1497		2550±50
108	Peterborough	Q-3129	2535±40	2565±35
		Q-1564	2610±50	
22	Brigg	Q-78		2784±100
126	Short Ferry	Q-79		2795±100
5	Appleby	Q-80	3050±80	
		Q-1462	3080±60	3120±35
		Q-3133	3135±40	
28	Chapel Flat Dyke	BM-213[2]	3450±120	
		Q-3122	3500±40	3520±45
		Q-3046	3590±60	
19	Branthwaite	Q-288	3520±100	3540±55
		Q-3053	3545±50	
M20	Locharbriggs	SRR-326		3754±125
Dendrodates				
Clapton	932 AD	1110 BP		
Hasholme	323 BC	2200 BP[3]		

two or more dates are available for the same boat the weighed mean is calculated, unless these samples were taken from different parts of the trunk.

2.2. Great Britain

In his survey of logboats of England and Wales, McGrail (1978) described 179 finds, while Mowat (1996) lists another 154 from Scotland. The total number of recorded logboats in Great Britain may be estimated as being in the order of 350-400. Of these, at least 66 have been dated by radiocarbon, and 2 by dendrodating. Most datings were carried out in Cambridge in the context of a research programme on early boats. Quite a number of boats were dated more than once in order to test different ways of pretreatment in the laboratory. These Cambridge dates are all published (Switsur, 1989). Since then, no other logboats have been dated by this laboratory (Switsur, pers. comm.). Scottish logboats are under-represented at the moment. All dated logboats are of oak, with the exception of Giggleswick Tarn (ash) and Warrington 11 (elm).

The above does not include the logboat from 'Cambridge?' (McGrail, 1978: cat.No. 27) as the original findspot appears to be County Leitrim, Ireland.

2.3. Comment: Ireland and Great Britain

The period during which logboats were used in Ireland and Britain is not immediately apparent from the datelists. This becomes more obvious when the dates are presented in a graph. In figure 1 the number of dated logboats per period of 250 radiocarbon years is given. Only the radiocarbon ages have been taken in account, not the standard deviations. From the figure it is immediately obvious that most of the logboats are very young. Of the 134 dates, 55 are younger than 1000 BP, and 99 younger than 2000 BP. The peak of the Irish series lies in the period 250-500 BP, which after correction for loss of sapwood and the number of rings in the dated samples, roughly corresponds with the period 1450-1700 AD. The peak in the British series occurs between 750 and 1000 BP, or roughly 1050-1300 AD. Prehistoric logboats are relatively rare. Given

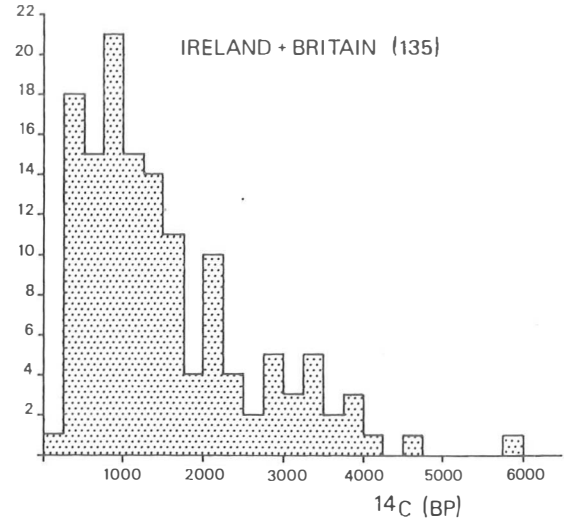

Fig. 1.

the large numbers of dates available, it seems very unlikely that much older logboats will turn up. Without the Carrigdirty date of c. 5800 BP we would have been inclined to postulate an introduction of the logboat in Ireland (and Britain?) at the beginning of the Neolithic, that is at c. 5300/5200 BP. In case the early Carrigdirty date is confirmed – redating is advisable – the introduction of the logboat took place during the Later Mesolithic, at least in Ireland. It is certain that during the Later Mesolithic contacts existed between Britain and the Continent, given the fact that around 6000 BP T-shaped antler axes appear in Britain and NW Continental Europe. In the flint industries these contacts are not noticeable. The Carrigdirty logboat may be the result of contacts between NW France and SW Ireland, without other traces in the material culture. At the moment it looks as if logboats were introduced in Ireland much earlier than in Britain, with no British logboat older than 4000 BP known. It is likely that further dating will bring the British series more in line with the Irish ones, but whether the gap of 2000 years can be closed, is questionable.

The shape of the curve is the result of several factors. First of all, increases in the population during the prehistoric period, the Early Christian period and the Middle Ages played a role as the number of logboats rose accordingly. Only after the 17th century did the logboat lose its popularity and, as a result, disappear rapidly. A second important factor is the chance of survival of a logboat. Many logboats ended up in places which were not conducive to long term survival. Younger logboats are therefore more numerous. However, this does not mean that older logboats must be less well preserved. Well preserved specimens such as the Lurgan, Co. Galway logboat survived in particularly suitable conditions. It is likely, however, that logboats of oak had a better chance of survival than specimens made of soft wood species like poplar and alder.

Table 3. Dated logboats of Norway.[4]

Radiocarbon dates		
Froland, Aust-Agder	T-3774	170±60
Aremark, Østfold	T-3810	210±40
Rakkestad, Østfold	T-4127	220±70
Aremark, Østfold	T-3813	270±80
Aremark, Østfold	T-3812	290±60
Vegårdshei, Aust-Agder	T-5740	290±70
Hurum, Buskerud	T-1580	330±110
Birkenes, Aust-Agder	T-6268	340±60
Rødnes, Østfold	T-4128	390±40
Tvedestrand, Aust-Agder	T-9045	395±75
Aremark, Østfold	T-3810	470±60
Birkenes, Aust-Agder	T-6266	580±40
Åmli, Aust-Agder	T-3773	580±70
Skrøvlingen, Telemark	T-2303	590±60
Gjerstad, Aust-Agder	T-3305	650±50
Gjesdal, Rogaland	T-5373	740±80
Moen, Telemark	T-1429	740±110
Froland, Aust-Agder	T-4351	790±80
Os, Hordaland	T-9700	795±65
Froland, Aust-Agder	T-3772	870±50
Birkenes, Aust-Agder	T-6267	980±70
Nissedal, Telemark	T-6083	1000±70
Bygland, Aust-Agder	T-1897	1140±70
Asvang, Hedmark	T-2052	1140±80
Søndre Land, Oppland	T-4288	1170±70
Froland, Aust-Agder	T-9307	1210±80
Froland, Aust-Agder	T-9306	1245±55

3. SCANDINAVIA

3.1. Norway

We have no information on the number of logboats found in Norway, but given the situation in Sweden, it can be estimated as being approximately 150-200. At least 27 of these have been dated by ^{14}C; no dendrodates are known. All dated logboats are from southern Norway.

3.2. Sweden

According to Westerdahl (pers. comm. 28-11-1991), some 400 logboats are probably known from Sweden. Of these, at least 38 have been dated by radiocarbon and 1 has been dendrodated. The oldest boat in this series dates to the transition Late Bronze Age-Early Iron Age. Two pollen dated logboats mentioned by Salomonsson (1957), namely the unfinished one from Tosthult in Scania, and the one from Sparreholm in Södermansland may be of the same age or slightly older.

3.3. Finland

According to Chr. Westerdahl (pers. comm. 28.11.1991), his Finnish colleague Toivo Itkonen once estimated that 500-600 logboats had been found in Finland. This is possibly an over-estimate. Only 8 Finnish logboats have been dated by ^{14}C.

Table 4. Dated logboats of Sweden.[5]

Radiocarbon dates		
Lassbyn, Råneå	St-5913/24	<250
Sjättesjö, Unnaryd	St-4890	<250
Månserudssjön, Björkäng	St-5915	<250
Västra Älten, Blekinge	St-603	<265
Blomskog, Värmland	St-5914	255±100
Bergvattssjön, Björna sn	St-8296	275±80
Vreta, Värmdö	St-5919	285±100
Lörby, Blekinge	St-605	315±80
Hyltinge, Tappnäs	St-5912	425±130
Ingmarsjön, Ljusterö	St-5917	430±95
Fagersanna, Västergötland	St-1660	465±65
Långvattnet, Björna sn	St-7844	525±80
Skärsjön 1, Skinnskatteberg	St-3738	565±100
Rumlaborg, Huskvarna	St-9923	590±80
Christiansø (40 miles NE)	St-27	595±150
Färila, Hälsingland	St-306	600±65
Kyrksjön	Ua-5924	635±55
Ursjön, Skorped	St-4101	720±100
Västra Lilltråsket, Nyland	Lu-2227	730±45
Åbyn, Byske	Lu-2226	770±45
Nyboholm, Sorunda sn	St-5923	945±90
Söderbysjön Nacka, Stockholm	St-784	970±80
Fiholm, Västmanland	St-5921	985±95
Vreta, Värmdö	St-5918	1010±90
Penningby, Uppland	St-786	1060±70
Skärsjön 2, Skinnskatteberg	St-4497	1065±100
Skyttorp, Uppland	U-67	1100±80
Mosjön, Kumla sn	St-5920	1155±95
Jusjön, Hil	St-11653	1165±70
Runsa, Ed sn	St-4392	1260±180
Fagerhult, Agunnaryd	St-5740	1475±80
Tuna socken, Uppland	St-5916	1545±90
Lindholmsundet	St-8534	1655±105
Lövsätra, Vallentuna	St-5922	1820±95
Västra Frölunda, Göteborg	St-2561	2005±100
Kvillehed, Bohüslan	St-787	2135±105[6]
Låssby, Göteborg	St-3550	2215±100
Skäggered, Göteborg	St-3551	2485±100
Dendrodate		
Trollhättan	1064 AD	900 BP

Table 5. Dated logboats of Finland.[7]

Radiocarbon dates		
Majalampi, Esbo	Hel-80	'modern'
Heinola, Salajärvi	Hel-1538	140±100
Suomenniemi, Luotolahti	Hel-2688	300±80
Valkolampi, Kyrkslätt	Hel-1001	410±100
Tammela, Liesjärvi	Hel-2687	430±80
Nyåker, Snappertuna	Hel-1003	690±100
Kolmikulmalampi, Esbo	Hel-1002	720±90
Sorvalampi, Esbo	Ua-11497	755±65

3.4. Comment: Norway, Sweden and Finland

The 74 dates combined in figure 2 clearly show that logboats were only introduced to Scandinavia at a late date. It is probably not a coincidence that the oldest dated logboat comes from southern Sweden, where continental influences are strongest. It is, however,

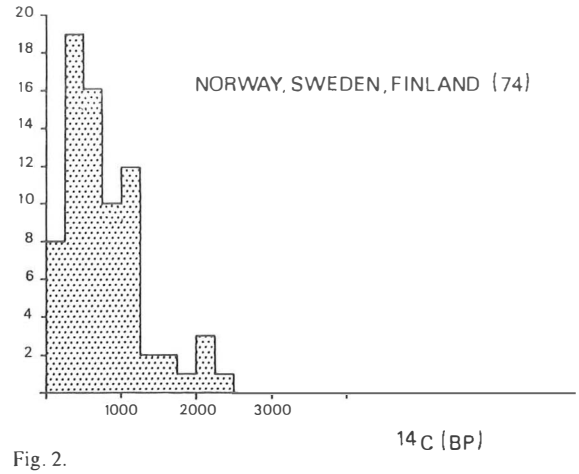

Fig. 2.

surprising that no late Mesolithic or Neolithic logboats are known from southern Sweden, as logboats were used by the Ertebølle and Funnel Beaker groups in Denmark and these two cultures are also found in southern Sweden. The Norwegian dates seem to indicate that logboats were only introduced there in the 7th and 8th centuries AD. The number of dates from Finland is too small for any clear picture but it appears that logboats were only adopted there after 1000 AD. Logboats were used in Scandinavia until very recently and in some places are still in use.

4. CONTINENTAL EUROPE, NORTH OF ALPS AND PYRENEES

4.1. Denmark

Sixty-nine Danish logboats were listed by Rasmussen (1953), but nearly forty years later, Christensen (1990) was able to list some 250 Danish logboats, of which more than 50 date to the Stone Age. These Mesolithic and Neolithic logboats were largely made of lime or alder, but from the Funnel Beaker period onwards were also made of oak. At least 39 Danish logboats have been dated by radiocarbon and 3 have been dendrodated. The number of Mesolithic and Neolithic logboats is clearly over-represented in this sample. A large number of older boats was apparently dated to prove that these have special characteristics. The logboat from Knudsbøl Mose may have been older than any of the radiocarbon dated examples. It was made of pine, but when found in 1945 it was not curated due to its bad state of preservation. The large gap between the youngest Neolithic logboat Verup 1 and the Late Bronze Age logboat Varpelev seems to be real. During Early and Middle Bronze Age logboats were either not used at all, or only at a very limited scale. It is very tempting to see a connection between the reintroduction of the logboat in Denmark in the Late Bronze Age and its first introduction in southern Sweden, shortly afterwards. From the famous

Table 6. Dated logboats of Denmark.[8]

Radiocarbon dates				
Ryå	K-3907		470±65	oak
Arslev Enge	K-1213		820±100	oak
Barsø	K-3743		940±65	beech
Fannerup	K-3893		970±70	oak
Randers Fjord	K-3787		1010±70	oak
Gåsekrog	K-3786		1050±70	oak
Kolindsund 2	K-1777		1050±100	oak
Gelsted	K-1483	1120±100	1100±70	oak
	K-1484	1080±100		
Nørre Kongerslev 2	K-848		1170±100	oak
Illerup 3	K-2768		1630±55	oak
Mondbjerg/Sattrup Mose	K-3501		1720±75	oak
Jyllinge	K-2898		1860±75	oak
Kallehavegård/Tebbestrupkar	K-1340		1870±55	oak
Egernsund	K-2513		1900±75	?
Vestersø	K-5328		2400±75	oak
Varpelev	K-2228		2780±100	oak
Verup 1	K-4098B		4220±75	alder
Øgårde 5	K-3637		4280±85	?
Praestelyngen 3	K-1649		4420±110	lime
Kildegård 2	K-4338		4500±85	lime
Bølling sø 3	K-1214		4510±120	alder
Søndersted 1	K-3638		4540±90	oak
Øgårde 1	K-3675	4520±65	4530±55	alder
	K-3676	4550±85		
Øgårde 3	K-1165		4590±120	alder
Bodal 2	K-2177		4690±100	alder
Broksø	K-4099		4790±90	oak
Praestelyngen 1	K-2009		4930±100	lime
Praestelyngen 2	K-1473		5010±100	lime
Tybrind Vig 3	K-6177		5090±140	?
Tybrind Vig 1	K-3557		5260±95	lime
Tybrind Vig 2	K-4149		5370±95	lime
Maglemosegårds Vaenge 2	K-4336		5420±75	lime
Maglemosegårds Vaenge 1	K-2722		5720±75	lime
Møllegabet 2	K-5640		5910±75	lime
Horsekaer 1	K-5313		6020±100	lime
Horsekaer 2	K-5314		6040±100	lime
Lystrup 1	K-5730		6110±100	aspen
Korshavn/Mejlø Nord	K-5040		6260±95	lime
Lystrup 2	K-6012		6550±105	lime
Dendrodates				
Ry bådehavn	1585 AD	350 BP		
Slåensø	1587 AD	350 BP		
Gudenåen 2	1598 AD	350 BP		

oak coffins in Early and Middle Bronze Age burials in Denmark it is clear that the lack of logboats in that period is not due to lack of suitable trees, or to lack of craftsmanship.

4.2. Germany

In his Kiel doctoral thesis of 1988, Hirte listed the logboats found in the former German Federal Republic. This work is unfortunately largely unpublished (see Hirte, 1989). The total number then known to him was 558. Since 1988, several new discoveries have been made. The number of logboats found in the former German Democratic Republic is unknown. However, in the Neubrandenburg area alone, some 40 have been discovered (Schoknecht, 1991). The total number of German logboats must therefore be in the order of 700-750. Of these, at least 71 have been dated by ^{14}C and 18 have been dendrodated. Of the latter, two were also dated by ^{14}C, but these ^{14}C-dates are not included here. It is possible that within Germany, there are differences in the date of introduction of the logboat. Both of the

Table 7. Dated logboats of Germany.[9]

Radiocarbon dates				
78a	Neuburg/Elde	Bln-3051		140±60
348	Feldafing (E1976-52)	KI-1171		160±70
357	Munich	KI-1089		200±60
	-Gadebusch	Bln-1665		235±40
162	Leese	KN-403		250±100
10	Bohnert	KI-2561		275±43
352	Inzell	KI-2139		320±36
17	Dollerup	KI-2251		330±50
1a	Altenhagen/Bolzsee	Bln-2007		360±60
8	Alt Bülk	KI-2104		370±45
362	Pflegersee	KI-931		380±50
	-Breiholz	KI-2970		380±50
247	Eisbergen	KN-2317		410±45
93	Hamburg	KI-637		435±42
134	Fischbeck	KI-2102		450±55
344	Barmsee	KI-2265		480±47
367	Staffelsee	KI-2264		490±49
368	Starnberger See	KI-1172		510±120
	-Eisenhüttenstadt	Bln-4394		550±50
368	Starnberger See (E1977-102)	KI-1332		560±50
406	Heilbronn	Hv-7385		565±35
349	Garstadt	KI-1432		575±45
	-Berlin-Spandau	Bln-3566		610±60
	-Seeoner See	KI-3232		640±50
164	Liebenau	Hv-5268		650±85
193	Steinhude/Bückeburg	Hv-10873		665±55
368	Starnberger See (E1977-77b)	KI-1331		670±55
78	Stocksee	KI-2367		690±42
347	Brunnensee	KI-2266		700±48
373/5	Viereth	KI-2141		810±47
6	Averlak	KI-2103		830±49
	-Starnberger See (No.?)	KI-3091		860±50
423	Pforzheim	KI-2389		870±41
	199Stolzenau	Hv-328		920±60
133	Evensen	Hv-5489		945±40[10]
211	Vietze	KI-1200		970±80
260	Kirchlengern	KI-2273		980±55
368	Starnberger See (E1974-87)	KI-1088		990±60
354	Leoni	KI-1940		1000±60
32	Haddeby	KI-2243		1085±49
353	Leoni	KI-1939		1100±60
	-Starnberger See (E1975-48)	KI-1093		1100±60
114	Bederkesa 1	Hv-7403		1110±55
33	Haddeby	KI-2244		1130±70
238	Benninghausen	KN-3455	1100±50	1175±45
		KI-2245	1310±65	
267	Meerbusch	BONN-1680		1180±70
246	Eisbergen	KN-2365		1250±45
214	Wienhausen	Hv-2507		1295±95
277	Rünthe	KN-3454	1290±55	1370±40
		KI-2246	1450±55	
343	Barmsee	KI-907		1370±60
253	Gohfeld	KI-2153		1378±41
53a	Klein Upahl/Lohmen	Bln-1719		1390±40
	-Wasserburg	KI-1739		1450±70
	-'Ems'	KI-2603		1570±44
115	Bederkesa 2	Hv-7404		1630±55
125	Dannenberg	Hv-1200		1720±75
31	Haale	KI-2250		1720±55
51	Leck	KI-2249		1790±44
85	Vaale	KI-2342		1820±55

Table 7 (Cont.).

194	Steinhuder Meer	Hv-10872		1835±60
	-Schwerin	Bln-1863		2100±65
	-Drochtersen-Ritsch	Hv-16666		2245±155
160	Lathen	KI-2248		2530±60
13	Berlin	KN-1606		3110±60
86	Warnsdorf	KN-320		3340±65
150	Hüde	Hv-55		4040±100
412	Mannheim	Hv-11748	4515±60	4640±45
		H-7204	4770±60	
151	Hüde	Hv-1221		4800±85
	-Dullenried	HD-11996-11546		4810±30
195	Steinhude/Wilhelmsburg	Hv-10871		5855±60
130	Dümmerlohausen	KI-2247.01	7610±100	
		KI-2247.02	7700±75	7670±50
		KI-2247.03	7670±75	
Dendrodates				
304	Grosskrotz	1622 AD	360	
433	Steisslingen	1428 AD	500	
	-Volkach-Astheim	1369 AD	670	
316	Schwebda	1322 AD	580	
399	Durnnersheim 1	1104 AD	920	
401	Durnnersheim 3	1104 AD	920	
400	Durnnersheim 2	927 AD	1110	
	-Flosswiesen	650 AD	1410[11]	
332	Speyer/Angelhof	569 AD	1490	
	-Schonungen	50 AD	1960	
349	Garstadt/Bergrheinfeld	260 BC	2230	
	-Roseninsel/Starnberger See	900 BC	2740[12]	
	-Forschner 3	1811 BC	3460	
	-Federsee WLM 3	1819 BC	3480	
	-Federsee WLM 2	1963 BC	3590	
	-Federsee WLM 1	1979 BC	3625	
	-Forschner 2	1983 BC	3630	
	-Forschner 1	2002 BC	3640	

oldest logboats came from northern Germany; the earliest logboat from Bavaria (Roseninsel/Starnberger See) dates to the Later Bronze Age. More dates are needed, however, to confirm this. The logboat from Dümmerlohausen is made of alder, that from Dullenried of oak. The wood species of Steinhude/Wilhelmsburg is unknown.

4.3. Netherlands

No up-to-date survey of logboats in the Netherlands exists. Van der Heide (1974: pp. 106-120) mentioned 10 finds (the Terbregge find was erroneously included twice). Since then, several new discoveries have been made. Moreover, Van der Heide overlooked several old finds. Some thirty logboats are now known, including several extended ones. The 'treetrunk-plank boats' of Utrecht-type (Vlek, 1987) are not included here, although they are clearly related to the extended logboat of Velzen. Two recently discovered logboats of Hardinxveld-Giessendam have not been dated yet, but on basis of the first ^{14}C-dates for the settlement ages between c. 6400 and c. 6000 BP are likely.

Samples of 19 logboats were available for radiocarbon dating. Four of these were sampled after the wood had been treated with polyethyleneglycol (PEG). The historic age of three of these logboats was known. The radiocarbon ages were several hundred years older than expected. The dates of these four logboats are therefore not included in the graph (see Appendix; the fourth logboat was found at Kerk-Avezaath). The remains of the Bergschenhoek logboat were dated indirectly, on three samples of wood found in the small fishing camp in which the remains of the logboat were excavated. The number of finds is surprisingly small for such a wet country. This seems to be partly due to a lack of interest on behalf of a former generation of archaeologists who were too quick to claim that logboats were naturally rotted out tree trunks.

The logboat of Pesse is made of pine, that of Bergschenhoek is made of alder. One of the Hardinxveld-Giessendam logboats is made of lime; the wood species of the second one is not yet known (pers. comm. L.P. Louwe Kooijmans 12.6.1998). Not everybody is convinced that the Pesse vessel is a logboat. It should be emphasized that it was found embedded in Boreal peat

(Van Zeist, 1957) in a small river valley (Harsema, 1992: pp. 29-32). McGrail (1978: p. 8) quotes Van der Heide as the source of his reservations and writes "it is the best that judgment be reserved". He must have misunderstood, however, what Van der Heide (1974: pp. 106-111) wrote, for Van der Heide is convinced of the logboat character of the Pesse find. He points out that given the ^{14}C-date the vessel could not have been used as a trough or a treetrunk coffin, and also that preliminary calculations show that it could carry a weight of 90-120 kg, i.e. an adult male. Søren Andersen (quoted in Beuker & Niekus, 1997: noot 3) also raised objections based on the small size, the crude workmanship and the thick walls of the vessel, compared with later Danish logboats. One should not forget that the Pesse logboat is the earliest known specimen in Europe, and that the oldest Danish logboat is 2000 years younger. The Pesse logboat compares very well with the logboats of Noyen-sur-Seine and Nandy in northern France, which are also made of pine. Only gradually was the experience necessary to construct thin-walled logboats accumulated. Even in case the Pesse logboat could only carry 60 kg, like Arnold (1995: p. 26) claims, its logboat status is not in danger. In 1999 the Drents Museum will construct two replicas of the Pesse logboat, to test its performance.

4.4. Belgium

No survey of logboats from Belgium in available. An unpublished thesis by N. Beeckman (Free University Brussels, 1985) lists 8 finds in Belgium. Four logboats have been dated by radiocarbon. The Mechelen-Nekkerspoel boat seems to have been impregnated with candlewax or a related substance. A small sample of purified cellulose has been dated by AMS (see also Appendix).

4.5. France

Cordier (1963, 1972) listed 98 French logboats, Lerat-Renon (1989) 160. But due to the large number of recent finds (Sanguinet, Paris-Bercy, river Brivet) the actual number may well be more than 200. Of these, 60 have been dated by ^{14}C, and 7 by dendrochronology. However, the dates of the logboats found in the river Brivet are not included in this list (see Miquel, 1996; Bahn, 1996). Four of the dendrodated boats were also dated by radiocarbon. The Mesolithic logboats of Nandy and Noyen-sur-Seine are made of pine, the logboats 1 and 6 of Paris-Bercy of oak. The Taillebourg (1984) logboat (Gif-6681 1480±50 BP) is not included in this list. Contrary to Arnold (1995: pp. 16-17) the association of the dated pole and the actual logboat is far from certain

Table 8. Dated logboats of the Netherlands.[13]

Radiocarbon dates			
Oss	GrN-19278		790±35
Essche Stroom	GrN-21479		970±20
Velzen	GrN-8276		975±30
Zeewolde	GrN-18884		1210±50
Daarle	GrN-2005		1285±65
Kuinre	GrN-20054		1450±50
Angerlo	GrN-8027		1700±35
Gieten	GrN-15888		1890±30
Empel	GrN-20552		2120±30[14]
Kolderveen	GrN-19277		2280±40
Nijeveen (1870)	GrN-15887		2480±25
Terbregge	GrN-18351		2505±35
Nigtevecht	GrN-16548		2745±20[15]
Hazendonk	GrN-9190		4400±60
Bergschenhoek	GrN-7764	5415±60	
	GrN-9897	5335±45	5380±25
	GrN-9898	5400±35	
Pesse	GrN-486	8270±275	8760±145[16]
	GrN-6257	8825±100	

Table 9. Dated logboats of Belgium.[17]

Radiocarbon dates			
Antwerpen/Austruweel 2 (1911)	Lv-827		820±45
Antwerpen/Austruweel 1 (1910)	Lv-826	1050±65	990±45
	IRPA-453	940±60	
Pommeroeul	IRPA-383		1725±45
Mechelen-Nekkerspoel (cellulose)	GrA-5432		2345±50

Table 10. Dated logboats of France.[18]

Radiocarbon dates			
Saint Fraigne, Charente	Gif-7159		250±50
Sanguinet 10, Landes	Gif-8776		460±60
Lepin, Lac du Paladru, Isère	Ly-2274		570±230
Moncey, Doubs	Gif-3716		610±90
Chalon 2, Saône-et-Loire	Ly-2743		720±120
Dompierre-sur-Charente, Charente Maritime	Gif-7388		800±60
Argenteuil, Val d'Oise	Gif-3750		870±90
Le Cellier, Loire-Atlantique	Gif-7040		880±60
Granat-sur-Engievre, Allier	Ly-2252		900±110
Massay, Cher	Gif-6379		940±60
Ancenis (1985), Loire-Atlantique	Gif-7041		1010±60
Oudon-Vauvressix, Loire-Atlantique	Ly-7154		1135±50
Gueugnon 2, Sâone-et-Loire	Gif-6761		1140±60
Port Berteau, Charente Maritime	Gif-7158		1150±70
Sainte-Anne de Campbon, Loire-Atlantique	Gif-5430		1190±60
Epervans, Saône-et-Loire	Ly-2199		1260±140
Saint Marcel 3, Saône-et-Loire	Ly-4749		1320±75
Saintes 1, Charente Maritime	ARC-455		1325±50[19]
Taillebourg, Charente Maritime (1980)	Gif-6680		1340±50
Port d'Envaux, Charente Maritime	Gif-6679		1350±50
Flavigny-sur-Moselle, Meurthe-et-Moselle	Ny-720		1410±80
Saintes 2, Charente Maritime	ARC-458		1450±50
Chissey, Jura	Gif-5539		1480±60
Baupte, Manche, (Marais de Gorges)	Gsy-60		1500±100
Bregnier-Cordon, Ain	Ly-68		1500±110
Sanguinet 1, Landes	Gif-7658		1520±60
Rauville-la-Place, Manche	Gif-2463		1530±100
Chaudeney-sur-Moselle 3, Meurthe-et-Moselle	Ny-314		1750±70
Paris – Ile de la Cité	Ly-6542		1815±50
Ancenis (1950), Loire-Atlantique	Gif-236		1820±200
Chaudeney-sur-Moselle 1, Meurthe-et-Moselle	Ny-313		1850±60
Sanguinet 21, Landes	Gif-9983		1880±55
Sanguinet 3, Landes	Gif-7657		1900±60
Sanguinet 2, Landes	Gif-7656		1930±60
Sanguinet 11, Landes	Gif-9976		2000±50
Sanguinet 18, Landes	Gif-9981		2040±60
Sanguinet 16, Landes	Gif-9980		2060±50
Sanguinet 14, Landes	Gif-9979		2130±70
Oudon, Loire-Atlantique	Gif-5431		2320±60
Saint Germain-du-Plain, Saône-et-Loire	Ly-5566	2370±45	2395±45[20]
	Ly-5819	2455±70	
Sanguinet 5, Landes	Gif-7431		2630±60
Saint Marcel 5, Saône-et-Loire	Ly-4751		2660±75
Sanguinet 9, Landes	Gif-8285		2660±50
Sévrier, Crèt de Chatillon, Haut Savoie	Ly-1951		2700±140
Sanguinet 22, Landes	Gif-9984		2930±70
Sanguinet 20, Landes	Gif-9982		3270±70
Sanguinet 7, Landes	Gif-9977		3300±50
Ile Bridon, Maine-et-Loire	Ly-5973	3575±75	3495±45
	Ly-6067	3457±50	
Brison-Saint-Innocent, Les Mémers, Savoie	Ly-2305		3740±130
Paris-Bercy 2	Gif-9225	3810±50	
	Gif/		3800±30
	LSM-9225	3800±25	
Paris-Bercy 8	Ly-6426		3860±75
Paris-Bercy 12	Gd-7318		4140±40
Paris-Bercy 3	Gif-9226	4180±50	
	Gif/		
	LSM-9226	4140±20	4145±25
	Ly-6023	4125±55	

Table 10 (Cont.).

Charavines-Les-Baigneurs, Savoie	Ly-792		4190±150
Bourg-Charente, Charente	Gif-5156		4540±110
Paris-Bercy 1	Gif/		
	LSM-9224		5510±20
Paris-Bercy 6	Ly-6880		5745±95
Noyen-sur-Seine, Seine-et-Marne	Gif-6559		7960±100
Nandy 2, Seine-et-Marne	ARC-1196		7990±55
Nandy 1, Seine-et-Marne	ARC-1197		8060±55
Dendrodates			
Saint-Aubin-en-Charollais, Sâone-et-Loire	1561 AD	340[21]	
Scey-sur-Sâone, Sâone-et-Loire	1534 AD	280[22]	
Verjux, Sâone-et-Loire	1466 AD	400[23]	
Noyen-sur-Seine, Seine-et-Marne	834 AD	1200[24]	
Chalain-Marigny, Jura (1904)	959 AD	2800	
Chalain-Marigny, Jura (1988-1)	2503 BC	4010	
Chalain-Marigny, Jura (1988-2)	3027 BC	4390	

Table 11. Dated logboats of Switzerland.[25]

Radiocarbon dates			
Beinwil am See, AG (1977)	UCLA-2706G		450±30
Cudrefin, VD (1871)	UCLA-2706A		2045±60
Bevaix, NE (1879)	Lv-270		2890±110
Grandson-Corcelettes, VD (1880)	ETH-15251	3075±50	3125±40[26]
	ETH-14257	3185±55	
Twann, BE (1975)	B-2750		3250±60[27]
Bevaix, NE (1990/3)	UZ-1593		3265±65
Bevaix, NE (1990/4)	UZ-3705/		
	ETH-12894		4540±65
Pfäffikon-Riet, ZH (1991)	UZ-1511		5135±90
Hauterive, NE (1976)	B-4771	5280±50	5440±35
	B-4529	5540±40	
Männedorf, ZH (1977)	UCLA-2706B		5490±50
Dendrodates/direct			
Bevaix, NE (1977)	39 BC	2040	
Chabrey-Montbec, VD (1989)	957 BC	2810	
Bevaix, NE (1980/2)	998 BC[28]	2830	
Twann-Wingries, BE (1880)	1000 BC[29]	2830	
Bevaix, NE (1980/1)	1003 BC	2830	
Bevaix, NE (1990/2)	1028 BC	2860	
Gals, BE (1942)	1216 BC[30]	2970	
Twann-St. Peterinsel, BE (1911)	1313 BC[31]	3040	
Erlach-Heidenweg, BE (1992)	1564 BC[32]	3290	
Bevaix, NE (1987)	1609 BC	3290	
Dendrodates/indirect			
Auvernier, NE (1975)	850-80 BC	c. 2715	
Hauterive-Champréveyres, NE (1984)	960-90 BC	c. 2820	
Hauterive-Champréveyres, NE (1985)	1030-50 BC	c. 2870	
Auvernier-Port, NE (1973)	c. 3680 BC	c. 4860	

(pers. comm. E. Rieth, 19-12-'96). The logboat of Mûrs-Erigné, Maine-et-Loire has been dendrodated to 569 AD (Jonchery, 1986: p. 11), but this date is not accepted by Gassmann et al. (1996: p. 117) and therefore has not been included here.

4.6. Switzerland

According to Arnold (1995; 1996) 133 logboats are known from Switzerland. The 'Mesolithic' logboat from Estavayer-le-Lac (Ramseyer, Reinhard & Pillonel 1989) is not included in this series. According to Arnold

(1995: p. 69) the object in question is a tree trunk with traces of insect damage, which collapsed into the water and was shaped by natural erosion and rotting processes. Ten logboats have been dated by radiocarbon, 10 by dendrochronology of the wood of the boat, and 4 by dendrochronology of settlement layers in which the boats were embedded. Four of the dendrodated boats were also dated by radiocarbon. Several dendrodates mentioned in previous publications (Arnold, 1985; Egger, 1985) have been withdrawn or changed in the meantime (see notes 26, 27, 29 and 30). The logboats of Auvenier-Port, Männedorf and Hauterive are made of lime, the logboat of Bevaix (1990/4) is made of pine. The wood species of the Pfäffikon-Riet logboat is not known.

4.7. Austria

The number of logboats from Austria is surprisingly small. Werner (1973) could list only eight finds. One logboat has been dated by radiocarbon:

Obertrummer See/Salzburg	KI-2724	580±50 BP[33]

4.8. Czech Republic

According to Gorecki (1985) in 1950 at least twenty logboats are known from the Czech Republic, largely from the Elbe and Morava valleys. One sample has been dated:

Mikulčice	GrA-9465	1180±40 BP

4.9. Poland

An up-to-date survey of Polish logboats is not yet available, but information provided by A. Szymczak (Szczecin) who is working on logboats found in the Oder catchment area and in Pomerania, and by W. Ossowski (Gdansk) working on logboats in NE Poland and the Vistula basin, makes clear that some 400 archaeological finds of logboats are known. A large number of these has been curated and could be sampled for dating. Unfortunately, a relatively large proportion has been treated with chemical compounds containing carbon, partly of modern origin (linseed oil a.o.), partly of fossil origin (oil- or coal-based). In a number of cases it turned out to be impossible to remove these substances. Of the 120 samples dated by radiocarbon, 9 were rejected for this reason (see Appendix). Of the remaining 111 ^{14}C-dates in table 12 the very young ones should be treated with caution. The oldest dates are reliable, however: the wood in question had either not been treated, or was sampled before treatment. Four of the five dendrodated boats have been ^{14}C-dated, as well.[34] In this paper the radiocarbon ages obtained by converting the dendrodate into a radiocarbon date by means of the calibration curve are used. In three out of four cases calculated age and measured age agree quite well; in the fourth case the measured age is considerably older. The

Table 12. Dated logboats of Poland.[35]

Wigry-binduga	Gd-7907	modern
Gim	Gd-7909	20±60
Lake Radunskie	Gd-5482	<40
Chelmno	Gd-6002	<50
Lake Mausz	Gd-5483	<50
Laskownica Wielka*	GrN-21957	50±30
Chmielonko*	GrN-20992	60±35[36]
Borkowo I	Gd-922	60±60
Bobrowniki (Sieradz)	GrN-22450	85±30[37]
Borsk*	GrN-20991	125±35
Wadag	Gd-9721	130±180
MNS A/17312	GrN-20650	130±30[38]
Bukowiec*	GrN-21955	140±30
MAP/CMM-2	GrN-21961	140±30[39]
Charzykowy	Gd-1010	<150
Szczecin-Rubinowy Staw	Gd-2313	<150
Radun	GrA-9462	165±35
Rusek	Gd-7916	190±50
Wigry	Gd-7915	190±50
Majcz	Gd-7905	200±50
Lake Radunskie	GrN-21419	215±35
Wieleckie Lake	GrN-21002	215±40
Dzierzazno	GrN-20994	225±65
KPE/164/E	GrN-21420	230±40[40]
Marvice 2	GrN-23056	240±15
Weltyn	GrN-20640	245±30[41]
Kashubian Lake Distr. 1	GrN-21859	245±30
Szklana Huta	GrN-21428	250±25
MAP/CMM-5*	GrN-21964	270±30
Borkowo II	Gd-1424	270±40
Radunskie Lake A	GrN-20997	290±110
Kamien Pomorski/Karpina Bay	GrN-20642	295±25
Lipnica-Trzebielsk	GrN-21413	295±30
Radunskie Lake B	GrA-9463	300±35
Omulew II	Gd-7918	300±60
Orzolek	Gd-7917	310±60
Kosewo	GrN-21952	330±25
Skorzecin A*	GrN-21958	330±45
MD/Tp/104	GrN-21001	340±60
Razny	Gd-7910	340±60
MNP/E/?	GrN-23351	350±30[42]
Czarnoglowy	GrN-20641	365±20
MNS A/17307	GrN-20647	365±25
MPS/E-SK3	GrN-21422	380±35[43]
Lake Biale	Gd-2656	400±60
MPS/E-SK2	GrN-21421	420±25
Kashubian Lake Distr. 2	GrN-21860	440±30
Elblag I	Gd-7914	460±60
Sierakow	GrN-21953	475±30[44]
Pawlowice	Gd-7938	480±50
Krosnowo	GrN-21861/62/63	490±18
Kwidzyn	GrN-23060	510±40
Czolnow	GrN-21418	530±30
MG-1	GrN-22461	560±40[45]
Wojtkowice	Gd-7921	570±50
Otalzyno Lake	GrN-21414	575±40
Zelazna	GrN-22457	590±50
Lake Jawor	GrN-20655	600±50
Lednickie Lake	Lod-272	610±100
Swleszewo	Gd-5956	620±50
Lubin	GrN-22459	640±35
Jelowa	GrN-23752	640±55

Table 12 (Cont.).

Jurki	Gd-7922	650±60
Glodowo	GrN-21951	680±30
Ostrow Lednicki III	Gd-10625	680±120
Marwice 1	GrN-20654	690±30
MAP/CMM-6	GrN-21965	695±30
Gora	GrN-21423	740±120[47]
Nowa Cerkiew	GrN-21429	780±90[46]
Chobienia	GrN-22451	825±40
MAP/CMM-3a	GrN-23061	830±50
Wolin/Dziwna R.	Gd-6335/47	835±55
Konin	GrN-21956	870±30
MAP/CMM-4	GrN-21963	900±50
Swarzedz	GrN-21960	900±30
Bojadka	GrN-22458	910±40
Nowa Sol	GrN-22460	930±45
Czerminica	GrN-20643	950±20
Poleczynsskie Lake	GrN-21426	950±100
Kamien Pomorski/Swiniec R.	GrN-21425	980±110[47]
Elblag II	Gd-11305	1030±110
MNS A/17305	GrN-20645	1100±30
MAP/CMM-3	GrN-21962	1120±30
Nieszawa	GrN-23059	1125±30
Szczecin-Podzamcze	GrN-20639	1135±30
MK/A/2842	GrN-21000	1140±45[48]
MNS A/17306	GrN-20646	1175±50
Czolpino	GrN-20651	1180±30
Puck	Gd-891	1190±70
Lednagora*	GrN-21954	1210±50
Steklin	Gd-11303	1230±90
Szczecin-Glebokie	GrN-20644	1235±25
Poleczyno	GrN-21415	1315±40
MNS A/17309	GrN-20649/21141	1345±35
Zlotoryjsko*	GrN-21959	1350±50
Bielice	GrN-20653	1360±50
MNS A/17308	GrN-20648	1400±30
CMM/OT/162	Gd-1895	1490±50
Szczecin Bay	GrN-20652	1550±30
Kamien Pomorski/cathedral	Gd-1876/2309	1570±40[49]
Lewin Brzeski 1	Gd-5958	1620±50
Lewin Brzeski 2	Gd-7279	1760±40
Bobrowniki (Otyn)	GrN-22449	1890±40
MAP/CMM 7	GrN-21966	1960±35
MNP/E/973	GrN-23352	2270±35
Chwalimki 2	GrN-23053	2910±35
Lazno Lake	Gd-11304A	2930±100
Ciesle	Gd-6604	3470±100
Chwalimki 1	GrN-22462	3660±40
MOB/A-1033	GrN-21416	4050±50[50]
Szlachcin	GrN-23058	4830±30
Dendrodates		
Zlotoryjsk	1394 AD	670
Nowa Cerkiew	959 AD	1110[51]
Gotland Bay	730 AD	1245[52]
Ulanow	728 AD	1245[53]
Pinczow	1220 BC	2975[54]

datelist is not complete: more ^{14}C- and dendrodates are in preparation, resp. available but not at our disposal.

Oak and pine are the preferred wood species. The oldest logboat, found under water on the edge of a lakeside settlement of the Funnelbeaker Culture (Wiorek phase) near Szlachcin (30 km SE of Poznan; Jazdzweski, 1936: pp. 291-292 and 380-381) and according to the radiocarbon date clearly belonging to this settlement, was made of alder, however (A. Szymczak, letter 15-12-'97).

4.10. Estonia/Latvia/Lithuania

Logboats have been found in the Middle Neolithic settlements of the Narva Culture, such as Sarnate in Latvia and Sventoji 1B and 4B in Lithuania (Rimantiene, 1992). None of these boats has been dated directly, but radiocarbon dates of other material in these and related settlements indicate dates in the bracket 4700-4400 BP (Rimantiene 1979; 1992). Logboats are also known from settlements of the Late Neolithic Bay Coast Culture, such as Sventoji 9 (Rimantiene, 1980). The Bay Coast Culture can be dated to 4350-3750 BP.

4.11. Comment: West and Central Continental Europe

When working with the dates of the logboats dealt with in chapters 4.1 to 4.10 some patterns in distribution both in space and time are noticeable. To visualize these patterns Continental Europe north of the Alps and the Pyrenees, and west of the Russian border has been divided in two zones (fig. 3). Zone 1 comprises Denmark, northwestern Germany (i.e. Schleswig-Holstein, Hamburg, Niedersachsen, Bremen and Nordrhein-Westfalen), Netherlands, Belgium and northwestern France (i.e. the regions Nord-Pas-de-Calais, Picardie, Haute- and Basse-Normandie, Ile-de-France, Champagne-Ardenne and the departments Eure-et-Loir and Meuse). Zone 2 comprises the rest of France and Germany, Switzerland, Austria, the Czech Republic and Poland. Although without ^{14}C-dates Latvia and Lithuania must belong to this zone, as well. The Swiss and Austrian logboats were found north of the Alps, in fact.

There is a clear difference between these two zones. Mesolithic canoes have only been found in the first zone (fig. 4). In the second zone logboats started clearly later, i.e. after the beginning of the Neolithic (fig. 5). Given the fact that Mesolithic population densities were much lower than those of the Neolithic and later periods, the number of Mesolithic logboats is surprisingly high. The combined figures used to construct figures 4 and 5 are probably large enough to warrant reliable pictures, even although samples were not collected completely at random. The majority of logboats dated in Denmark are older than 4000 BP, which seems to be the result of selective dating of typologically older boats, made of lime and alder, with younger boats made of oak being

Fig. 3.

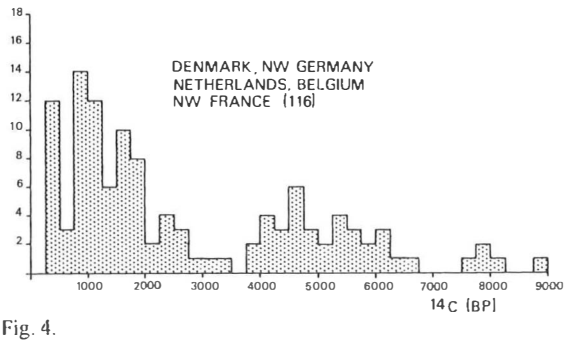

Fig. 4.

neglected to some degree. The selection of samples in Switzerland was not random either, with an emphasis on dendrodated logboats of the Later Bronze Age. These selection criteria do not influence the overall picture, however.

In zone 2 two regions with earlier logboats are present. The first one is a wide corridor along the southern edge of the Baltic Sea, from Mecklenburg to Latvia and Lithuania. The logboat is introduced here between 5000 and 4500 BP. The second one is a wide Rhine-Saône-Rhône corridor, that comprises eastern France, southwestern Germany and western Switzerland. Here logboats are introduced around 5500 BP. The remaining parts of zone 2 seem to have accepted the logboat only gradually. It is amazing to see that the earliest logboat in Bavaria is of Late Bronze Age date.

The continuity in the southern part of zone 1 is not so self-evident as it looks. This is the area of the Linear Bandceramic Culture (LBC), which until recently was seen as the classic example of an invading group, spreading rapidly from the Hungarian Plain over the loess areas of Central and western Europe. Recently doubts have been expressed. Tillmann (1993) sees the earliest phase of LBC as a result of a 'neolithization' of the indigenous Mesolithic groups in Central Europe shortly after 6400 BP. In northern France, Belgium, the German Lower Rhine area and the southern part of the

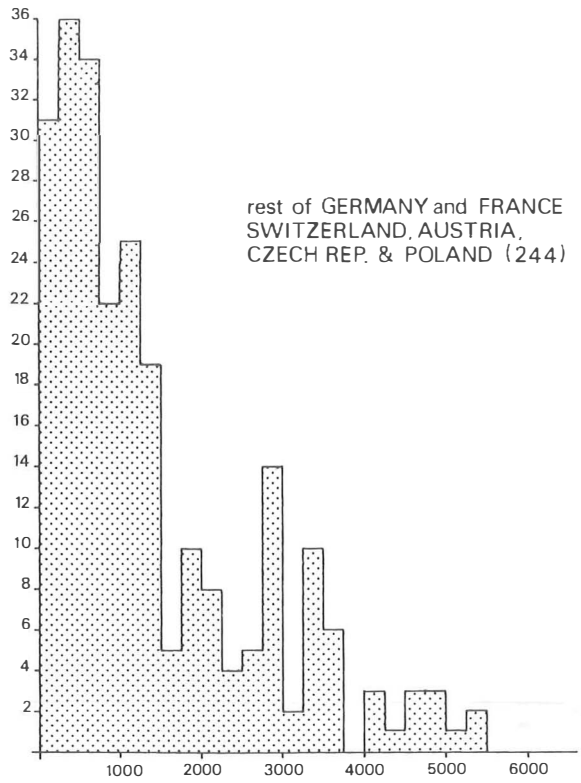

Fig. 5.

Dutch province of Limburg the lateralization of the asymmetric flint arrowheads of the LBC can only be explained by a related process or by absorption of the Mesolithic population by invading LBC farmers (Löhr, 1994). In Schleswig-Holstein and Denmark the basic population continuity during the transition Early Ertebølle-Late Ertebølle-Early Funnelbeaker Culture, despite cultural influences from outside the area, has never been doubted. In the Netherlands and NW Germany west of the Elbe, more and more indications for continuity are found. In NW Germany sites like Dümmer and Hamburg-Boberg are likely to show the gradual 'neolithization' of the local Mesolithic populations (Schwabedissen, 1994). In the northern Netherlands the Bronneger-Voorste Diep finds (Lanting, 1992) and the Almere-'Hoge Vaart' settlement (Hogestijn et al., 1995; Hogestijn & Peeters, 1996) probably represent a comparable development. Apparently the Hardinxveld-Giessendam settlement (in excavation at the moment of writing) shows transition from pure Mesolithic to ceramic Mesolithic, as well.

5. ITALY AND THE NORTHWESTERN BALKAN

5.1. Italy

Cornaggia Castiglioni & Calegari (1978) listed 57 logboats, largely from northern Italy. Since then, a small number of new finds has been published. The most interesting new find is the logboat of Lago di Bracciano near Rome, found on the edge of a submerged early Neolithic settlement (Fugazzola Delpino & Mineo, 1995). This logboat is made of oak, worked with axes and has four low ridges across the inside of the base. Thirteen boats have been dated by radiocarbon; the Lago di Viverone logboat dated to 5010±110 BP (R-1637) is rejected by Fugazzola Delpino & Mineo (1995: p. 238) and is not included in table 13. The Lago di Bracciano vessel is dated indirectly; the sample was taken from a pole near the stern that kept the boat in position.

5.2. Former Yugoslavia

Erič (1993/1994: p. 126) states that c. 60 logboats and logboat models are known in Slovenia. Of these, ten

Table 13. Dated logboats of Italy.[55]

Radiocarbon dates			
Lago Monticolo	R-894á		710±50
Lago Trasimeno	Pi-84		744±110
Lago di Monate 1	F-62	940±75	950±65
		970±105	
Selvazzano 2	R-918á		1200±50
Selvazzano 1	R-917á		1210±50
Lago di Monate 2	F-63	1580±105	1460±60
	R-854á	1430±50	
Valle Isola	R-2		1810±140
Sasso di Furbara	Pi-?		2695±100[56]
Lago Lucone 1	R-375	3360±50	3260±35
	R-375á	3160±50	
Bertignano	R-1639		3460±180
Bande di Cavriana	R-786á		3520±50
Lago di Fimon	R-359á		4580±50
Lago di Bracciano	R-2561		6565±64

Table 14. Dated logboats of former Yugoslavia.[57]

Radiocarbon dates			
Ozalj, R. Kupa (Cr.)	Z-563		'modern'
Vukovar, R. Danube (Cr.)	Z-224		237±63
Slavonski Brod, R. Sava (Cr.)	Z-553		240±80
Sremska Mitrovica, R. Sava (Sb.)	BC-42		250±100[58]
Karlovac, R. Kupa (Cr.)	Z-164		281±67
Hrvatska Dubica, R. Una (Cr.)	Z-255		417±60[59]
Hutovo Blato, Desilo spring, (B.-H.)	Z-236		430±60
Bosanska Gradiska, R. Jablanica (Cr.)	Z-256		1759±55
Iska Loka (Sl.)	GrN-20808		1800±35
Lipe, Ljubljansko Barje (Sl.)	Z-634		1940±80
Sisak, R. Kupa (Cr.)	Z-1147		2040±130[60]
Krtine II (Sl.)	GrN-23544		2050±30
Bevke-Notranje Gorice (Sl.)	GrN-20809	2125±30	2090±22
	GrN-20810	2055±30	
Zakotek (Sl.)	Z-1932		2310±90
Matena (Sl.)	GrN-20811		2700±35
Blatna Brezovica (Sl.)	Z-1931		3140±90
Ledina Malence (Sl.)	Z-737		3290±120[61]
Veliki Mah (Sl.)	GrN-23550		4210±40
Hotiza, R. Mura (Sl.)	GrN-20807	7340±30	
	Z-2294	7392±177	7325±70
	Z-2359	7030±110	

logboats have been dated by radiocarbon. Of special interest is the Hotiza logboat, with its very early date, and its low ridges across the inside of the base. The vessel is clearly related to the Lago di Bracciano (It.) logboat. No corresponding surveys are known from other parts of former Yugoslavia. Nine logboats found in Croatia, Serbia and Bosnia-Hercegovina have been dated by radiocarbon, however, showing that they occur in these areas. All dated logboats are of oak.

5.3. Comment (Italy and former Yugoslavia)

The dates from Italy and former Yugoslavia have been combined in a single graph (fig. 6). These logboats share a distribution area south of the Alps. The number of dates is too limited to be conclusive, but the existence of a second centre of origin seems likely. The Hotiza date is surprisingly early for a canoe made of oak (Erič, 1993/1994), but there are no grounds for doubting the reliability of either find or date. In fact the Lago di Bracciano logboat is only slightly younger, of the same type and made of oak, as well. The gap between Hotiza and Veliki Mah on the one hand, and Lago di Bracciano and Lago di Fimon on the other is remarkably large. This may be due to the small number of dates available at the moment. But one could question the continuity of the use of logboats in these areas between c. 6500 and c. 4500 BP.

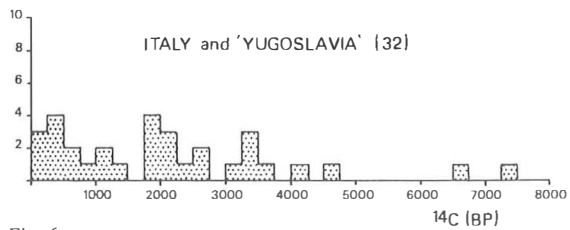

Fig. 6.

6. THE REST OF EUROPE

6.1. Spain/Portugal

According to Alves (1988), only three archaeological logboats have been discovered in Portugal and one or two in Spain. It is known, however, that logboats were in use till quite recently. One of the Portuguese finds has been dated:

Geraz do Lima	ICEN-20	1000±40 BP

References in Strabo's *Geographica* indicate that logboats were in use on the river Guadalquivir (book 3, chapter 2,3) and in the northwestern part of the peninsula (book 3, chapter 3,7) during the last centuries BC and the first century AD. How much earlier the logboat was introduced, is not established, yet.

6.2. Bulgaria

Only one logboat from Bulgaria seems to be known, namely the one found on the lake bed in front of the Early Bronze Age settlement of Ezerovo III (c. 4100-4200 BP; Tončeva, 1981: p. 45 and fig. 4: 1 a-d). This logboat is not prehistoric like claimed by Neville (1993). It was dated both in the British Museum (*Radiocarbon*

19, 1977: p. 143) and in Berlin (Görsdorf & Bojadžiev, 1996: p. 157) and turned out to be medieval:

BM-760	559±40 BP
Bln-1017	618±100 BP

6.3. Greece

During the International Radiocarbon Conference of 1997 in Groningen one of the Greek participants mentioned the discovery of a logboat in a Late Neolithic settlement near Lake Kastoria. We have not been able to collect first-hand information, so far. Almost certainly the find in question is 'the trace of a small flatboat' found in the Late Neolithic site of Dispilio on the shore of Lake Kastoria (Andreou, Fotiadis & Kotsakis, 1996: p. 568). The corresponding radiocarbon ages for Late Neolithic are 6400-5800 BP. In case this early date is confirmed, and the 'flatboat' is indeed a logboat (Paret (1930) uses the term *Flachboot* for a logboat with a flat base), this find can be used as another argument in favour on an independent origin of the logboat in SE Europe.

6.4. Russia/White Russia/Ukraine

No survey of logboats in these countries seems to exist. Okorokov (1995) published 26 logboats from Russia and Ukraine, four of which have been dated by radiocarbon. Unfortunately he mentions no laboratory numbers in three cases:

Confluence of Protva and Oka R., 1992	
GIN-7282	240±30 BP
Drutskoye, 1960	300±60 BP
Khortitsa, 1984	550±40 BP
Khortitsa, 1985	990±40 BP

Recently Burov (1997) described eleven logboats found in Russia and Ukraine, and one from Latvia. Of the Russian and Ukrainean examples six are not mentioned by Okorokov. Burov mentions the Khortitsa 1984 and 1985 dates, under entry 9 ('Town of Zaporozhye'). He also mentions a logboat found in 1961 near Glazunovskaya village, in southern Russia, found in sediment of the Medveditsa river. This logboat has been dated by ^{14}C to the third-fourth centuries AD, which means c. 1650 BP. A laboratory number, or standard deviation is not given.

Thanks to Burov, another puzzle can be solved. In *Radiocarbon* 12 (1970: pp. 131-132) the Leningrad laboratory published a date for a logboat found near Peschanoye, Cherkassy Oblast, Ukraine:

Le-654	1120±100 BP

Okorokov does not mention this boat or its date. It seems likely that it should be identified with Burov's No. 6, a logboat found near Peschance, district of Zolotonosha, Ukraine, given the fact that the findspot on Burov's map and the latitude/longitude in *Radiocarbon* correspond. One of the entries must contain a printing error; with the second 'c' in Peschance turned into an 'o' or the other way around. According to Burov 15 bronze vessels of the 5th century BC were found beside the boat, but the radiocarbon date makes clear that boat and vessels are not associated.

6.5. Slovakia/Hungary/Romania/Albania

Although logboats were still in use in these countries until quite recently (Paret, 1930; McGrail, 1978), no information on 'archaeological' finds is available, apart from the fact that Paret (1930: p. 111) mentions a logboat in the Museum of Budapest.

7. DISCUSSION

It is not yet possible to describe in detail the origin and spread of logboats. However, a distinct trend is already apparent. The oldest logboats are to be found in northwest Germany, the Netherlands and northern France where dates older than 7500 BP occur. From here, they spread out towards Denmark before 6500 BP, towards Ireland shortly after 6000 BP and towards eastern France and western Switzerland around c. 5500 BP. The logboats from Hotiza (Slovenia, c. 7100 BP) and Lago di Bracciano (Italy, c. 6550 BP) do not conform to this interpretation. Almost certainly a second centre of early logboats was established in the northern Balkans and Italy. The possible Greek example of c. 6000 BP belongs to this second core area, as well. Later, logboats spread to the rest of Europe: along the southern coast of the Baltic Sea (Poland after c. 5000 BP, Latvia/Lithuania, c. 4500 BP), Southwest Germany after 5000 BP, Great Britain around 4000 BP (?), Southwest France after 3500 BP (?), Southeast Germany after 3000 BP (?), southern Sweden, also after 3000 BP, northern Sweden and Norway after 2000 BP, possibly Finland after 1000 BP. Logboats may have disappeared from Denmark between c. 4000 and 3000 BP. In case logboats disappeared from the Balkan and Italy after c. 6500 BP, re-introduction may have taken place from SW-Switzerland and/or SE-France after 5000 BP. There are sufficient dates to demonstrate the differences between the northern part and the remainder of Continental Europe, Scandinavia (i.e. Norway, Sweden and Finland) and Ireland/Britain. The graph for the northwestern part of Continental Europe shows continuous use from c. 9000 BP onwards. Earlier use of logboats was probably not possible because trees of sufficient size and suitable quality were not yet available. The graph of the Scandinavian logboats contrasts markedly, with dates from 2500 BP onwards. The Irish/British curve occupies an intermediary position.

It is clear, however, that other types of boats must have been in use in these areas before the introduction of logboats. Good supporting evidence is provided by the dates of wooden paddles. It is very unlikely that bulky and relatively strong objects such as logboats

would disappear completely where much smaller and fragile objects such as paddles, which are often made of relatively soft wood species, could survive. Dates for paddles have not been collected systematically, but a few examples will suffice. In Finland at least three paddles have been dated (Vilkuna, 1986):

Konginkangas/Lake Keitele *Pinus*	SU-1327	3660±110 BP
Laukaa *Pinus*	SU-1328	3840±130 BP
Järvensuo, Humppila?	Hel-1004	4210±140 BP

In Sweden a paddle made of pine and found at Kroknäs, Skellefteå has been dated (*Radiocarbon* 28: p. 1126):

Lu-2384	4200±60 BP

In Denmark, a number of paddles have been dated by radiocarbon, or found in dated settlements (Rieck & Crumlin-Pedersen 1988). The oldest ones are:

Holmegard	*Salix*	K-4152	8220±100 BP
		K-3749	8090±100 BP
Ulkestrup Lyng	*Corylus*	K-2174	8140±100 BP

In Britain a large part of a paddle made of *Betula* was found at Star Carr. This site can be dated to c. 9500 BP, or slightly later.

In northern Germany at least three paddles were found in Friesack 4 in Early Mesolithic contexts, with dates of c. 9400-8800 BP (Gramsch 1987: Abb. 17:6 and Taf. 24:3). Other paddles are known from Duvensee 2, with a date of c. 9300 BP (Schwantes, 1958: Abb. 56) and from Gettorf/Duxmoor with a pollen date of 8000-9000 BP (*Schleswig-Holstein in 150 archäologischen Funden*, 1986, Nr. 9).

In every case, paddles appear much earlier than logboats in the same areas. Thus other types of boats must have been used and these were almost certainly skin- or barkboats. That is not a new idea, but has been concluded before (a.o. Smith, 1992: pp. 139-143). There is evidence that skinboats were already in use during the Late Upper Palaeolithic Ahrensburg Culture, about the time of the transition Younger Dryas/Preboreal, c. 10,000 BP. This evidence consists of worked reindeer antlers which may have been used as frames (Ellmers 1980; Tromnau 1987). Younger skin- and barkboats will have had wooden frames. Archaeological evidence is not known but in any case would be difficult to recognize. Skinboats, in the form of coracles, were used until the recent past on inland waters of Ireland and Britain (McGrail, 1987: ch. 10; Evans, 1957: ch. 17). The closely related seaworthy curraghs which use nowadays tarred canvas instead of hide are still in use. Rock art in Scandinavia leaves no doubt that skin- or barkboats were in use there in the Bronze Age (Johnstone, 1980: ch. 9). Strabo makes clear that skinboats were used in NW Iberia shortly before the beginning of our era (*Geographica* book 3, chapter 3,7). Barkboats were still produced in Norway around 1860 (Ellmers, 1990: p. 195).

A clear development in the choice of wood is visible. The oldest logboats, from Pesse (NL), Nandy 1 and 2 (Fr) and Noyen-sur-Seine (Fr) are made of pine. This is certainly not a coincidence. Before 8000 BP, in northwestern Europe pine was the only tree of sufficient length and diameter available for this purpose. During the Later Mesolithic a clear preference existed for soft and easily workable wood such as lime, alder and poplar/aspen. The earliest appearance of alder in this context is the logboat from Dümmerlohausen (Ger) which dates to 7600 BP. Oak was exploited only during the Neolithic. Up to now logboat 6 from Paris-Bercy (c. 5750 BP) is the oldest example north of the Alps. The use of oak is probably connected with a preference for longlasting wood combined with the development of the tools which made the working of this harder wood possible. But it is likely that the absence of lime and alder of sufficient size in the late Neolithic will also have contributed to this change.

South of the Alps the use of oak started earlier. The Hotiza and Lago di Bracciano logboats seem to be the products of an early Neolithic centre of development which may be independent of the developments in northwestern continental Europe. The possible Greek example belongs to this early Neolithic tradition, as well. It is not sure, however, that the later developments on the Balkan and in Italy are independent of what happened elsewhere in Europe. There may have been discontinuity in the use, and re-introduction after 5000 BP.

8. NOTES

1. The datelist is largely based on published evidence. Information was provided by R. Switsur (Cambridge), M. Hardiman (Harwell), R. Mowat (Dunfermline), A. Sheridan and T. Cowie (Edinburgh). Numbers without prefix refer to McGrail's catalogue, the ones with prefix M to the catalogue of Scottish logboats by Mowat (1996).
2. Recalculated: the published error term included a contribution of ±80 years for possible isotopic fractionation effect.
3. Also radiocarbon dated on sapwood: HAR-6395 2550±100, HAR-6394 2350±50 and HAR-6441 2280±80 BP.
4. The datelist is largely based on unpublished information provided by S. Gulliksen (Trondheim), to whom many thanks are due.
5. The datelist is largely based on Westerdahl (1988/1989), with additonal information provided by B. Westenberg (Stockholm), S. Claesson (Stockholm), I. Olsson (Uppsala), G. Possnert (Uppsala) and Chr. Westerdahl (Copenhagen).
6. Older part of wood dated.
7. Three unpublished dates have been provided by H. Jungner (Helsinki) en M. Söderman (Uppsala).
8. The datelist is largely based on published evidence (Rieck & Crumlin-Pedersen, 1988; Christensen, 1990). Additonal information was provided by S.H. Andersen (Aarhus) and K. Rasmussen (Copenhagen).
9. For unpublished dates and information regarding the samples we wish to thank H. Willkomm (Kiel), M. Geyh (Hannover), Chr. Hirte (now Berlin), J. Görsdorf (Berlin), H. Dannheimer (Munich), H. Beer (Munich), K. Günther (Bielefeld) and F. Steffan (Wasserburg/Inn). The catalogue numbers are from Hirte's thesis.
10. Previously dated to 2830±60 BP (Hv-4653).
11. This is the definitive result. The preliminary date was 1094 BC (!). Also ^{14}C-dated: HD-13239/13617 1584±75 BP.

12. Also ^{14}C dated: KI-2968 2570±70, KI-3197 2880±65, KI-3198 2690±65 and KI-3199 2910±90. The mean of these four measurements is 2755±40 BP.
13. The following datelist is partly based on information stored in the database of the Groningen radiocarbon laboratory, and partly on information provided by V.T. van Vilsteren (Assen), H. Sarfatij (Amersfoort), M.D. de Weerd (Amsterdam), K. Vlierman (Ketelhaven), L.P. Louwe Kooijmans (Leiden) and G.H.J. van Alphen (Den Bosch).
14. A sample of wood taken from the inside of the bottom was dated to GrN-19723 2110±35 BP.
15. Charcoal found within the logboat was dated as well: GrN-16549 2420±25 BP. Some sherds found within the boat indicate an archae-ological date of c. 600 BC.
16. Two parts of the same sample were dated. Despite the larger standard deviation the mean age should be used instead of GrN-6257.
17. The information on the provenance of the Austruweel sample dated in Brussels was taken from Beeckman's thesis. Thanks are due to A. Cahen-Delhaye (Brussels), M. van Strydonck (Brussels) and E. Warmenbol (Antwerp).
18. The datelist given here is based on published information and unpublished results provided by E . Rieth (Paris), L. Bonnamour (Chalon-sur-Saône), J. Evin (Lyon), R. Jeagy (Nancy), J. Corrocher (Vichy), B. Maurin (Sanguinet) and V. Grandjean (Annecy).
19. ARC: Archeolabs.
20. The Saint-Germain-du-Plain logboat has been dendrodated to 959 BC (Dumont & Treffort, 1994), but this date is not accepted by Gassmann et al. (1996: p. 122).
21. Also ^{14}C-dated: Gif-5413 480±80 BP.
22. Also ^{14}C-dated: Ly-6543 585±45 BP.
23. Also ^{14}C-dated: Ly-5677 390±50 BP.
24. Also ^{14}C-dated: Ly-5891 1305±65 BP.
25. The datelist is based on Arnold (1995; 1996).
26. A dendrodate of 978 BC has been withdrawn.
27. A dendrodate of 986 BC has been withdrawn.
28. Also ^{14}C-dated: UZ-1594 2645±60 BP.
29. Originally published as 975 BC, but meanwhile corrected.
30. Previously known under the name Erlach, BE (1942).
31. Dendrodate previously given as 949 BC (!). Core of trunk ^{14}C-dated to 3310±55 BP, ETH-14258.
32. Also radiocarbon dated: rings 20-21 UZ-2906/ETH-93623395±60 BP; rings 119-129 UZ-2907/ETH-9363 3335±55 BP. The total number of rings present is 134.
33. This unpublished date has been provided by H. Willkomm (Kiel) and E. Stüber (Salzburg).
34. Three samples treated with chemicals were ^{14}C-dated in Groningen, and dendrodated lateron in Poland. ^{14}C-sample MAP/CMM-1 (Swarzedz) equals dendrosample Tczew 1 a/b. The ^{14}C-dates are 900±30 BP (C-fraction) and 830±70 BP (N-fraction); the dendrodate is reported as 1547 AD, which means a ^{14}C-age of c. 340 BP. NAP/CMM-2 equals Tczew 2+3. ^{14}C-results: 140±30 BP (C-fraction) and 125±30 BP (N-fraction). Dendro: 1583 AD or c. 340 BP. MAP/CMM-5 equals Tczew 10. ^{14}C-result: 270±30 BP (both fractions combined), dendro: 1153 AD or c. 900 BP.
    At first glance the results seem to be quite devastating for ^{14}C-dating. It is more likely, however, that either ^{14}C-samples MAP/CMM-1 and 5, or dendrosamples Tczew 1 a/b and 10 got mixed up. In that case the ^{14}C-results would still be too young, but within limits. Another possibility is that the dendrodates are not correct. Given these uncertainties the dendrodates are not included in table 12.
35. The datelist includes unpublished information provided by the late M. Pazdur (Gliwice), W. Filipowiak and A. Szymczak (Szczecin) and W. Ossowski (Gdansk).
36. Base of boat. Side dated to 215±35 BP, GrN-20993 (also treated with chemicals!).
37. See appendix.
38. MNS = Muzeum Narodowe, Szczecin.
39. MAP/CMM = Centralne Muzeum Morskie/Polish Maritime Museum, Gdansk.
40. KPE = Kashubian Ethnographic Park, Wdzydze Kiszewskie.
41. Repair of the same boat dated to 180±25 BP, GrN-20980.
42. MNP = Store of National Museum Poznan, in Adam Mickiewicz Muzeum, Smielow.
43. MPS = Ethnographic Skansen Museum, Kluki.
44. The same boat was dated in Gliwice, as well: 270±250 BP, Gd-9764.
45. MG = Museum, Gliwice.
46. See appendix. A sample of this boat was dated in Gliwice, as well: 1070±40 BP, Gd-3176. This date is in between the dates of the C- and N-fractions dated in Groningen, as could be expected (780±90, resp. 1850±140 BP).
47. A sample of this boat was dated in Gliwice to 770±60 BP, Gd-2311. The age is halfway the ages of C- and N-fractions, dated in Groningen: 980±110, resp. 720±120 (GrN-23663).
48. MK = Regional Museum, Koszalin.
49. GD-2309 on tree nail, Gd-1876 on wood from side of boat.
50. MOB = Regional Muzeum, Bydgoszcz.
51. Also ^{14}C-dated: 1070±40 BP, Gd-3176.
52. Also ^{14}C-dated: 1200±50 BP, Gd-1896.
53. Also ^{14}C-dated: 1300±50 BP, Gd-2064.
54. Also ^{14}C-dated: 3130±70 BP, Gd-11304.
55. The following list is based partly on unpublished results, supplied by M. Alessio and S. Improta (Rome), and L. Fozzati (Turin).
56. The Pisa laboratory no longer exists. We have been unable to establish the precise result and the laboratory number. The published date is 746±100 BC (Brusadin Laplace & Patrizi Montoro, 1977-1982: p. 371).
57. The datelist is partly based on unpublished information provided by M. Erič (Ljubljana) and N. Horvatinčić (Zagreb).
58. BC = Brooklyn College, New York.
59. A second sample, possibly of older wood of the same logboat has been dated: Z-251 541±60 BP.
60. A sample of wood from the core of the trunk has been dated: Z-1148 2330±140 BP.
61. According to M. Erič, this sample was taken from a logboat. *Radiocarbon* 23 (1981), p. 413 mentions only "fragments of wood, associated with wooden oar".

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APPENDIX: The reliability of dates on preserved wood.

In a number of cases, samples were submitted for dating which had been taken from logboats that had been treated with carbon containing chemicals to preserve the wood. Experience has shown that it is sometimes very difficult to remove these substances completely, and that dates obtained on samples of preserved wood may therefore be unreliable. This can be shown for two chemicals, namely polyethylene glycol (PEG) which is widely used in modern preservation techniques, and candlewax, which was used for the same purpose towards the end of the last century and at the beginning of this century.

PEG

The logboat from Crevinish Bay, Co. Fermanagh was sampled for dating before treatment with PEG:

HAR-1969 1860±70 BP

After preservation, another sample was taken and dated in Belfast. The sample was not given special treatment, and the resulting date is far too old:

UB-2396 2855±50 BP

The wood must have contained 10-15% PEG. This contamination does not show in the $^{13}C/^{12}C$ ratio. The $\delta^{13}C$-values were -28.1‰ and -27.5‰, respectively.

The logboat of Alblasserdam (NL) was found in a definite Roman context (1st-3rd century AD; see *Jaarverslag R.O.B.* 1973: p. 14). The boat was treated with PEG shortly after discovery. In the laboratory the cellulose fraction was separated and used for dating:

GrN-20053 2410±130 BP

It is clear, that some PEG (at least 5%) was still present in the dated fraction, for the expected ^{14}C-age is 1800-1900 BP.

The logboats (Nos 3 and 5) and the plank-built boat (No. 2) of Zwammerdam were also found in Roman context (De Weerd, 1988) and also treated with PEG. The samples were finely divided, boiled with water several times, and finally given the standard acid-alkali-acid treatment. This was apparently insufficient to remove all traces of PEG:

Zwammerdam 2	GrN-20517	2180±35 BP
Zwammerdam 3	GrN-20518	2185±40 BP
Zwammerdam 5	GrN-20519	2180±50 BP

The expected ^{14}C-ages are 1800-1900 BP. This means that some 3-5% PEG must still have been present.

The amount of contamination is also visible in the dates of the alkaline extracts:

Zwammerdam 2	GrN-20713	2285±40 BP
Zwammerdam 3	GrN-20715	2450±140 BP
Zwammerdam 5	GrN-20714	2725±55 BP

The $\delta^{13}C$-values for residues, resp. extracts are:

Zwammerdam 2	-27.7	-27.2‰
Zwammerdam 3	-26.0	-27.9‰
Zwammerdam 5	-26.5	-27.7‰

With Zwammerdam 3 and 5 the differences are quite large, and probably related to the degree of contamination.

Later on, pure cellulose was prepared from a large chunk of PEG-treated plank of boat No. 2. The yield was quite small, showing that most of the cellulose had degraded. This time the date was according to expectation:

GrN-21647 1930±55 BP

The $\delta^{13}C$-value of the cellulose was -26.8‰.

By way of experiment a sample of the PEG-treated wood was combusted, without chemical pretreatment, and two fractions of CO_2-gas were collected and dated. These contain the volatile constituents (N-fraction), resp. the carbonized residu (C-fraction). The dates were:

GrN-21516	N-fraction	10.510±120BP
GrN-21481	C-fraction	4750±60 BP

The $\delta^{13}C$-values were -26.2, resp. -28.0‰. It is clear that PEG can only be removed with the greatest possible effort.

Candlewax

The wood of the Mechelen-Nekkerspoel (B) logboat, which was found next to a settlement of the Middle Iron Age, was apparently impregnated with candlewax or a closely related substance. In the Groningen laboratory the finely divided wood was treated with hot, but not boiling, water. This was insufficient to remove the candlewax:

GrN-20372 3180±40 BP

Subsequently, cellulose was separated from another part of the sample. Again this turned out to be insufficiently cleaned: with the naked eye small lumps of wax were visible in the cellulose powder. The date shows the extent of the contamination:

GrN-20566 4700±140 BP

The alkaline extract of the same portion of wood, containing the lignin fraction, was dated as well:

GrN-20469 2610±35 BP

This fraction may have contained humic substances as well and the date should be considered as a *terminus post quem.* A small sample of cellulose, treated with boiling water and with petroleum ether, was dated by AMS. The result is according to expectation:

GrA-5432 2345±50 BP

Other chemicals

A large number of Polish logboats turned out to be treated with chemicals, sometimes even more than once. In a few cases the vessels had only been stored in 3 to 10% formaldehyde solutions, which can be considered to be harmless for dating purposes. But in most cases the boats had been impregnated with mixtures of turpentine and linseed oil with or without the addition of resin or candlewax, or with mixtures of turpentine and varnish, or mixtures of turpentine, beeswax and chlorophenols. But also substances like alum, polyvinyl-acetate and coal tar were used. It is clear, however, that in some cases the documentation is incomplete.

The technician of the Groninger radiocarbon laboratory, mr. Harm-Jan Streurman, spent a lot of time and energy on the development of methods of pretreatment for this kind of samples. In the end dating two fractions gave the most satisfying results. This method can be applied to purified wood samples, and to purified cellulose samples. Preparing cellulose is more time consuming, requires more sample material, but has the advantage of getting rid of a larger amount of contaminants. The wood or cellulose sample is heated to 1000 °C in the combustion oven in a stream of pure nitrogen. This result in pyrolysis of the sample material, and in the production of a series of carbon-containing substances of low molecular weight, like CO, CO_2, CH_4 etc., as well as H_2O, NO_2 etc. These gases are collected, combusted to CO_2 with pure O_2, purified etc., and finally dated. This is the so-called N-fraction. The remaining material is pure carbon, which is subsequently combusted in pure oxygen. The resulting CO_2, the so-called C-fraction, is dated as well.

In both fractions the carbon content can be calculated. In a pure wood sample the carbon content is in the order of 50±6% (Mook & Streurman, 1983: p. 48), in a pure cellulose sample c. 38% (Streurman, pers. comm.) although Mook & Streurman (1983: p. 48) quote 44%. Experiments have shown that in the case of pure cellulose the carbon divides almost equally over the C- and N-fractions. This can be shown in three cases of cellulose samples prepared from Polish logboats (C_v = carbon content, expressed in % of the original sample):

Lubin	C	640±35	GrN-22459	C_v: 19%
	N	350±35	GrN-23010	C_v: 20%
Nowa Sol	C	930±45	GrN-22460	C_v: 20%
	N	1010±55	GrN-22998	C_v: 22%
MG-1	C	560±40	GrN-22461	C_v: 19%
	N	710±40	GrN-23008	C_v: 21%

In a sample of cellulose prepared from freshly collected bog pine in a peat cutting in the Wicklow Mountains, Ireland:

	C	4570±60	GrN-23353	C_v: 17%
	N	4720±50	GrN-23360	C_v: 22%

In wood the results seem to be less predictable, probably depending on the state of preservation of the wood. But in those cases where carbon contents of C- and N-fractions in untreated wood can be checked, the carbon content of the C-fraction seems to be much higher than that of the N-fraction.

Glodowo	C	680±30	GrN-21951	C_v: 33%
	N	650±80	GrN-23029	C_v: 18%
Kosewo	C	330±25	GrN-21952	C_v: 31%
	N	360±30	GrN-22996	C_v: 17%
Lipnica	C	295±30	GrN-21413	C_v: 32%
	N	235±30	GrN-23012	C_v: 17%
Kash. Lake Distr. 2	C	440±30	GrN-21860	C_v: 37%
	N	450±50	GrN-23171	C_v: 15%
Krosnowo 2	C	490±35	GrN-21862	C_v: 33%
	N	310±40	GrN-23172	C_v: 20%

These data can be used to check the reliability of dates obtained on C-fractions of cellulose. Assuming that contaminants disappear largely or completely in the N-fraction, the carbon content of the C-fraction should be close to the expected value of 19%. The carbon content of the N-fraction may differ from the expected value, depending on the amount and nature of the contaminants. In case the carbon content of the C-fraction deviates, part of the carbon must originate from the contamination. One should not be too dogmatic in these cases, however, differences up to plus or minus 2% should be tolerated.

In wood carbon contents of 30-35% in the C-fractions should be expected, but differences up to ±5% seem to occur, depending on the amount of lignin left in the material. The carbon content of lignin is much higher than of cellulose: 61 vs 44%, according to Mook & Streurman (1983: p. 48). The radiocarbon ages of both fractions may provide additional information. More or less comparable ages suggest that the contaminants are of the same age as the wood, and that contamination therefore does not affect the age of the C-fraction. It is possible, however, that the carbon of the contamination divides equally over both fractions, resulting in comparable deviations of the real ^{14}C-ages. In a number of cases it can actually be shown that the contaminants occur in both fractions. Some logboats had been treated with chemicals based on modern carbon, with ^{14}C-activities of more than 100%. These activities can only be expected in natural products grown after 1956, when test explosions in the atmosphere of nuclear weapons started.

First some examples of contaminated cellulose:

Drobnice	C	111.0±0.47%	GrN-22452	C_v: 24%
	N	115.9±0.69%	GrN-23005	C_v: 22%
Skorzecin B	C	112.3±1.06%	GrN-22456	C_v: 23%
	N	116.7±0.96%	GrN-23002	C_v: 30%
Sliwiny	C	108.8±1.76%	GrN-20999	C_v: 26%
	N	112.2±1.28%	GrN-23664	C_v: 28%

The C-fractions contain less contamination than the N-fraction, the carbon contents of the C-fractions are closer to the expected values, but are still far too high. It is clear that the contaminants in question did not disappear fully into the N-fraction during the pyrolysis. That is not surprising. The experiment with Zwammerdam 2 (see above) showed that some chemicals cannot be removed by pyrolysis. In one of the wood samples the same process is noticeable:

Osieczna	C	115.5%	GrN-20995	C_v: 27%
	N	128.5%	GrN-23027	C_v: 33%

The four samples are not included in table 12, although it must be clear that the logboats in question cannot have been very old specimens.

In case one of the fractions has a ^{14}C-activity over 100%, and the other one has a definite ^{14}C-age, the final judgment may depend on the carbon contents of the fractions. Three examples of cellulose:

Bobrowniki (Sieradz)	C	85±30 BP	GrN-22450	C_v: 20%
	N	100.8±0.45%	GrN-23009	C_v: 19%
Gniezno	C	150±40 BP	GrN-22453	C_v: 23%
	N	103.9±0.64%	GrN-23001	C_v: 29%
Gora	C	740±120 BP	GrN-21423	C_v: 20%
	N	100.1±1,57%	GrN-23665	C_v: 29%

These logboats were clearly treated with chemicals based on modern carbon. Given the high carbon content of the C-fraction of the Gniezno vessel, its C-fraction date cannot be trusted. The C-fraction was still contaminated, and the real age must be considerably older than 150±40 BP. In case of the Bobrowniki vessel the carbon contents of both fractions are more or less according to expectation. The N-fraction contains almost certainly some modern carbon, but the C-fraction might be clean. I am inclined to accept the date of 85±30 BP, keeping in mind that this can indicate a real age around 1700 AD, or in the 19th century.

The same is true in the case of the Gora logboat. The carbon content of its C-fraction is according to expectation. The large standard deviation of the determination of the carbon content of the N-fraction (±1.57%) does not exclude the possibility of a ^{14}C-age of this fraction of 250-350 years. The age of the C-fraction, 740±120 BP, can be accepted.

Rejected, however, should be three dates on wood, for which no separate C- and N-fractions were collected:

Zukowo Slawienskie	103.6±0.40%	GrN-21003	C_v: 53%
Jastarnia	101.0±0.46%	GrN-21429	C_v: 59%
Suleczyno	101.0±0.41%	GrN-21427	C_v: 61%

The Jastarnia logboat has been dated in Gliwice, as well: 40±170 BP, Gd-9739. Given the large standard deviation of the Gliwice date, and the uncertainty in the Groningen determination which does not exclude the possibility of a definite ^{14}C-date, the dates agree quite well. It is likely that these three boats were not very old, anyhow.

In the remaining samples of which two fractions were dated, both fractions had definite ^{14}C-ages. That does not imply, however, that the C-fraction dates are automatically reliable. These samples may have been treated with chemicals based on fossil carbon. In those cases where cellulose was prepared, the judgment can be based on the

carbon contents of the fractions. Two cases of large age differences between C- and N-fractions in cellulose samples are worth mentioning:

Bobrowniki (Otyn)	C 1890±40	GrN-22449	C_v: 21%
	N 4370±50	GrN-23009	C_v: 28%
Prezyce	C 2195±35	GrN-22455	C_v: 25%
	N 5390±80	GrN-23006	C_v: 28%

The Bobrowniki logboat had been treated a.o. with engine oil and 'candlewax'. The pretreatment of the Mechelen-Nekkerspoel vessel (see above) showed how difficult it is to get rid of this substance completely. Although the carbon content of the C-fraction of the Bobrowniki logboat is within limits (seeabove), a slightcontamination seems likely. Nevertheless the date of the C-fraction is accepted as a more-or-less reliable indicator of the real age, which can only be slightly younger than 1890±40 BP. The pretreatment of the Prezyce vessel is not fully documented. It had been treated before World War II with unknown substances, and after the war with turpentine/linseed oil. It seems likely that the unknown substancescontained 'candlewax'. In this case the C-fraction must have been severely contaminated, given the high carbon content. The real age must be much younger than 2195±35, perhaps as much as 600-1000 years. The date is not included in the list.

Other cases with large age differences between both fractions are:

Bielice	C 1360±50	GrN-20653	C_v: 18%
	N 2080±70	GrN-21349	C_v: 27%
Nova Cerkiew	C 780±90	GrN-21429	C_v: 22%
	N 1850±140	GrN-23667	C_v: 25%

The date of the Bielice C-fraction might be reliable, given its carbon content. The carbon content of the Nowa Cerkiew C-fraction is relatively high. Nevertheless the date is accepted, because the real age can be only slightly younger. It is clear that in both cases large amounts of contamination went into the N-fractions.

There is one case of a large age difference between C- en N-fraction in a wood sample:

MNS A/17309	C 1340±40	GrN-21141	C_v: 22%
	N 2425±65	GrN-21142	C_v: 24%

In this case a cellulose sample was prepared and dated, as well, after rigorous pretreatment:

	C 1350±50	GrN-20649	C_v: 15%
	N 1670±30	GrN-21140	C_v: 29%

It is clear that the C-fraction of the wood sample produced a reliable date.

A number of logboats were dated on wood, without separation of fractions. In table 12 the boats with received treatment with chemicals (in all cases with turpentine/linseed oil) are indicated with an asterisk. The corresponding dates should be treated with caution, because the reliability of these dates cannot be checked.