Lichonometric Dating of BoulderLabyrinths on the Upper Norrland Coast of Sweden

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Abstract

More than 50 boulder labyrinths along the Swedish Bothnian coast have been dated using a lichenometric method. The lichen used for this study is *Rhizocarpon geographicum*, a common species on post-glacial uplifted (isostatically raised) boulder beaches in the Bothnian region. The lichenometric method is described below and the results show that many of the labyrinths were constructed between 1500 to 1650 CE. There is also a weaker tendency, in the region under study, for the labyrinths in the south to be older than those further north. As the region is affected by isostatic uplift, the elevation of the labyrinths also reveals that very few can theoretically be older than 1000 years.

Boulder labyrinths are found along most of the Swedish coastline. The Bothnian coast is especially well known for the great number of labyrinths in this region (see *Caerdroia* 25 (1992), p.32-40). Most of them are found on isostatically raised boulder-fields and are constructed of local boulder material. Two common types of labyrinths are found - the classical 'cross-labyrinths' and the 'spiral-formed labyrinths' - and various types of compass-roses are also often found alongside these labyrinths.

A labyrinth at Rataskar, Vasterbotten, Sweden. This labyrinth is the older of the two on this island and is dated to 1542 CE, ±35 years Photo: R. Sjöberg

The problem

Not so long ago we did not know when the labyrinths were constructed. The aim of this paper is to describe a dating method that can be used to date these labyrinths and similar boulder constructions. The question "why were the labyrinths constructed?" is, however, not discussed here.

To date a boulder construction such as a labyrinth using normal archaeological dating methods, such as carbon-14, is impossible, since the construction contain no carbon material. However, as the research area is affected by isostatic land uplift, the altitude above sea level can only give us an absolute oldest age for the construction, since they certainly cannot have been constructed below the surface of the sea, and most probably not even exactly at sea-level. Our problem was to find a method that made it possible to date when a boulder was brought from a boulder field and placed into the construction.

A spiral labyrinth at Husbyn, Ångermanland. This labyrinth is dated to 1660 CE, ± 50 years. Photo: R. Sjöberg

Dating Methods

During the mid-1980s, at the Center for Arctic Research at Umeå University, Sweden, Dr. Noel Broadbent developed a lichenometric dating method measuring the growth of the lichen *Rhizocarpon geographicum* on isostatically raised boulder fields (Broadbent & Bergqvist 1986). As the rate of land uplift makes it possible to determine when each boulder field was situated at sea level, to a specific time before the present, Broadbent could construct very accurate growth rate curves for the investigated lichen. Broadbent also found that only the largest lichen on each level could be used for the construction of the growth curve, since this individual represented the oldest surviving lichen of the population for the specific altitude. The growth curve also allows for the fact that lichen growth undergoes two distinct phases, a very rapid initial growth for 100 to 300 years, termed "the great period" by Beschel (1950), followed by a slower linear growth rate for up to 1000s of years (Armstrong 1976, Topham 1977). The shore growth of lichens has here been described using linear equations, and as such, apply primarily to the second growth phase. This means that most of the curves apply to lichen growth from locations 2 metres above sea level (a.s.l.) and higher, or from c.1750 CE or earlier (Broadbent 1987). Several such growth curves have been constructed by Broadbent and the author along the coastline under investigation.

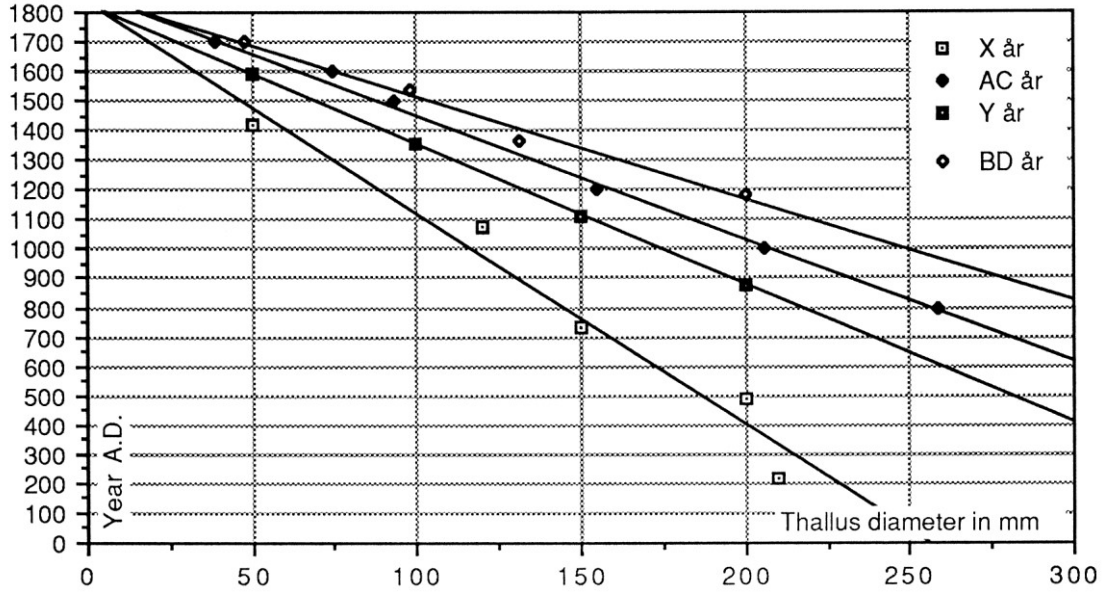

Figure 1: Growth curves for* Rizocarpon geograficum *along the Swedish Bothnian coast
The Y-axis ends at 1800 CE, to avoid the "great period" of lichen growth. The graph shows that growth rates increase from south to north. X = the southern Bothnian coast (the provinces of Hälsingland and Medelpad); Y = the province of Ångermanland; AC = the province of Västerbotten, and BD= the inner Bothnian Bay (the province of Norrbotten).

One example: for the area at Bjuröklubb, south of the city of Skellefteå, a growth curve was constructed, which has proved to be useful as a standard curve for the coastal parts of the province of Västerbotten. When calculated based on thallus diameter, the growth curve followed an equation (Y= 1.21 + 0.035 X) where X is equal to the thallus size in mm. This equation has a standard deviation (s) for Y of ±0.45 mm. The equation describing thallus diameter by elevations follows an equation (Y= -32.5 + 28.3 X) where X equals the elevation above sea level. The standard deviation for Y is ±12.86 cm. Since elevation can be converted to a specific time before the present, when the specific level was situated at sea-level, this growth curve followed an equation (Y= 147 + 3.48 X), where X is the maximum diameter of the lichen, and Y is the age of the studied lichen. This equation has a correlation-coefficient (R xy) of 0.9, and standard deviation of ±35 years. The equation for the age of lichens further south along the coast has been calculated to Y= 164 + 4.73 X (with X and Y as above), and along the southern Bothnian coast to Y= 158 + 7.17 X (Sjöberg 1991, p.96-102). The correlation coefficients for these latter equations are 1.0 and 0.9, but the standard deviation is somewhat higher, ± 50 years.

In figure 1 it can also be seen that the growth rate of the studied species is higher in the northern part of the region, than in the southern part. This might be explained by the longer daylight during the growing season in the northern part of the studied region. As the growth of a specific lichen is disturbed when the boulder with the lichen is moved, the growth rate will slowly decline, and finally the lichen will die. Thus, the lichens on the boulders of the labyrinths usually cannot be the same as those growing on the boulders when they were in situ in the boulder field. Therefore, the age of the lichens, as calculated by the formula, gives us a latest possible age of the labyrinth.

At the start of this dating project, we still faced the problem that some lichens could be survivors from the boulder field. Such lichens could not be used for the dating of the specific construction. This problem was solved by studying the weathering of the boulder surface. Here we used an instrument called the Schmidt Test-hammer. This instrument gives quantifiable data of the softness of the tested surface. We found that the protected underside of boulders in situ on the boulder-field had a considerably slower rate of weathering, than the exposed upper side (Sjöberg & Broadbent, 1990). During the construction, some boulders would inevitably be placed upside down, compared with their original position. If the studied lichen was growing on such an upturned former underside, we were assured that the lichen had started to grow after the boulder was put into the construction. In this way questionable lichens could be tested and eliminated.

In one example, (Grundskatan, no.45 in the table at the foot of this article) the labyrinth was constructed by taking the boulders from the walls of a primitive hut construction, known as a *tomtning*. These huts were used by seal hunters in the Bothnian region during late Iron Age to early mediaeval times. In the hearth of this hut we found charcoal that could be dated by carbon-14, which revealed that this specific hut was in use around 1000 CE. The labyrinth was therefore probably constructed after huts of this type had lost their function. This is the only example of a *terminus ante quem* dating of a labyrinth in Sweden. The lichenometric investigation showed that the youngest possible age for the labyrinth was 1507 CE ±35 years.

Results and discussion

More than 40 labyrinths along the Bothnian coast have been dated by Broadbent and Sjöberg using this lichenometric dating method. Some labyrinths were not possible to date because the lichens were destroyed by air pollution, overgrowth by vegetation, recent reconstruction of the labyrinth, etc. The age of the dated labyrinths is shown in the table below, where the labyrinths are listed from south to north. Some of these datings demand further explanation.

The labyrinth at Bredsand (7) showed a very peculiar lichenometric result. However, a summer cottage owner revealed that this labyrinth was constructed by the daughters of the family in the early 1970s!

The labyrinth Ratan 1, Båkskäret (43) is according to Broadbent (1987) an older model of Ratan 2, Båkskäret (44). The latter seems to have been constructed after a sailor's inn was opened in the harbour of Ratan at the end of the 17th century. Ratan was then the major export harbour for northern Sweden.

The labyrinth at Svarthällsviken (46) is dated by a very local growth curve (Broabent 1987), which is why it differs in age when compared to the adjacent labyrinth at Grundskatan (45). The largest thallus has in both cases a diameter of 95 mm. The former is also interesting in that it seems that it has never been completed. Only parts of the angles and the two inners rows were constructed before abandonment.

The labyrinth at Skötgrunnan (47), outside the town of Piteå, seems, according to the lichenometric result (1677 ±35), to have been constructed when the rights for fishing were granted to the local fishermen by Queen Christina (1632 - 1651) in the middle of the 17th century.

The labyrinth at Jävre (49), situated 100 metres above sea level, is constructed close to a Bronze Age grave cairn. Our studies of the weathering (Sjöberg 1987) revealed that the labyrinth was most probably constructed from boulder material from the cairn, and the largest lichens revealed that this happened at the end of the 13th century.

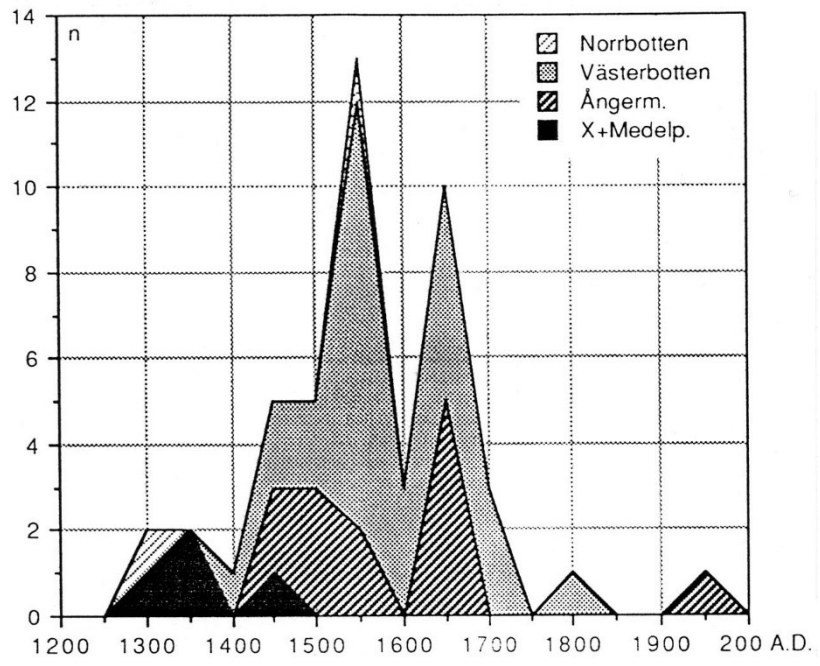

Figure 2: Licheometric dating of 44 labyrinths along the Swedish Bothnian coast. Note that the majority of the labyrinths were constructed between 1500-1650 CE

Fig. 2 shows the age of the dated labyrinths. It reveals that a majority seem to have been constructed in the 15th and 16th century CE, with a peak in the middle of the 16th century CE. The oldest labyrinths were according to the diagram constructed at the end of the 13th century CE The diagram also reveals that there is a small tendency that the labyrinths in the southern parts of this coastal area are somewhat older than the labyrinths further north. However, we do not have any real proof to conclude that the tradition of constructing labyrinths has moved from south to north. Earlier hypothesis supposed that the spiral formed labyrinth was a later, degenerated form of the classic labyrinth. From the table we can read that on the contrary, they are in fact contemporary to the classic labyrinths. This is also the case for other boulder constructions such as compass roses.

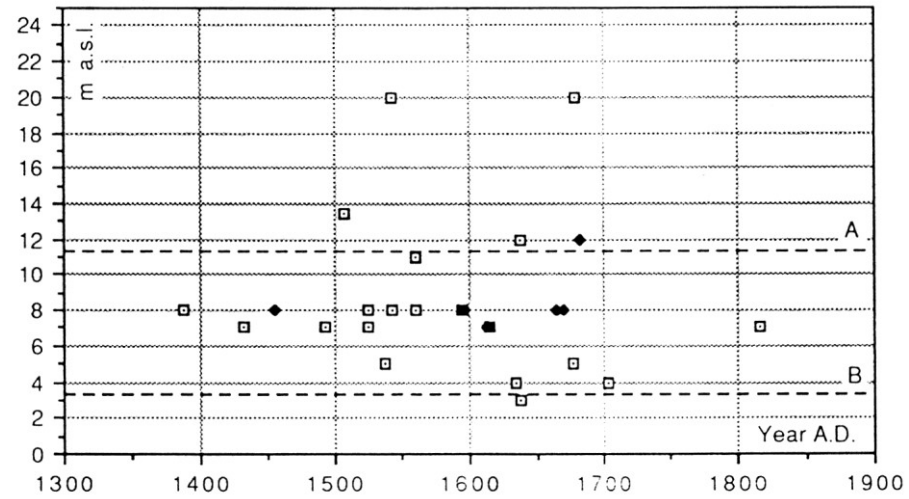

Figure 3: The altitude of labyrinths and compass roses along Bothnian coast of the province of Västerbotten compared to their age as measured by lichenometry. The horizontal line A shows the sea-level during the Viking age (900 CE). Line B shows the sea- level in 1600 CE. The graph shows that according to altitude very few labyrinths could theoretically have been constructed before 900 CE

Based on these results it is also possible to show that the altitude of the labyrinths cannot be used for dating. From Fig. 3 it shows that labyrinths dated from the 15th to 17th century CE are distributed at levels between 5 to 20 m above sea-level, and that labyrinths situated at a level between 5 to 10 m above sea-level may have been constructed from the late 13th century to the beginning of the 19th century. The altitude, thus, only give us the oldest possible age of the labyrinth, while the lichenometric datings give us a youngest possible age. However, compared to the labyrinths in the White Sea region, which are said to be several thousands of years old, it is possible to use the rate of land uplift, Fig. 4 and 5, in the Bothnian region to show that only three of the dated labyrinths can theoretically be older than 2000 years.

Rabbe Sjöberg, Centre for Arctic Research, Umeå University, Sweden; 1995.

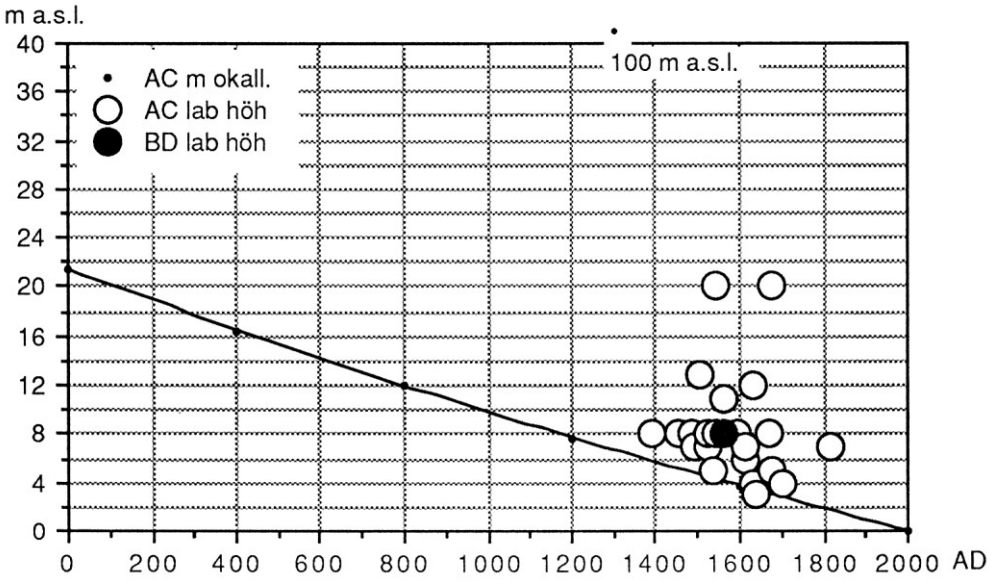

Figure 4: The altitude of dated labyrinths in the counties of Västerbotten (AC) and Norrbotten (BD) compared to a curve of the isostatic land uplift in the area. This diagram shows that only one labyrinth can theoretically be older than 2000 years. The majority of the labyrinths cannot be older than 800 years

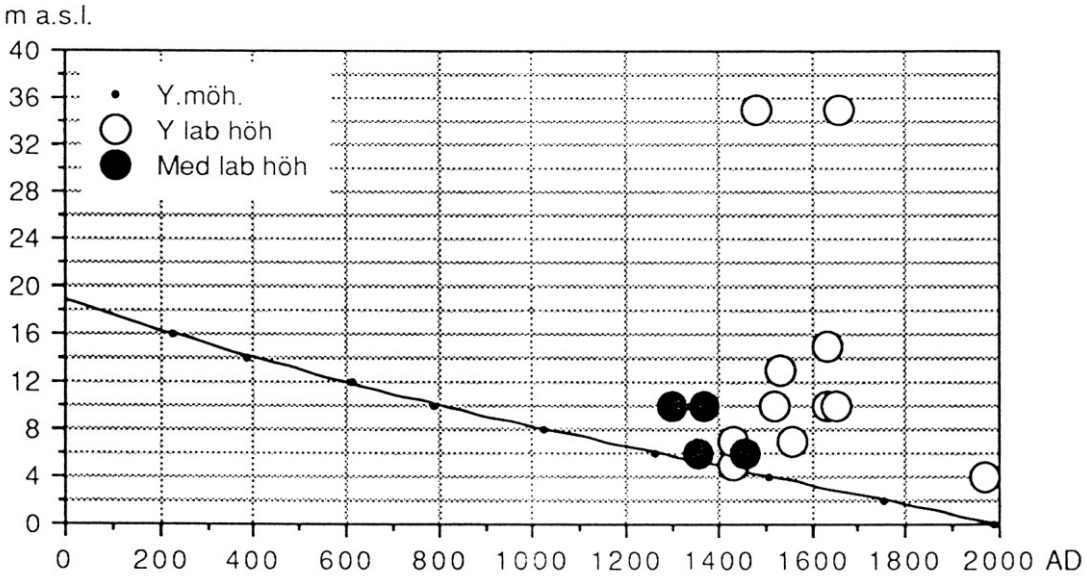

Figure 5: The altitude of dated labyrinths in the county of Västernorrland (Y) compared to a curve of the isostatic land uplift in the area. This diagram shows that, because of the altitude, only two labyrinths theoretically can be older than 2000 years. Most cannot be older than 1200 years. Eight of the labyrinths coincide with a level of +5 m above the contemporary sea-level

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Dated Labyrinths along the Swedish Bothnian Coast

The labyrinths are listed from south to north

No.	Location	Height above sea level (m.)	Design type	Max. thallus diameter (mm.)	Dating (accuracy)
Province of Hälsingland					(± 50 years)
1	Kuggören	10	classical	60	1371
Province of Medelpad					(± 50 years)
2	Lörudden 60	6	classical	52	1457
3	Lörudden 60 A	6	classical	-	not dateable
4	Lörudden 61	6	classical	69	1355
5	Lörudden 62	10	classical	74	1299
Province of Ångermanland					(± 50 years)
6	Stubbsand	5	classical	83	1433
7	Bredsand	4	classical/spiral	-	1970
8	Trissvarpsundet	7	spiral	56	1561
9	Haraskär 142	10	classical	37	1651
10	Haraskär 143:1	8	classical	-	not dateable
11	Haraskär 143:2	8	classical	-	not dateable
12	Haraskär 351:1	15	spiral	41	1632
13	Haraskär 351:2	13	classical	62	1533
14	Tvärlandsberget	35	spiral	72	1485
15	Husbyn	35	spiral	35	1660
16	Vörtskär	12	classical	-	not dateable
17	Malnviken	4	classical	-	not dateable
18	Själnöhamn 71:1	10	classical	65	1518
19	Själnöhamn 71:2	10	classical	41	1632
20	Långroudden	7	classical	105	1433

Province of Västerbotten					(± 35 years)
21	Snöan 1	7	classical	30	1816
22	Snöan 2	7	classical	100	1493
23	Snöan 3	7	classical	65	1615
24	Snöan 4	5	classical	87	1538
25	Snöan 5	7	classical	90	1525
26	Snöan 6	7	classical	90	1525
27	Snöan 7	8	classical	130	1388
28	Bredskär	12	classical	59	1637
29	Lövöudden	8	rebuilt as compass rose	50	1669
30	Rovågern 1	4	classical	40	1704
31	Rovågern 2	4	spiral	60	1634
32	Västersandskär	4	classical	60	1634
33	Rovan 1	8	spiral	112	1453
34	Rovan 2 (remains)	8	?	102	1488
35	Bjuren	6	classical	67	1610
36	Stora Fjäderägg 1	8	classical	85	1542
37	Stora Fjäderägg 2	11	classical	80	1560
38	Stora Fjäderägg 3	8	classical	85	1560
39	Stora Fjäderägg 4	8	classical	70	1595
40	Stora Fjäderägg 5	8	classical	90	1525
41	Stora Fjäderägg 6	7	classical	90	1525
42	Lilla Fjäderägg	8	classical	90	1525
43	Ratan 1	20	classical	85	1542
44	Ratan 2	20	classical	46	1678
45	Grundskatan	13	classical	95	1507
46	Svarthällsviken	3	classical	95	1638
47	Skötgrunnan	5	classical	46	1677
Province of Norrbotten					(± 35-40 years)
48	Jävre	100	classical	155	1299
49	Storrebben	8	classical	80	1561
50	Seskar-Furö	5	classical variety	40	1751
51	Tervaluoto	c. 14	?	75	1612

The oldest of four labyrinths at Lörudden fishing harbour is dated to 1299 CE, ±50 years. Photo: R. Sjöberg