

The past Finnish slash-and-burn or *kaski* turnip (*Brassica rapa*) as an ignored resource for selecting of the oil turnip rape, and about the mutants of the *kaski* turnip

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In 1845, the wild turnip (*Brassica rapa* ssp. *campestris*) was presented as the worst weed species in barley fields in Finland in a text-book for the Mustiala Institute written by S. Gripenberg. Since then, the growing of turnip (*B. rapa*) in fire lands, i.e. *kaski* and *kytö*, declined, and wild turnip became rare. The now extinct wild turnip formed a genetic continuum together with the cultured form. Wood as charcoal was dated with 95.4% probability 24 ... 226 AD with radiocarbon in the studied Saarela Site (Kouvola, SE Finland) where and when growing of turnip was shown to have occurred. The Saarela Site has a megalith gnomon which could be used to determine the summer solstice, which defines the sowing time of turnip. An oven between boulders covered with a megalith had been used to bake turnips in the Saarela Site, which has depressions of ancient turnip pits, and altogether 129 ancient turnip pits occur within 1-km radius around. The indicator of using fire, *Geranium bohemicum* appeared in the Saarela Site after two soil digging events, and in a nearby site, after prescribed forest land burning. Historical remarks and remains of past *pantio* towers in the village are shown. The *pantios* were used to make souerkrout for food and feed from heat treated turnip tops and other vegetables. My crosses within the *kaski* turnip landrace 'Liperi' resulted in the segregation of spring habit, which could also have a hypocotyl-tuber. Mutations from slender base to the hypocotyl-tuber are not rare and demonstrate a single-step evolution of the *kaski* turnip from the wild turnip. Liperi also segregated a novel stem mutant, named *varsinauris*, 'stem-turnip'. This recessive mutant has a 2 á 3 cm thick and 0.5–1.3 m high stem as its storage tissue. Back-mutation from spring habit to winter habit was observed. The 'Enon kanta' landrace of *kaski* turnip was very variable. A single turnip plant wintered in my cocultivation trial of winter rye sown on the first of July as *juuriruis* ('root-rye') together with Enon kanta turnip as the first-season crop. The base of the wintered turnip was slender, representing a spontaneous segregant of the turnip rape type. Enon kanta produced i.a. *riplikas* segregants with red-and-whitish variegating cortex of the hypocotyl-tuber. To produce a true-breeding, homozygous *riplikas* variegating strain failed; a low, non-Mendelian proportion of plants with all-whitish cortex repeatedly occurred in progenies from crossing or self-pollinating. This suggests that the *riplikas* variegation is caused by an unstable gene. The weedy turnip was not exploited to develop an adapted seed oil crop. On the contrary, learned people warned of spontaneous outcrossing of flowering *Brassica* seed stocks with weedy turnip causing harmful progenies. Since 1757 until 1945, the few trials done in Finland with imported oil seed *B. rapa* strains resulted in failure due to lack of wintering, lateness when sown in the spring, and damage by insects in the small trials.

Key words: atavistic segregant, mutator gene, prehistoric crop, progenitor of turnip

Preface

Turnip is a crop of European origin (Hyams 1971, Reiner et al. 1995). The rapidly perishable vegetative samples and highly fragile seed coats in soil when charred make turnip less frequent to be found archaeologically from soil. The *kaski* turnip type has its origin in the slash-and-burn growing used by Finns since the prehistory, being a genetic source for this type of turnip in Eurasia and North America (Ahokas 2010). The names *narsku*, *nakris*, *nauris* and other variants thereof denoting 'turnip' (Ahokas 2002) are original and indigenous in the Finnic languages, suggesting a separate Finnish centre of origin of this crop species. The basic term may have been *narsku* or *narska* derived from the onomatopoeic verb *narskua*, 'to crunch', and *nauris* from *narista*, 'to creak', or sounds heard while chewing a fresh turnip. In the prehistory, turnip may have been the staple food crop during several months of a year in Finland; in 18th century, turnip and rutabaga were the peasants' principal food in the autumns in the Satakunta province (Gadd 1751).

The Vepsian, a Baltic-Finnish language calls turnip *nağriž* (Kettunen and Siro 1935), and Tunkelo (1946) recognised the Vepsian to have destined the *hīnad* term for 'the stems of turnip', also suggesting a long co-existence of the Veps with the crop turnip, while *hiin* in general means 'grass' in Vepsian (Zaitseva and Mullonen 1972). The word *hina* existed in an old Finnish folklore meaning a kind of shore hay carrying head and glumes (Ganander 1786–1787), destined for *Danthonia* (*Sieglingia* or *Triodia*) *decumbens*.

In critically cool and short season in Finland, the importance of turnip as a foodstuff became evident. Uutela's oral tradition (1957) knew, that turnip was the only crop which produced yield in the litti municipality in the famine 1865 season. This shows a good adaptation of the turnip to the local environment, and supports the idea that the turnip type preceding the cultivation can have been an adapted wild species in the territory of Finland. Habitats of the past wild turnip might have been forest lands burned by wild-fire, flood plains and eroded river and lake sides, all of them being plentiful in the past. These environments also guarantee soluble boron for a season or so. A good level of boron is needed in the healthy development of *Brassica* species (Jamalainen 1935, Gupta 1979). Any of the early archaeological Brassicaceae (Cruciferae) pollen findings might represent a wild turnip, with examples from Humppila Järvensuo prior to 4000 ¹⁴C years (Aalto et al. 1985), Valamo Skiitanlahti prior to 1769 cal BC, Valamo Eastern Igumeeninlampi 780 cal BC, Valamo Niikkanlampi 420 cal BC, and Valamo Luostarinlahti ~2000 years ago (Vuorela et al. 2001), Uukuniemi Papinniemi prior to 3390 ¹⁴C years (Alenius and Laakso 2006), Hiitola Kilpolansaari prior to 2070 ¹⁴C years (Taavitsainen et al. 1994), and Mikkeli Orijärvi ~2000 years BP (Alenius et al. 2008).

According to Ganander (1786–1787) turnip with an elongated root was called *moiliainen* in Finnish and they were abandoned in the land in the autumn. Such deep-rooted turnip variant was called *jurikas* or *purikas* in the Maaninka (Rytönen 1931) and the Tuupovaara municipality (Suhonen 1938), while in the Keuruu municipality, they were called *purikas*, *pura*, *jupero* and *kupulanauris* (Valjakka 1936). Such turnips abandoned on the land increased the chance of wintering and evolving of weedy turnip. Seed from *in situ* wintered turnips was known to have resulted in poor quality tubers in the Tervo municipality (Heimonen 1934), which may mean a selection towards weediness in linkage with winter-hardiness. In the Orivesi municipality, weedy turnip spontaneously occurred in spring sown grain crops in the past (Hellenius and Salovius 1789). Sometimes turnip seed was harvested from plants left or remained to winter on a *kaski* land (Loune 1958). In the Tyrvää dialect, such wintered flowering turnips could be called *ukkosennauris* when flowering in the next season (Urhola 1976), which was named *narsku* e.g. in the Keuruu municipality (Valjakka 1936). Seed of *ukkosennauris* giving turnips substantially without tubers was also sold from a local pharmacy (Urhola 1976). Grotenfelt (1910) considered a minimum isolation of 100 m between turnip seed growing and ssp. *campestris* plants. Spontaneous hybrids of ssp. *campestris* with rutabaga and turnip were described e.g. by Sauli (1922, 1930). Ssp. *campestris* occurred both in spring (Θ) and winter habits (Θ) (Sauli 1930).

In the years 1914 and 1915, Linkola (1916, 1921) found the weedy turnip in many areas on the northern coast of the Ladoga, usually in fields, especially of summer cereals, at houses and as ruderal, while turnip was frequently grown on small burnt parcels then. Describing the flora of the Tuusniemi municipality, Pitkänen (1940) found on such burnt-land patches grown with turnip, this species to have occurred even during several successive seasons. This kind of observations corroborate the continuum of the cultural turnip towards naturalizing recombinants of the outcrossing turnip species. Valle (1954) described seed production from an incidentally wintered *naattinauris* turnip field on the Fiskars farm in South Finland; for the *naattinauris*, 'big-leaf turnip' or 'leafy turnip', see below.

In Sweden, Triewald (1742) found barley with plenty of weeds, principally *åkerkål* (evidently *B. rapa* var. *campestris*), to lower the yield to 7 grains, instead of 13 grains in neighbouring parcel without the weeds. This is in agreement with Gripenberg's (1845) observation that the wild turnip was the worst weed of barley in Finland. In the 1920's in Finnish Karelia, the grain crops following *kaski* turnip were typically rye and oats (Loune 1958), perhaps barley was avoided because of its poor competitiveness with the weedy turnip.

In the Russian Karelia, the distribution of the Finnish slash-and-burn turnip without interruption continued eastwards of the east boundary of Finland, as shown by Veselovskaya's map (1926, also in Sinskaya 1928: p. 207), and up to 69° 30' N in burned fields called in Russian *пала* (*pala*) (Tret'yakov 1932) which must be a loanword from the Finnish *palo* ('slash-and-burn', 'fire-land'). *Palo* anciently appeared also e.g. in the toponym Palma from the Finnish *palomaa*, 'fire-land' (Pogodin 1932) with several other *palo* derivatives adopted to Russian (Ahokas 2009: p. 92–93). On the NW Soviet Union side, in Louhi (Лохы) in Karelia and Hiipinä (Хибины) in Kola, *B. campestris* was found to be a meaningful weed of barley in 1925 (Zinserling 1926) coherently with the note 80 years earlier in Finland (Gripenberg 1845).

The 'Finnturnip' (*Finnrova*) was also widely grown and liked in the Proper Sweden in the past (Rosenhane <1663), and often also grown in *kaski* land (Linnæus 1751). The *kaski* turnip was also grown on the Gotland Island of Sweden on the Baltic Sea, with the names *brandroga* and *skogsroga* (Pettersson 2015), and in Norway, called *braatenæpe* (Grotenfelt & Relander 1912); the Norwegian *bråte* (*braate*) denotes 'slash-and-burn', '*kaski*' (Iversen 1959). The traditional sowing manner of Finns by spitting turnip seeds from mouth (Grotenfelt 1899: p. 178, Rytönen 1931, Saarinen 1933, Rönkkö 1934, Itkonen 1944) was adopted both to Sweden (Linnæus 1751) and Russia, viz.

Archangel and Vologda governorates and “elsewhere” (Veselovskaya 1926). If the seed spitter used chewing tobacco, the seedlings were said to be protected from beetles (Kauppinen 1930).

Koch (1833) recognised the turnip (*Brassica rapa*) to appear as an *Urform*, i.e. a weed in grain field and cultivated land, and in Germany needing two seasons. McNaughton (1995) suggested a stubble-turnip era, growing as an autumn crop after cereal harvest, to have occurred in Europe perhaps in the fifteenth-eighteenth centuries. The dated Saarela Site in southeastern Finland belongs to the ancient, probably oldest turnip growing zone in Europe. On the Valamo Island on the Ladoga, the growing was apparently pre-Christian probably using slash-and-burn. As samples of cultivation and settlement indicators on the island of Valamo (Kare 1929), Brassicaceae pollen in the sediments were dated earliest prior to 1769 cal BC (Vuorela et al. 2001). The Ägräs God of cabbage and turnip growth by the Karelians (Harva 1932) also dates their growing to the first AD millennium or earlier. The expedition of Pytheas found eating of “roots” (~322 BC; Stichtenoth 1959) in the north where sun did not set in the summer (Strabo). A recent review showed turnip to have been introduced to Iberia in the 13th/14th AD centuries (Peña-Chocarro and Pérez-Jordà 2026). The Byzantine Sparta in Greece had turnip (Hather et al. 1992). The town of Novgorod, having also Finnic (Chudic) inhabitants, had turnip as a commercial article in 1215 AD, when during a famine year its (high) price was written down (Anon. 1971). Turnip was introduced from Europe to China (Kučera et al. 2018, Šamajová et al. 2024).

Traditional sowing of *kaski* turnip around the summer solstice in Finland

Slash-and-burn or *kaski* turnips were sown on three dates a year in Savonia, Finland in the past (Bennet 1792, Grotenfelt and Relander 1912), firstly, 14 days before Midsummer Day (summer solstice, nearly corresponding to St. John’s Day), secondly, a week before Midsummer Day, and thirdly, a week after Midsummer Day, the last matching St. Peter’s Day. Weckström in his agricultural encyclopaedia (1850), gave as traditional turnip sowing dates June 12 (Eskil), 17 (Botolphi), 23 (St. Johannis), 29 (Petri) and July 8 (Kilian). Weckström’s information sources were probably mainly from the southern Finland. Kiljan was mentioned as a typical sowing date in many regions in South Finland, e.g. in Jokioinen (Saarinen 1933). Kauppinen’s (1930) informants in the Pieksämäki municipality knew, that there were three permitted turnip sowing dates, the first, second and third Friday after Midsummer Day, each being called *hiki-perjantai*, ‘sweat-Friday’.

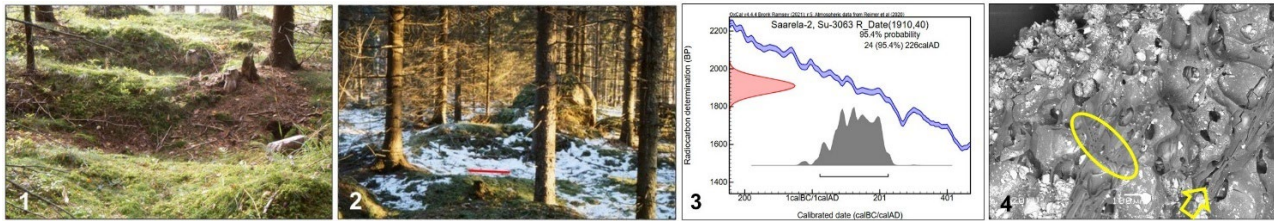
Together with turnip, *Finneråg* (‘Finnrye’) was sown immediately after Midsummer Day in Sweden (Rosenhane <1663). Ivan’s (St. John’s) Day determined turnip sowing also in Ingria (Teplov 1767).

The main meaning of the astonishingly late date of sowing was to avoid damages by beetles to the seedlings. Bennet (1792) described the purposes of the turnips from the three different sowings. The earliest sowing produced the turnips stipulated the seed-stock in the next spring and was partly the summer food. The second sowing was principally conserved fresh or baked in the *nauriskuoppa* or turnip pits (Figs. 1, 10A & B, 11A & C). The pitted turnips were started to be eaten after the Christmas, when the harvest of the third sowing ran out.

From prehistory to historical era. Successful agriculture needed a reliable calendar

In the prehistory, before the written calendars the determination of the summer solstice or Midsummer Day was important for a successful growing of turnip. The summer solstice, known in printed Finnish as *päivänpalaus* since 1644 (Jussila 1998) was taken with the name *päivänpalaama* as a turnip sowing calendar point (Ojala 1934). The three days of maximal height of the sun around *päivänpalaama* were called the *pesäpäivät* days in Karelia (Mennander and Aurenus 1751). With the rune-staffs used in Finland and Karelia (Hirsjärvi 1944, 1957) one could determine the Saints’ dates, which were optimal for the turnip sowing. The rune-staffs usually dated e.g. St. Peter’s day, June 29.

An upright boulder apparently shaped and possibly also erected by humans served as a megalithic gnomon with which the highest sun, or the summer solstice of the year could be determined with an accuracy of ± 3 days in the Saarela Site, Rahikkala village in the Elimäki municipality, in 2009 annexed to Kouvola (Figs. 5A – C; Ahokas 2012). At a distance of 8 m SW of the megalith, slightly submerged, I found a small, flat triangle of potassium feldspar. The angles of the triangle match the triangle formed by the megalith and its shadow at the highest sun (Figs. 5A & B).



Figs. 1–4. The Saarela Site of ancient turnip culture. – **Fig. 1.** Depressions of the ancient turnip pits (Finnish *nauriskuoppa*), two visible of the three pits side-by-side. Sept. 26, 1998. – **Fig. 2.** The bowl-like bottom of a roundish, apparent ancient *kota* hut with the entrance (Finnish *eteinen*) projecting to the south (*etelä*), from where the noon sun shines. There had been no fire place in the hut. Red scale 1 m. 22 December 1998. – **Fig. 3.** Calibration of the wood charcoal sample dug at the depth of about 8 cm in moraine under the surface 15 m NW of the megalith (Ahokas 2010). The prehistoric charcoal had an evident charred piece of turnip dug on 26 September 1998. Calibrated age of the charcoal forming wood is with 95.4% probability 24 ... 226 AD from the ^{14}C age of 1910 ± 40 (Saarela-2, Su-3063) using the OxCal v4.4.4. calibration program. – **Fig. 4.** A scanning electron microscope (SEM) view of a charred, archaeological fragment determined to be from turnip tuber based on artificially charred references. Found among the wood charcoal for the ^{14}C dating at about 8 cm below the surface. The water cells of turnip tuber are usually devoid of starch grains. Vascular tissues are visible as pits (within yellow ellipse) and as longitudinal splits (arrow) (cf. Lund and Kiærskou 1886, Hather et al. 1992). Scale 100 μm .

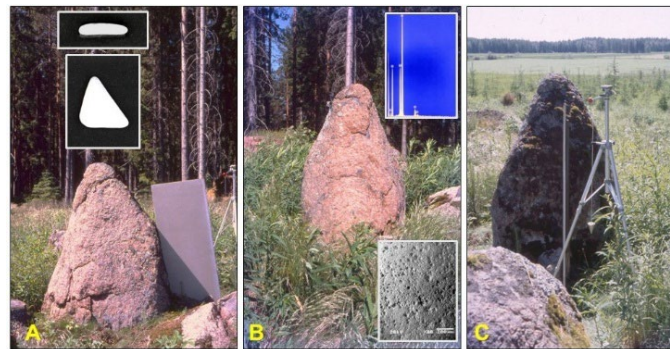


Fig. 5A–C. The gnomon megalith is taken as the central point of the Saarela Site destined in this study. The megalith has an exceptional, upright and symmetric shape differing from the other boulders. – **A.** The east-side view of the megalith with the upright board showing the shadow continuing the 37.2° angle of the upper northern face of the megalith against the altitude at the highest sun during the summer solstice, on 21 June 2005. The summer solstice marks the optimal turnip sowing time. This observatory shows a maximal height of 52.8° of the upper limb of the sun on the current 44 m level above sea. The inserts show micro-photographs from “top” and side of the flat microlith which I found under the intact field layer slightly submerged in the mineral soil 8 m SW of the megalith on 21 September 2003. Taking the microlith as a triangle, its angles, 75° , 52° and 53° resemble the side view of the megalith with its shadow cast along the upper northern face from the highest midsummer sun. The long side of the microlith is 11 mm, mass 173.7 mg. – **B.** The south-projecting edge of the fairly symmetrical megalith photographed from south on 21 June 2005 with two inserts of the microlith studied with SEM. Upper insert: The SEM detected elements Si, O, Al and K which with the other features show the microlith to be potassium feldspar. Lower insert: the surface of the microlith with corrosion pits. Scale 200 μm . – **C.** The megalith from north and the set-up with the board and the plummet hanging from the tripod. This set-up was used to determine the shadow angle of the highest sun on 21 June 2005 found out with the shape of the megalith. The above-ground dimensions of the fairly symmetric megalith: the total height 140 cm, and the height of the upright corners of the northern side 80 cm. The dimensions of the approximately triangle base on the ground: $105 \times 105 \times 85$ cm, the last being the northern side.

In the short-season north, optimal timing of the sowing is important. The points of rise and set of the sun in respect to the horizontal markers, the position of stars or constellations could advise to the sowing (Gadd and Gadd 1764). Winter rye was sown around the Dog Star’s setting (Olaus 1555), or in June, which can be followed only in the southern Finland due to light summer nights in the north. The Dog Star’s setting can also have been the indicator of the turnip sowing time. Different types of gnomons casting the shadow were made for time reckoning in the past (Olaus 1555, Rålamb 1690).

Within one kilometre around the megalith of the Saarela Site, there are, usually side by side (Figs. 1, 10A, 10B & 11A) or as less ordered groups, 129 depressions of ancient turnip pits plus a number of suspected turnip pits in moraine eskers and slopes, the nearest 11 m ESE of the gnomon (Fig. 1). In a group of 18 ancient turnip pits, ~240 m WNW of the Saarela Site, the depth, width and length of the largest pit of all are 1.2, 2.6 and 5.2 m, approximately fitting to a golden section (depth : width = width : length). Many pits have probably been used repeatedly. A shelter for the growers may have been a *kota* hut in the Saarela Site (Fig. 2). A cottage (Loune 1958) or a lean-to (Rytkönen et al. 1938–1939) was made for the workers’ comfort on distant *kaski* lands. Using the annual land

upheaval of 3.6 mm measured for the zone in the early half of the 20th century (Kääriäinen 1963), the megalith had ≈ 6.8 m lower level 1900 years ago, when the sun correspondingly had a slightly steeper angle on the megalith site. Tilting of the megalith may have occurred upon time, but is supposedly little thanks to its sunk base in the moraine.

The baking of turnips to *hautanauris* or *naurishauta* (in Finnish) for the pitting could be done directly with hot cobbles in the pit (Fig. 11C, Gadd 1751), or in a stone oven (Figs. 6A & 7) which could be made *ad hoc* in the field (Rytönen et al. 1938–1939). Baking of turnips and other root-crops could be done in pit-oven lined with cobbles which were heated with fire (Fig. 7, Rönkkö 1934, Suhonen 1938, Nirvi 1942, Itkonen 1944).

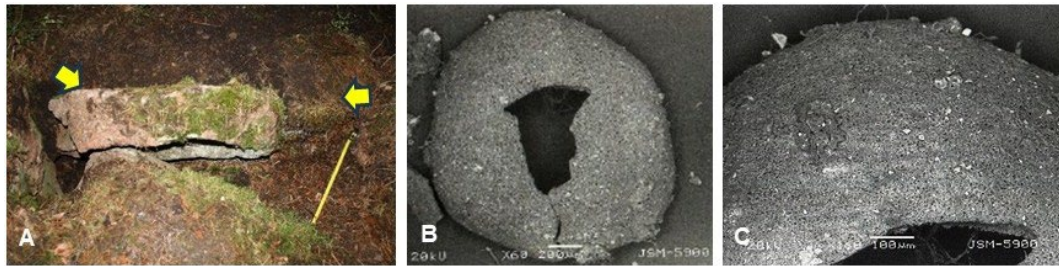


Fig. 6A – C. About the ancient turnip oven of the Saarela Site. – **A.** The oven from above. The $\sim\frac{1}{2}$ -tons flat megalith disc (thickness 20–25 cm, diameter ~ 120 cm) formerly a cover, fallen from the disintegrated rapakivi granite of the supporting side-boulders (between the arrows). After the soil had been dug underneath down to a rock, this formed an ancient oven: max. height of the vault ~ 90 cm, breadth ~ 70 cm, length ~ 115 cm. Scale 50 cm crosswise on the open end of the oven. The oven was evidently used to bake turnips, with the nearest turnip pits being ~ 10 meters NE (Fig. 1). The oven lies 16 m S of the gnomon megalith (Fig. 5). The covering megalith on the oven was apparently transported ~ 21 m from a boulder. The latest fire in the oven was burned sometime after 1478 AD (for the dating, see text). Photo with flash on Dec. 2, 2024. Additional illustrations available from 1998 and 2002 in Ahokas (2004). – **B & C.** SEM views of a charred fragile seed coat of turnip found among the oven bottom deposits sampled in 1998. Scale 200 μm (B), 100 μm (C).

The several tiny bits of wood charcoal from the bottom of the oven (Fig. 6A) identified from litter and picked under microscope in 2000 were pooled and dated: Saarela-5, Hv-24228, ^{14}C age of 215 ± 130 . The calibration of these age parameters is not thrustable, the last heating of the oven could have happened after 1478 AD until the modern. Since each tiny bit of the charcoal sample had wood of at the maximum from 5 different years, a decreasing the error of the mean to ± 30 years would give at 86.1% probability the age of 1641–1807 AD. In the few centuries old samples under the human caused variation in the atmospheric ^{14}C , the historical data can be implemented to give the probable age (Pauly 2020). Because the permanent dwelling of Saarela happened in about 1900, historical data suggest that the growing of the turnip in the *kaski* forest and the last heating the oven for baking turnips occurred during the 1700's. The villagers' refuge in the forests during the Great Hate (Oksanen 1985), would fit to the time range of the calibrations.



Fig. 7. A cairn of cobbles on the Ukonmäki hill dedicated to the Finns' pre-Christian Ukko God, the Lumivaara municipality, Kesvalahti village, at the Ladoga, a territory of Finland until 1944/1947. Young people traditionally gathered together on the Ukonmäki hill in the past (Mikkonen 1969). There they baked turnips and other root-crops. This kind of pit-oven lined with cobbles which were heated with fire beforehand was used in baking (Rönkkö 1934, Suhonen 1938, Nirvi 1942, Itkonen 1944). In the neighbouring Ihojärvi village in the past, boys used to visit girls braking flax, when they ate baked rutabagas and turnips as sweets as told by Mr. Kaapro Kuntsi (*1881 †1958) (Kuntsi 1985). An exceptional, big and branched turnip was called *ägräs* or *ägröi*, while *Ägräs* was worshipped as a pre-Christian god of cabbage and turnip growth by the Karelians (Harva 1932). The yellow scale, 20 cm. June 27, 2009.

Occurrences of the archaeophyte and fire indicator, *Geranium bohemicum*

A 0.65-ha clear-cut of forest in 2003 around the megalith in the Saarela Site exposed the gnomon to unshaded observations under the highest midsummer sun in 2005 (Figs. 5A–C). At least eight seeds of *Geranium bohemicum* from the seed bank of the soil germinated after the forest cut (Fig. 8). *G. bohemicum* is a species with a seed longevity of centuries, needing for germination a heat treatment or scaring of the seed coat (Perttula 1934). After the forest cut in the Saarela Site, the germination was evidently induced in the 2003 July by a spot cultivator working the soil for reforestation. It must have scared the seeds staying dormant in the soil for over a quarter

of millennium (Ahokas 2004). The scaring induced germination, while no fire was burnt there. Experimental scaring of the seed coat of *G. bohemicum* induced germination (Perttula 1934). The ancient turnip cultivation in the *kaski*-burned land had maintained *G. bohemicum* seed bank in the site. As I had earlier found a single flowering *G. bohemicum* plant in 1971 (the museal herbarium specimen H 183926, Kastikka dok. 562937; Lampinen and Lahti 2020) on the recently dug soil from the ditch beside the Pajarinmäentie road bordering the Saarela Site, these nine plants altogether suggest that fire cultivation on this site has an old tradition, apparently prior to the year 1800 (Figs. 9, 10A & 11B).



Fig. 8. On the Saarela Site a *Geranium bohemicum* plant has germinated, and on its right side, leaves of raspberry, *Rubus idaeus* emerge from the underground stem plus a *Pinus sylvestris* seedling has been planted. For afforestation, the clear-cut forest land was harrowed in July 2003 with a spot cultivator resulting in the disturbed moraine. The harrowing must have scared the seed coat of the *G. bohemicum* seeds inducing the germination from the dormancy evidently lasted for over two centuries since the previous *kaski* burning for turnip. Altogether eight *G. bohemicum* seedlings were observed in the 2003 season on the 0.65-ha clear-cut area around the Saarela Site. Sept. 14, 2003. – **Fig. 9.** 135 m NW of the Saarela Site, a sandy silt area suitable for turnip was *kaski* burned over three centuries ago, 1437 ... 1625 cal AD (Saarela_Kr9, Beta-688303) determined from wood charcoal from the depth 20–25 cm. Sept. 30, 2024.

I also found a *G. bohemicum* plant on June 23, 2012 on the nearby forest land where the seed scaring by the movement of the forest harvesters, or heat by the burning on 31 May 2012 (see Figs. 10B–D) induced the germination (the museal herbarium specimen H 831492, Kastikka dok. 836308; Lampinen and Lahti 2020). Among *G. bohemicum* plants, there can be summer annuals or wintering types, and its seedlings can be surely identified thanks to the special marks in the cotyledons (Perttula 1934).

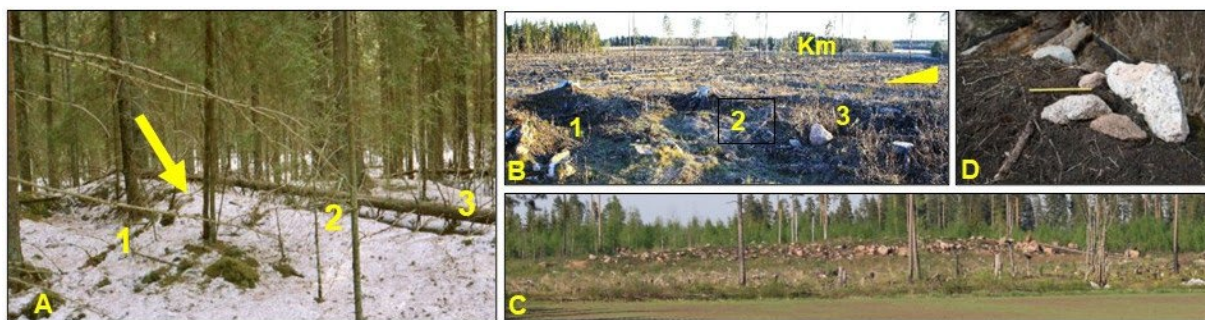


Fig. 10. A de Geer moraine ridge serving as turnip-pit terrain in a past *kaski* forest of the Rahikkala village. – **A.** Featured with the declining snow cover on April 2, 2000, three turnip-pit depressions (1, 2, 3) of the seven pits side by side. The arrow points to the site where, on June 9, 2002, I took wood charcoal from down to 7 cm depth for radiocarbon dating. Its age is 1459 ... 1689 cal AD at 75.7% probability (OxCal v4.4.4 calibrated, Saarela-7, Hel-4590, 270 ± 60 BP ^{14}C age). Wood of that age could have been charred sometime between 1713 and 1721 during the Great Hate. Then the Rahikkala people lived in forests escaping the torching and marauding Russian troops, which also burnt the Rahikkala village (Oksanen 1985: p. 173). – **B.** The same three pits (1, 2, 3) after clear cut of the forest and subsequent prescribed burning (Salonen 2012) on May 31, 2012. Km for Kuoppamäki points the trees on another de Geer moraine ridge (195 m long), with 9 turnip pits also dated with radiocarbon (Kuoppamäki-1, see Fig. 11B). The triangle shows the sector of the photography of Fig. C from the opposite direction. I found a flowering plant of *Geranium bohemicum* in the burnt area on June 23, 2012 (the museal herbarium specimen H 831492). April 4, 2014. – **C.** The 145 m long de Geer moraine ridge (Figs. A, B, D) with erratic boulders on its southern edge photographed from 400 m SW (the triangle in Fig. B). May 23, 2014. – **D.** The disappearance of the moss on a boulder near by the turnip pits during the burning revealed five cobbles of different colours and sizes lifted on the boulder in the past. They supposedly served as toys signifying livestock for children. The children were along on the *kaski* lands also participating in the work (Kauppinen 1930, Rytönen 1931, Rönkkö 1934, Rytönen et al. 1937, 1938–1939, Urhola 1976). Scale 22.5 cm. April 30, 2014. The Saarela Site (Figs. 5A–C) is 460 m WSW of the pits in Figs. A and B.



Fig. 11. – **A & B.** The Kuoppamäki de Geer ridge about 250 m SSE of the Saarela Site (Km in Fig. 10B). – **A.** Four depressions (arrowed) of the nine ancient turnip pits on the ridge top of Kuoppamäki which are proofs of ancient turnip growing nearby. The topography and coarse moraine ensure water to run away from the narrow ridge. May 23, 2014. – **B.** The site of the radiocarbon sample on the sampling date (March 9, 1997). On this southern flank of the Kuoppamäki ridge, an alder (*Alnus incana*) dominant stand on sandy silt soil with some boulders, would have been a suitable *kaski* area for turnip growing also in 1997. Alder is a nitrogen fixer with its root symbiont and was favourable preceding wood of a turnip *kaski*. The AMS dating of two pooled equal charcoal pieces, birch and pine from a depth of 13–16 cm suggests that this was under fire cultivation with wood grown in 1179 ... 1432 cal AD (Kuoppamäki-1, Ua-13190, OxCal v4.4.4 calibration of 14C years 675 ± 90 BP). – **C.** Schematic drawing of a turnip pit dug in land from end, side and end filled with turnips layered with hot cobbles and an insulating cover (Antila 1936).

Other *G. bohemicum* plants from a dormant seed bank in the soil evidently being a forest since the late 1700's, was reported after a clear-cut in 1989 in the Espoo town, Finland (Ihamuotila 1990). After the forest cut, the branches were partly burnt and the surface run with a cultivator for reforestation (Ihamuotila 1990). A seed dormancy of *G. bohemicum* exceeding two centuries was evident also in this occurrence in Espoo.

Historical era. Field observations and herbarium specimens of the declining weedy or wild turnip

In the 1964 summer for the last time within the Elimäki municipality, I saw a traditional wild turnip in the fallow of the Uotilanaho field, 990 m SE of the Saarela Site. Since 1792 (Ottelin and Kihlström 1792–1810, Ottelin 1793), this field rented by the Uotila peasant was known with the name Pykälistönaho, where the *pykälistö* appellative denotes a forest barked to be *kaski* burnt (Juslenius 1745), having large trees as illustrated by Linkola (1932), and Manninen (1932), and called *pykälikkö* by Suhonen (1938: p. 84). A neighbouring meadow rented in 1792 by the Kalkela peasant was designated Huhtamäenaho. The *huhta* appellative reminds of the past *kaski* cultivation as also wood charcoal mixed in the clayey topsoil observed in that forest site in 1998. These toponyms show the *kaski* growing to have been important in the 1700's.

In the Hirvensalmi municipality, I saw wild turnips sporadically flowering in the Junes towards the end of the 1960's. Its association with the past turnip growing was understood, because the local people called it *naurisheinä*, 'turnip-grass' (pers. commun. Mr. Heikki Manninen, born in Hirvensalmi in 1912). In 1893, 20% of crops of Hirvensalmi was harvested in *kaski* lands (Grotenfelt 1899). The *kaski* burning ended in Hirvensalmi in 1939, the last peaceful season before the attack of the Soviet Red Army to Finland (pers. commun. Mr. Otto Hurri, born in Hirvensalmi in 1926). Fig. 12 illustrates a cut forest area in Hirvensalmi in 1918 to be burnt for *kaski* growing.



Fig. 12. About 20 years old birch (*Betula* ssp.) dominant stand cut after the leaf emergence to dry for *kaski* burning on a gentle slope. The stems are approximately directional for the rolling (*vierto*) burn-technique. The high tree was apparently saved with the hope of a nesting falcon, a predator of gnawers. The Hirvensalmi municipality Suosalmi village. In Hirvensalmi, *kaski* burning continued to the 1939 season. Photo from the 1918 year in the Mustiala Museum, Tammela.

The following reviewed two populations are based on the data in Flora of Satakunta (Suominen 2013), herbaria (H, OULU, TUR), Kasviatlas database (Lampinen and Lahti 2020), and MapSite (2025). Among the last traditional wild turnip populations in Finland, there was one in 1973 in the Kihniö municipality, Korhosjärvi, north of the Paloniemi forest, where the *palo* appellative is synonymous with *kaski*. Only in the governmental forests in Kihniö, *kaski* burning occurred altogether on 820 ha in the years 1847–1857 (Nikkilä 1934). Another wild turnip population was in 1976 in the Parkano municipality, Karttiperä, Huhdanpää, the last name having *huhta* appellative in the genitive case. The Kihniö and Parkano occurrences were still seed producing populations when Dr. Juha Suominen surveyed them in 1973 and 1976, respectively.

In the 1840's, Eljas Raussi in the Virolahti municipality wrote that growing of turnip has much declined in association with the increase in potato growing (Raussi 1840's). The same was observed about the turnip growing in the *kaski* lands (Grotenfelt 1899), so that in 1860–1880 turnip growing in *kaski* was common only in the northern part of East Finland.

Conspectus florae fennicae (Hjelt 1904–1906) shows both weedy or wild and cultivated turnip to have been common in Finland. Among the plant species in the tame-hayfields in Finland sown in the mid-20th century, Paatela (1953) found *B. campestris* and *B. rapa* at a very low abundance of less than 0.01%. They may have originated from local seeding plants or come along with the sown hay seed. Between the years 1911 and 1955 of his survey, Eklund (1958) concluded *B. campestris* to have varied in abundance but become rarer from year to year in the Southwestern Archipelago of Finland.

Pantio souerkrout was mostly made of turnip and rutabaga tops and cabbage

Pantio souerkrout was made from fresh tops of turnip and rutabaga, and leaves or heads of cabbage by heat-treatment and subsequently pressing the heat-treated leaf mass tightly in land pits or small wooden towers (Fig. 13, Ahokas 2002). The land surveyor Frisius' archival instrument of land division (1752) shows that two old *pantio* cairns ("*pandio stenar*") existed on a 'turnip land' (*Rofland*) in the separate part of the Rahikkala village (called Napa, later Nappa) in the NW Elimäki municipality bordering on the Keltti village of the Iitti municipality. The Keltti people claimed the Napa people's old *pantio* cairns to be boundary marks. One of these two *pantio* cairns was written to have a circle of six stones ("*13*"), the other ("*14*") being in a mapped position 75 *alns* west of the Niinioja brook (Frisius 1752). A single cobble of 23 × 25 cm dimensions was visible on the point of the latter in 2025 perhaps respected and saved as a putative boundary mark, the other stones perhaps being covered with soil dug from the adjacent ditch. The other *pandio stenar* cairn with six stones was not detected in the 2026 survey being probably removed from the later arable field with ~7 m wide strips made after 1752. Trees grew in the ditches of the strips in 1941 (Ilmakuva 1941), hence the field was abandoned years prior to 1941, currently being a spruce forest. At a distance of 1070 m SW of the Saarela Site in the Rahikkala village, there is a circle of stone blocks evidently remained of the basal support and top weights of a *pantio* tower (Fig. 14) at an old parcel suitable for *Brassica* growing, afforested in the 1970's.



Fig. 13. A *pantio* tower drawn by V. Tarkiainen (~1900) in the Juva municipality, Soiniemi village. This wooden tower was somewhat higher than a man (~2 m), and hence had a diameter of 0.65 á 0.75 m. Eisen (1772–1774) in Estonia knew the Finnish peasants' *pantio* towers to be three feet (~0.9 m) in diameter. Likewise, the diameter of a *pantia* was known to be less than 1 m in the Valkeala municipality (Mäkelä 1955). Tops of turnip and rutabaga, or leaves and heads of cabbage after heat-treatment were tightly packed in the tower additionally pressed with stones on the top. Stone blocks supported the tower base. Afterwards a *pantioraunio* cairn remained. – **Fig. 14.** An apparent *pantioraunio* cairn in a forest nearby a *kaski* or *kytö* parcel historically dated to the latter half of the 19th century. The scale shows 0.62 m, the diameter having been ~0.7 m in the apparent tower. Lack of charcoal and soot shows that stones had not been in contact with fire. The old parcel less than 1 ha in area, reforested in the 1970's was on a slope receiving capillary soil moisture, and was used to grow *Brassica* because it has on its northern side a moraine ridge with 20 depressions of past turnip pits. The cairn is 1.07 km SW of the Saarela Site on the NE slope of the Paavalinmäki ridge, Rahikkala, Elimäki, Kouvola. June 13, 2024. – **Fig. 15.** Flush with leaves, field grown heterotic F_1 hybrids of the turnips, Chinese cabbage (♀) × (♂) 'Enon kanta' *kaski* turnip. Such crosses might be used to breed new variants with only leaves to be harvested. The width of the photo area is 1.08 m. Jokioinen. Sept. 28, 2001.



Fig. 16. Part of a twice self-pollinated or S_2 progeny from the cross within the *kaski* turnip var. 'Liperi' segregating the varsinauris, 'stem-turnip' mutants (yellow frame). The appearance of the other types was in part environmentally controlled and their appearance and frequencies varied in the samples of the two different seasons. Jokioinen, Oct. 7, 2010. Scale 17 cm. – **Fig. 17.** Post-seasonal varsinauris turnips before flowering grown for crosses on a window board of a flat with supplemented light from a Na-vapour lamp. Helsinki, Nov. 2, 2013. – **Fig. 18.** Growing varsinauris plants in the Kirkkonummi municipality, South Finland. Scale 0.5 m. August 24, 2015. – **Fig. 19.** Autumn appearance. Scale 0.5 m. Kirkkonummi, Oct. 13, 2014.



Fig. 20. A new appeared hypocotyl-tuber in a varsinauris turnip. The width of the upright grey measure (to the left) is 15 mm. Kirkkonummi, Aug. 1, 2014. – **Fig. 21.** Top of a varsinauris at the termination of the season with very small flower primordia in the topmost leaf axils. Oct. 5, 2015. – **Fig. 22.** Two lodged varsinauris and two Liperi kaski turnips. The purple hypocotyl-tubers with the concave bottom were the idiotypes of var. Liperi according to the maintainer of the stock (pers. communication in 2002). Oct. 14, 2014. – **Fig. 23.** Post-seasonal varsinauris plants grown under Na-vapour illuminators in a summer-hut resulted in a good seed-set with cross-pollination. Dec. 21, 2014.

Table 1. From the cross within 'Liperi', a fraction of the F_3 generation after being self-pollinated once (S_1) and twice (S_2) producing the varsinauris types.		
Selfed; Season of growing	<i>Varsinauris</i>	Other types
S_1 ; 2009	24	34
S_2 ; 2010	42	96
S_2 ; 2011	28	35
S_2 , Total	70	131
$S_1 + S_2$, Total	94	165

Table 2. Segregation of varsinauris $\times$ riplikas (of 'Enon kanta' turnip, see below) backcrossed with the varsinauris mutant (BC_1-F_1) grown in the 2015 and 2017 seasons.		
Identification; cross formula ($\varnothing \times \sigma$) $\times \sigma$	<i>Varsinauris</i>	Typical turnips
764; (varsinauris $\times$ riplikas) $\times$ varsinauris	18	15
765; – $\times$ –	22	32
766; – $\times$ –	26	13
768; – $\times$ –	39	34
769; – $\times$ –	7	23
Total	112	117

Table 3. Breeding of a constant *varsinauris* stock in var. 'Liperi'. Controlled *varsinauris* × *varsinauris* crosses, and those followed by backcrosses with various *varsinauris* pollen parents. Plants with anew occurrence of hypocotyl-tuber counted.

Identification of the parents, ♀ × ♂	Number of plants in the F ₁ generation in 2014. (Those with hypocotyl-tuber in parenthesis)	Number of plants in the backcrossed generation (BC ₁ -F ₁) in 2015. (Number of those with hypocotyl-tuber in parenthesis)
687-3 × 694-1	1	
689-1 × numberless	2	8
689-1 × 687-1	3	
689-1 × 687-2	2	7 (2)
689-1 × 687-3	2	
689-1 × 689-3	8 (1)	19 (2)
689-1 × 694-1	10 (4)	
689-1 × 694-2	2	
689-2 × 687-1	3	
689-2 × 689-3	5	14
689-2 × 689-4	16 (1)	20
689-2 × 691-2	10	4 (1)
689-2 × 691	23	25 (3)
689-3 × 689-2	1	
689-3 × 694-1	1 (1)	
689-4 × 691-1	2	22
694-1 × 689-2	2	
694-2 × 689-1	3	29 (2)
With tuber	(6.8%)	(6.3%)

Table 4. Progenies of controlled crosses of self-pollinated *varsinauris* (S₁) × *varsinauris* in var. 'Liperi', and anew occurrence of plants having hypocotyl-tuber grown in 2015.

Identification of the S ₁ plant pollinated with <i>varsinauris</i> , ♀ × ♂	Number of the <i>varsinauris</i> plants in the F ₁ generation. (Number of those with hypocotyl-tuber in parenthesis)
689-1 S ₁ × numberless	4
689-1 S ₁ × numberless	6
689-1 S ₁ × numberless	(1)
689-3 S ₁ × numberless	2
689-4 S ₁ × numberless	1 (2)
689-4 S ₁ × numberless	4 (1)
694-1 S ₁ × numberless	2 (3)
694-1 S ₁ × numberless	3
With tuber	(24%)

A *pantio* (*pandio*, *pandia*, *pantia* or *panne*) cairn could be taken as a boundary mark. Nissilä (1972) found a boundary called Pandianaho Raja ('*pandia*-meadow boundary') in the Rural municipality of Viipuri/Vyborg in 1693. The age of this toponym also proves for the long tradition of the *pantio* making in the Finnish Karelia, as also presented by Lampinen (1953) in her traditional Karelian cook-book. Gadd (1751) described *pandio* from the Satakunta province. The German explorer A.F. Büsching (1770) in his report from the Kymenkartanon lääni province, SE Finland in 1764 also described the *pantio* tradition for conserving cabbage heads treated with hot water. Turnip tops were made *pantio* fodder after heat-treatment in Virolahti (Raussi in the 1840's, facsimile in Ahokas 2002). Making of *pantio* was contemporarily described by Grotenfelt (1899).

The Finnish *pantio* used in Ingria, appeared in local Ingrian folklore (Törneröos and Tallqvist 1859). In Ingria, the *pantio* as *panti* and *pandera* (пантi, пандера) was adopted to Russian (Теплов 1767). In 1793, monk Herman or

German Zyryanov (later called Herman Alaskalainen, St. Herman of Alaska) with seven brothers left the Valamo monastery on the Ladoga for Kodiak, Alaska, North-America. In Kodiak since 1795, he conserved turnips by sour-fermenting probably with the *pantio* method which he had learned from the Finns while staying on the Valamo island since 1782 (Ahokas 2026, manuscript to be published).

The description of *pantio* for food and feed was recorded in the Iitti and Jaala municipalities by Ms. Aino Oksanen, M.Sc. still in 1926–1930. Her records were posthumously edited and published under her marital name Valli (1989). The plant material for *pantio* comprised leaves of both cabbage, turnip and rutabaga, leaves (with stems?) of *Cirsium helenioides*, *C. arvense*, *Urtica dioeca*, and stems and tubers of potato (Oksanen 1926–1930).

During his school years, the future chemist and Nobel Prize Winner A. I. Virtanen must have seen *pantio* making around his home-town Viipuri/Vyborg. He in the 1920's elaborated the fodder conserving effect of the pH sinking by added acid solutions which worked well, and introduced acidic fodder conserving. The natural fermentation causing sink of pH in *pantio* plant mass was probably the standpoint of Virtanen's idea. Virtanen's AIV fodder was in the beginning, since the end of the 1920's, made either in land pits or towers which were also the traditional ways for *pantio* conservation (Ahokas 2002). Likewise, Heikonen in his study about Virtanen's life, concluded the AIV fodder conservation to continue the *pantio* tradition, the name of which little by little was forgotten after the AIV conserving was introduced (Heikonen 1994). Some laymen in the first half of the 20th century also recognised the AIV method to have modernized the *pantio* method (Ahokas 2002).

The historical *pantio* plant, turnip got a renaissance as an AIV fodder species since the 1940's in the field grown 'leafy turnip' or 'big-leaf turnip', in Finnish *naattinauris*; the name was coined by Ms. Liisa Mali, M. Sc. (Agr. For.) (Yllö 1956). The history of *naattinauris* began, when Finland was attacked by the Soviet Red Army in 1939, and in the second year of the war, in 1940, the Red Cross of the USA presented to the war-amputated Finland with large quantities of vegetable seeds. Among these was the turnip which was intended for growing of food. This first *naattinauris* variety proved to have a dense foliage and to be productive in the climate of Finland and suitable to AIV fodder (Valle 1950a, Valle 1951), but still making tubers to be harvested from soil. Adapted leafy turnip types lacking a root worth of harvesting, could be bred from hybrids between Chinese cabbage and *kaski* turnip as evidenced from my minor crossing experiments (Fig. 15).

Past trials with *rapsat* turnip in Finland

The Medieval term *rapsat* denoted turnip seeds for pressing oil which was also called with the archaic *naurisöljy* name in Finnish. The Dutch names *raepsaet*, *koolsaet* and *mostaert saet* from the 14th century meant, respectively, seeds of *Brassica rapa*, *B. oleracea* and *B. nigra* or *Sinapis alba* (Reiner et al. 1995). Prof. Pehr Adrian Gadd (1751) seems to have had an idea that turnips could be sown in the autumn after the cereal harvest in a *kaski* land for seed oil production in Finland; then deep-rooted type of turnip should be preferred because they better survive our winter. Since 1757 until 1945, the few trials done here with oil seed *Brassica* strains, probably all imported and not adapted to Finland, resulted in failure due to lack of wintering, lateness when sown in the spring, and damage by insects.

Prof. Pehr Kalm (1759) has tried to grow *rapsaet* in or nearby Åbo/Turku during three seasons. Because the common growing of turnip in Finland (=the East-Land of the Kingdom of Sweden), its grains were promising as source of turnip oil (*naurisöljy*) along with oil from flax and hemp grains. The trials of Gadd (1767) aimed to the production of oil seeds: the bourgeoisie in Åbo/Turku declared themselves willing to operate plantations for oil pressing, in exchange for support for the construction of an oil mill at the Halistenkoski rapids, as no such mill previously existed in Finland. This was approved at the 1762 Diet in Stockholm, but was subsequently never implemented (Hermelin 1774). Neither the written Halistenkoski history recognised an oil press (Toropainen 2015). Where available, the seed oil of turnip, hemp or flax could be burnt in lamps for lighting (Anon. 1853, Grotenfelt 1919). Hollowed tubers of turnip also served as oil-burning lamps probably since the Middle Ages (Soininen 2024).

In 1767, Gadd wrote that his experiments with *rapsat*, synonym *Brassica Napus* (= turnip) had occurred during "6 à 7" years, hence succeeding Kalm's trials. Both spring-sown and winter *rapsat* were tried, and Gadd (1767) also considered *B. rapa* var. *campestris* as an oil source. Much later also Grotenfelt (1919) recognised the high oil content of var. *campestris*. By 1778 the oil turnip trials had apparently ended, and Gadd and Florin listed *rapsat* (*B. napus* growing in Gotland) as a foreign seed oil crop. Weckström (1850) described *rapsat* or *Gottlands rofva* (a turnip with a wedgelike root; see Fig. 34) as a wintering oil crop, but it is unclear, if he had results from Finland. Mr. H. von Knorring (1862) had tried to grow *rapsat*, which did not winter in the 1850's. After the famine

years of the 1860's, *rapsatinauris* turnip was suggested to be grown for feeding as fresh or soured (Anon. 1871), the latter meaning *pantio* fodder. During that adverse climate period, irregular and cold summers were frequent (e.g. Uutela 1957).

Of the *Brassica* oil crops, only the *rapsi* turnip was introduced in small scale growing during the War II years in Finland (Anon. 1943). Prof. Otto Valle (1950b) organised trials of winter turnip rape on farms in Finland after the War II since 1947, whereupon the weedy turnips in the flora of Finland could represent escapes from the turnip rape growing and handling. In the governmental Plant Breeding Institute in the Jokioinen municipality, the first spring-sown *rypsi* (the former *rapsat*) and *rapsi* (oil rutabaga) plots for display were sown in 1949 with seeds obtained from Svalöf, Sweden and the Turku filial of the Hankkija Whole Sale Company (Anon. 1949). In Finland, the consumption of all *Brassica* species was primarily as food and feed, that of turnip, being prehistoric, instead the oil seed use is quite modern. This is against the wild guesses presented in several recent publications, where the oil production has been thought to be the earliest, millennia old exploitation worldwide.

Mutants in *kaski* turnips

Varsinauris, 'stem-turnip' from the 'Liperi' *kaski* turnip

I use 'stem-turnip', *varsinauris* in the sense of a kale-resembling turnip with a storage tissue derived from the epicotyl stem. Variants of the *varsinauris* having the hypocotyl-tuber also occur. Axelson (1907, 1908) had earlier used the Finnish term *varsinauris* meaning the precocious turnip with first-season bolting, which he counted in the long turnip strains Östersundom, Scotch B, Mammoth, Dales Hybrid, Yellow Tankard and Bortfelder in different field trials; their percentage was low, mostly zero, at the highest, 0.96%. Sauli (1930) used "*varsinauris*", in quotation marks, in Axelson's sense.

The *varsinauris* mutant segregated from controlled crosses within the *kaski* turnip landrace 'Liperi' (syn. 'Liperin sininen') following self-pollinations (Table 1, Fig. 16). There were no significant differences of the S_1 and S_2 segregations of *varsinauris* in the three years ($P = 0.105$; Table 1). Testcrosses of *varsinauris* with typical *kaski* turnip (var. Enon kanta) followed by a single backcross with *varsinauris* suggest that the *varsinauris* mutant is a single-gene recessive ($P = 0.741$; Table 2).

Crossing *varsinauris* plants of var. Liperi with each other establishes a true-breeding *varsinauris* stock with unexpectedly a minority, 6–24% of the plants having the hypocotyl-tuber (Fig. 20, Tables 3 & 4). Grown in the same conditions in 2015, the ratio of the tuber carriers in the BC_1-F_1 progeny (Table 3) 148 : 10, and the ratio in the $S_1 \times varsinauris$ progeny (Table 4) 22 : 7, differ significantly, $P = 0.007$. The *varsinauris* type is apt to lodge by bending when the stems are soft (Fig. 22). Especially before the lignification, the stems can be used as vegetable.

Mutations from winter to spring habit and vice versa

A cross progeny within the *kaski* turnip 'Liperi' resulted in a segregation of spring habit, both with swollen hypocotyl-tubers and slender bases (Fig. 24).



Figs. 24–27. Var. 'Liperi' *kaski* turnip spontaneously mutated to spring habit and back-mutated from spring to winter habit. – **Fig. 24.** The first self-pollinated (S_1) generation of the back-mutation segregates. The upper plants to the left, spring habit mutants with the hypocotyl-tuber, and, to the right, with slender bases. Sown on May 18 in the field, photo Aug. 22, 2007 in Jokioinen. – **Fig. 25.** The same S_1 stock sown on June 19 in the field, photo Aug. 29, 2008 in Jokioinen. – **Fig. 26.** A late flowering spring habit pedigree derived from var. Liperi turnip by crossing S_1 plants. Yellow measuring band 1 m. Sown on May 31 in the field in Kirkkonummi, photo Sept. 1, 2015. – **Fig. 27.** Stem bases of spring habit Liperi at the end of flowering. Grown in a green house without any chilling treatment. Three slender and one with a base tuber. Scale 1 × 5 cm. June 4, 2006.

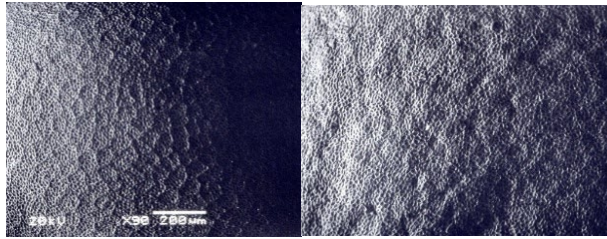


Fig. 28. SEM views of seed coat relief in var. 'Liperi'. The relief of a typical black seed (left), and the diffuse relief of a whitish seed (right). Scale 200 μ m for both.

The apparent dominance of the spring (O) and winter habit (O) may surprisingly vary in var. Liperi and its mutants. The hybrid of two spring habit plants, segregated a single winter habit plant (called mutant) plus 44 spring habit plants under field conditions sown on May 12. The S_1 generation of the only winter habit mutant segregated and the offspring numbers from two seasons in the field are given in Table 5. The ratio of 399 winter and 184 spring habit plants suggests that the winter habit may be dominant, if determined by a single gene.

Table 5. Number of segregants in the first self-pollinated (S ₁) generation of the single winter habit mutant among 44 spring habit plants. Original source was a sib-pollination in var. ‘Liperi’. Results of two seasons partly classified according to leaf form (lyrate or entire) and base type (slender or with tuber).					
Winter habit Ø		Spring habit Ø			
Lyrate	Entire	Lyrate		Entire	
Type of base unclassified		Slender	With tuber	Slender	With tuber
146	70	62	17	2	2
		Leaves fallen (see Fig. 24), unclassified			
Type of base unclassified		Slender		With tuber	
112	71	50		51	
Total, winter habit: 399 (= Lyrate 258 + Entire leafed 141)		Total, spring habit: 184 (= Slender base 114 + With tuber 70)			

In conflict with the previous conclusion, the following example suggests rather spring habit to be dominant. The F_1 generation of the cross between sibs of winter (♀) $\times$ (♂) spring habit in Liperi produced 39 spring and no winter habit plants. Sown on May 24, the field grown F_2 resulted in 2 winter, and 19 spring habit plants. The latter started to flower in the end of June. After I removed the protective Nylon weave on July 5 for weeding, the beetles destroyed the winter types, and they could not be studied further.

The same pedigree of var. Liperi segregating the spring habit, also segregated whitish and black seed coat colour. A further segregation of seed colour with whitish and light brown seed coat colours were also observed from the cross. Under SEM examination, the relief of the reticulum of the seed coat is diffuse on the whitish seeds (Fig. 28). Variation of the relief patterns of seed coats within *Brassica* species has been described (Berggren 1962). The maintainer of the Liperi variety (pers. commun. T. H., Kouvola) had also noticed paler seed coat variants. The "white" seed colour was also recorded as a variant in another Finnish landraces of a *kaski* turnip (Saarinen 1933). The seed coat colour determination in turnip is dependent on many genes and is complex (Zhao et al. 2022). In Rahman's (2001) material, seed colour was under digenic control and yellow seeds were found to have a transparent coat.

Evolution of hypocotyl-tuber from the slender-base turnip witnessed

Lines with slender base in var. Liperi frequently generates mutants or recombinants with the hypocotyl-tuber (Figs. 20 & 27, Tables 3 & 4). This landrace may represent a population between the ancient wild turnip and the early domesticated *kaski* turnip which formed useful hypocotyl-tubers. The spontaneous segregation of slender base types from the *kaski* turnips with the hypocotyl-tubers, and vice versa, tuber types from slender base types, were observed in the landraces studied. The anew appearance of the hypocotyl-tuber types may resemble the simple evolution step of the *kaski* turnip from the original wild *B. campestris* presumably having a slender base. Selection in the wild *B. campestris* towards thick root since 1874 for 14 years resulted in a 2-cm root width, whereafter the experimental botanist (the first name not stated, probably Prof. Raphaël) Blanchard concluded that "there must at some time have been a fleshy-rooted mutant from which the cultivated turnips derive" (Hyams 1971).

The unstable *riplikas* gene of variegation

The 'Enon kanta' *kaski* turnip strain is highly variable from plant to plant, but also within the individuals shows variegation visible in the colour patterns of the cortex of the hypocotyl-tuber (Figs. 29 & 30). Some other strains of Finnish *kaski* turnips, which I grew, also showed *riplikas* segregants. The *riplikas* term was recorded in the Sulkava municipality (Hämäläinen 1933). Gene of white turnip colour is in principal recessive in the crosses (Table 6). The breeding of a stably *riplikas* stock failed. Some of the aberrant segregations might be due to distorting gametophytic factors. Crossed, once or twice self-pollinated progenies of evidently homozygous *riplikas* plants unexpectedly contained white turnips in low proportions, 9.3 and 2.6%, respectively (Table 8). The gene determining the purple-and-white *riplikas* is unstable leading to heterozygosity within an individual level. Forced self-pollination of a white turnip (402A; white 1) unexpectedly led to *riplikas* and white in the proportion 34 : 53 (Table 8). This was probably possible through a transposition in the vegetative tissue of the seed forming plant leading to a mutated chimeric distribution of the *riplikas* gene. In the interspecific F_1 hybrid of *riplikas* Enon kanta turnip $\times$ 'Pentland Brig Kale' showed an apparent instability of the purple *riplikas* gene in the leaf tissue (Fig. 30C). Pentland Brig Kale is a tetraploid ($2n = 4x = 36$) borecole derived from the cross of thousand-headed kale and curly kale (McNaughton 2005). Its seeds were obtained from the breeder, Dr. Ian H. McNaughton, Pencaitland, UK. Several genes were deduced to participate in the anthocyanin pigment formation (Shui et al. 2026) in the tuber cortex of turnip.



Fig. 29 A – C. Var. 'Enon kanta' *kaski* turnips. – **A.** The typically concave bottom of the hypocotyl-tuber of the *kaski* turnip is often without secondary roots. If tight, the hypocotyl-tubers turn on edge described with the Finnish verb *longistaa* (Rönkkö 1934), and are fairly clean. Oct. 2, 2009. – **B.** The tuber to the left shows a variegation of the chlorenchyma. Its pattern is alike that of the purple tissue in the lowest tuber in Fig. A. The mode of inheritance of, or the external influencers on the green variegation are unknown. F_1 segregants from a cross of the tuber colours white $\times$ purple of Enon kanta. Oct. 2, 2001. – **C.** Trying to produce a true-breeding *riplikas* stock. A *muttinen* turnip ('*rapa non adulta*'; arrow) bent on lying before photography. Sept. 15, 2009.

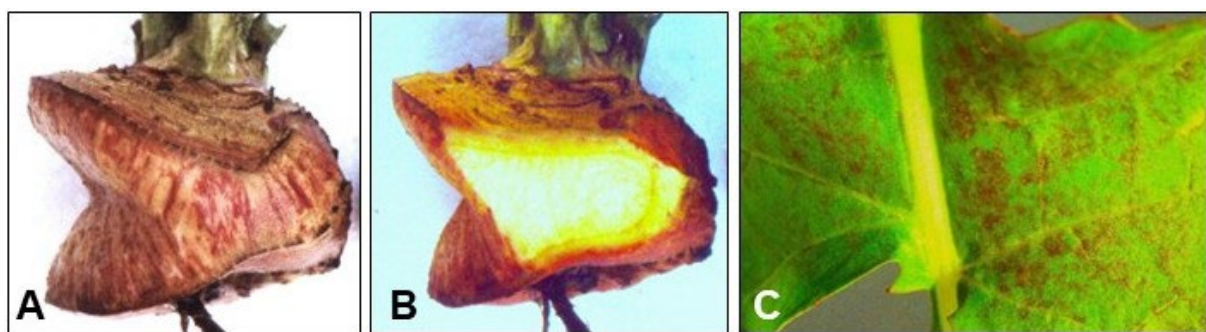


Fig. 30. A – C. Expression of the *riplikas* gene. – **A.** A spontaneously split *riplikas* tuber in var. 'Enon kanta' with vertically striped variegation on the cured epidermal tissue. The split, "laughing" turnips are sweeter than the intact ones and have more starch in the subcortical tissue (Ahokas 2011). Oct. 1, 2002. – **B.** A piece cut away from the turnips of Fig. A shows the variegating cell to be expressed in the superficial cells only. – **C.** Tissue of upper leaf lamina expressing the *riplikas* gene in the F_1 plant of *riplikas* Enon kanta (♀) $\times$ 'Pentland Brig Kale' (♂). Pentland Brig Kale lacks any red colour. The purple cells are above the secondary veins and therefore can appear in the epidermis. Enlarged, $\sim 1.5\times$. Aug. 22, 2007.

Table 6. F_1 progenies of crosses of *riplikas* and white segregants and two F_2 progenies within 'Enon kanta' *kaski* turnip landrace.

Generation, identification; phenotypes ($\varnothing \times \sigma$)	Tuber colour of F_1 plants	
	<i>riplikas</i>	white
F_1 402A; white 1 $\times$ <i>riplikas</i> 1	33	0
F_1 402A; <i>riplikas</i> 1 $\times$ white 1	30	0
F_1 402B; white 1 $\times$ <i>riplikas</i> 1	40	0
F_2 402B; – » –	76	30
F_1 402B; <i>riplikas</i> 1 $\times$ white 1	109	0
F_1 402C $\times$ 402A; white 2 $\times$ <i>riplikas</i> 1	3	0
F_1 537; white 1 $\times$ <i>riplikas</i> 1	5	0
F_2 537; – » –	138	3
F_1 Total	220	0
F_2 Total	214	33 (13.4%)

Table 7. Segregation of *riplikas* and white tuber colour in crosses of *riplikas* $\times$ *riplikas* within 'Enon kanta'.

Identification (pooled seeds)	Tuber colour of F_1 plants	
	<i>riplikas</i>	white
258 (pooled 10 pairs)	122	1
398	55	4
402	62	0
402A	78	9
402B (pooled 4 pairs)	67	1
402C	133	2
403 (pooled 3 pairs)	19	0
404	106	9
538	74	4
Total	716	30

Table 8. Progenies of once (S_1) or twice (S_2) self-pollinated plants of the assigned lines (see Table 7) within 'Enon kanta'.

Selfed generation, identification; tuber colour	Tuber colour	
	<i>riplikas</i>	white
S_1 402A; white 1	34	53
S_1 402A; white 2	0	22
Subtotal	34	75
S_1 402A; <i>riplikas</i> 1	60	0
S_1 402A; <i>riplikas</i> 2	14	0
S_1 402A; <i>riplikas</i> A	43	0
Subtotal	117	0
S_1 402B; white 1	0	21
S_1 402B; white 2	0	2
Subtotal	0	23
S_1 402B; <i>riplikas</i> 1	211	10
S_1 402B; <i>riplikas</i> A	85	0
S_1 402B; <i>riplikas</i> B	82	33
S_1 402B; <i>riplikas</i> C	96	21
S_1 402B; <i>riplikas</i> D	118	22
Subtotal	592	86

S_1 538; <i>riplikas</i> A	121	1
S_1 538; <i>riplikas</i> D	15	3
S_1 538; <i>riplikas</i> F	34	0
Subtotal	170	4
S_1 of white parents, total	34	98
S_1 of <i>riplikas</i> parents, total	879	90 (9.3%)
S_2 402A; <i>riplikas</i> ämp 1	162	4
S_2 402A; <i>riplikas</i> ämp 2	162	6
S_2 537; <i>riplikas</i> 1 ämp	46	0
S_2 537; <i>riplikas</i> 2	2	0
S_2 537; <i>riplikas</i> A	10	0
S_2 Total	382	10 (2.6%)

Table 9. Aberrant F_2 segregations from crosses of <i>riplikas</i> and white turnips within 'Enon kanta'.		
Identification; ♀ × ♂	Tuber colour	
	<i>riplikas</i>	white
640; 536 white 2 × 536 <i>riplikas</i> 1	10	1
641; – » –	46	4
Subtotal	56	5
624; 537 white 1 × 537 <i>riplikas</i> 1	32	3
625; – » –	253	20
626; – » –	97	3
627; – » –	81	2
628; – » –	47	9
Subtotal	510	37
629-01; 537 <i>riplikas</i> 1 × 537 white 1	68	5
629-02; – » –	80	6
629-03; – » –	15	0
630; – » –	46	3
Subtotal	209	14
Total	775	56

A slender stem base variant from the *kaski* turnip 'Enon kanta'

The slender base mutant of var. Enon kanta (Fig. 31) as the pollen parent was crossed with the spring habit mutant of Liperi. The F_1 generations of two separate crosses were sown in the field on May 24, 2011 and ranked on Sept. 9, 2011. The roots were either slender (75) or wedgelike (13) in the pooled numbers (Table 10). The cross no. 1 segregates spring and winter habit plants in the ratio of 24 : 8. The corresponding ratio of the cross no. 2 is 24 : 32. The pooled numbers of spring : winter habit plants were 48 : 40. This fits a 1 : 1 ratio ($P=0.602$), the meaning of which is doubtful, because the ratio of the two crosses deviates significant from each other ($P=0.007$). The cross no. 2 has a different genetic constitution for the winter habit from that in the cross no. 1. The seed parent in the cross no. 2 perhaps resembles that in Table 5.

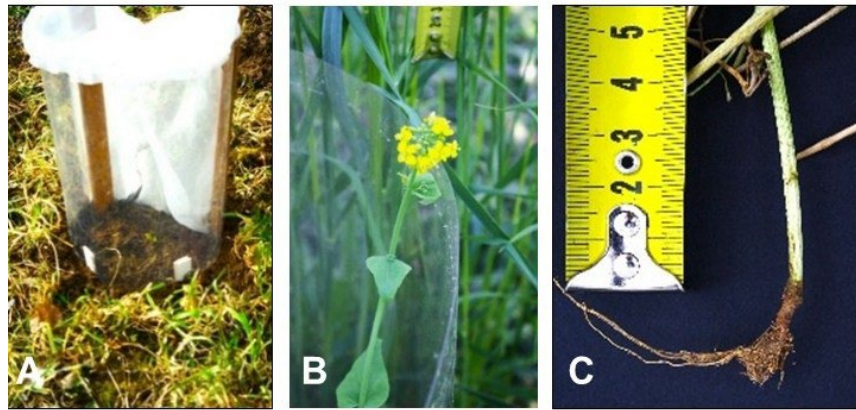


Fig. 31A – C. A slender stem base variant from the *kaski* turnip ‘Enon kanta’. – **A.** A single wintered turnip protected with a PVC funnel and Nylon weave before the emergence of insects in the spring. Jokioinen, April 23, 2010. The ‘Enon kanta’ turnip as the first season crop was co-cultivated with rye sown together on July 1, 2009. The rye occurs as the wintered seedlings around the funnel. – **B.** The same wintered turnip at anthesis shortly opened from the protecting construction for photography and getting its pollen. June 2, 2010. – **C.** After the senescence, pressed specimen of the slender stem base and roots of the wintered mutant turnip, resembling those of an oil turnip rape.

Var. *Enon kanta* segregated from its sib-crossed hybrid a spring habit starting flowering about 35 days after sowing in the field (Fig. 32). With human eye under sun light, *Enon kanta* has at least two types of petal colours, bright yellow and brownish yellow. The petal colours were not studied further. The archaic Finnish term *muttinen* referred to an incompletely grown turnip (*‘rapa non adulta’*; J. Canstren in Koskimies 1917). They might have occurred as modifications or mutants. An example of the *muttinen* without a hypocotyl-tuber is in Fig. 29C.

The old Finnish *kaski* turnip ‘Navet jaune de Finlande’, syn. ‘Petrovski’ mutated

The seed catalogue of Vilmorin and Andrieux (1891) described the Finnish yellow, flat turnip variety, morphologically a typical *kaski* turnip, under the names ‘Navet jaune de Finlande’, ‘Petrovski’, ‘Yellow Finland turnip’, ‘Finländische gelbe Rübe’. They also wrote about variation in the variety (translated from French): ‘Foliage is very short, compact, little divided, sometimes completely entire in seed stocks imported directly from Finland’. The modern commercial Petrovski stocks have less concave bottoms than those over a century ago. A red mutant in this variety was found in the Westermarck Plant Breeding Institute in South Finland in the early 1900’s (Fig. 33). In their breeding pedigrees of Petrovski, there also appeared light-red turnips (Anon. 1920). These observations on variation in the Finnish *kaski* turnip are consistent with the novel observations of genetic variation which I have present above.

Table 10. The F_1 phenotypes of two crosses “Spring habit Liperi” ♂ (Fig. 26) (♀) × (♂) “wintered, slender-base Enon kanta” ♂ (Fig. 31).

Cross no.	Spring habit with flowers ♂		Winter habit ♂		
	Slender	Wedgelike tuber	Slender	Slender, cauline	Wedgelike tuber
1.	20	4	3	3	2
2.	22	2	16	11	5
Total	42	6	19	14	7
Habit	Total spring 48		Total winter 40		

Conclusions

Turnip is a prehistoric crop in Finland. Its advantageous sowing time needed a way to determine the summer solstice (Fig. 5). Turnip pits (in Finnish singular, *nauriskuoppa*) were frequent in the turnip growing areas in places avoiding water accumulation (Figs. 1, 10A & 11). Turnips were stored either fresh or baked in the land pits. Turnip tops could be made to *pantio* souerkrout (Figs. 13 & 14). Turnip is a highly variable species; as a root crop two extremely different types are those with the hypocotyl-tuber or *kaski* (‘slash-and-burn’) turnip type (Figs. 29 & 33),

and those in which the tap-root makes the storage organ (Fig. 34) without the meaningful involvement of hypocotyl or epicotyl. *Varsinauris* ('stem-turnip') is a novel, spontaneous variant of the *kaski* turnip with the epicotyl forming the storage organ (Figs. 16–23). Special arrangements were needed after the season to get the *varsinauris* plants to make seeds: *varsinauris* would not have successfully survived if stored in a traditional turnip pit (Fig. 1). Therefore, *varsinauris* would have been lost in the past local culture. If they occurred, *varsinauris* plants were harvested for feeding or making *pantio* souerkraut (Fig. 13). No previous crossing with the *riplikas* ('variegating tuber') mutant (Figs. 29 & 30) is known. The *riplikas* gene appeared to be unstable. The *kaski* turnip var. Liperi segregates atavistic types of the turnip which apparently occurred wild in region of the current Finland in the pre-history. Mutations from hypocotyl-tuber to slender base, and vice versa, and from winter habit (Θ) to spring habit (O), and vice versa, were observed. The growing for food is ancient, 1910±40 radiocarbon years old in the Saarela Site (Figs. 3 & 4). The people living 2127 km north of the Dnieper mouth, or in 65 – 66 °N, in the middle of Finland (Stichtenoth 1959) might have had turnips reported as "roots" by Pytheas ~322 BC (Strabo). Other peculiarities to Pytheas in the north were the continuous daylight in the summer, and that the people could not thresh grain crops under open sky, but had to thresh in houses (Strabo), possibly meaning the heated *riihi* log houses of the Finns used still in the 20th century. The growing of turnip for seed oil is a modern practice starting in the 1940's in Finland prompted by the wartime economy. Though Prof. P. A. Gadd (1767) considered *B. campestris* as a possible source of turnip seed oil, and Prof. G. Grotenfelt (1919) recognised the high oil content of *campestris* seeds, the wild turnip was not developed to a cultured, adapted oil crop perhaps because of its repute of a bad weed.

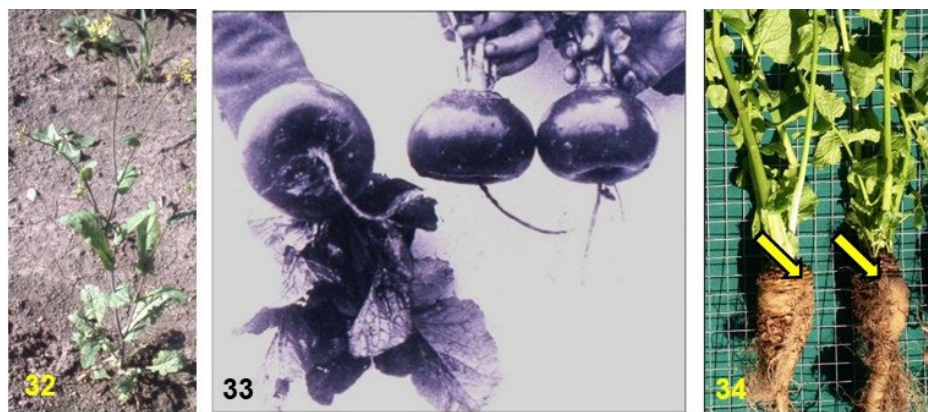


Fig. 32. A spontaneous spring habit mutant or segregant from Enon kanta turnip sown on June 28, photography on Aug. 5, 2004, at the beginning of anthesis. – **Fig. 33.** Dark-purple tuber mutant found among the Finnish yellow *kaski* turnip var. Petrovski in the Westermarck Plant Breeding Institute, Tuusula, Finland in 1919. The bottom of the hypocotyl-tuber of a *kaski* turnip has a single slender main root with some secondary branches. The B&W photography probably by Mr. V. A. Pesola, M.Sc. – **Fig. 34.** In contrast to the hypocotyl-tuber of the *kaski* turnips, the old landrace 'Bayerische Rübe' ('Bavarian turnip') lacks the hypocotyl part in its wedgelike tap-root tuber. Secondary roots emerge in two longitudinal lines on the length of the tap root. The arrows point to the topmost of the secondary roots. Grown in Kirkkonummi, South Finland from authentic seeds of Bayerische Rübe obtained from Prof. L. Reiner, Germany. Net mesh 12 mm in the background. Oct. 18, 2025.

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