Fossil Pinus-cone in Late-Tertiary Erratic from Western Jutland (Denmark)

Fossil Fyrrekogle i Sen-Tertiær Erratisk Blok fra Vestjylland

by

Eske Koch

Abstract

On basis of a cast is described a detailed impression of a Pine cone: PINUS HERNINGENSIS N. SP. Lengh: 19 cm., max. diametre: 6-7 cm. It belongs to the "Soft Pines" with affinity to the group *Flexiles* (Subsection *Cembra*). Age is assumed to Late-Tertiary (*Miocene* or *Lower Pliocene*).

Introduction

The object of this description is an almost complete mould of a cone in an Erratic of strongly consolidated quartz sandstone. The boulder is borrowed from Herning Museum (Herning, Jutland), where Professor A. Rosenkrantz found it in a stone fence by the roadside some years ago. A similar boulder belongs to the Mineralogical Museum of the University of Copenhagen. It was found at Rødding in Salling (Jutland) by the physician Dr. V. Wilkens (ref. P. Harder 1913 pag. 348). The boulder from Herning contains pebbles of quartz and flint, so it must belong to the association of boulders designated as "flint conglomerates", which are said to be common in an area south of the western part of the Limfjorden, an area of which also Herning forms a part (ref. Harder 1913). From where this rock originates is not known, apart from the fact that it was found in the neighbourhood of Herning, and in spite of persistant searching during the summer of 1955 in the peninsula of Salling and particularly on the coast of this peninsula, the author did not succeed in finding any more fossiliferous boulders of the type. A considerable collection of fossils will be necessary to make a more exact age-determination than the one presented in this paper.

The cone from Herning is interesting on account of its affinity with the group "Soft Pines", but it cannot yield a final age-determination of the "flint conglomerates".

The making of the cast

The mould of the cone is so complicated that it was impossible to make a complete cast of it before plastics (the polyvinyle chloride method) became known here. Together with Dr. Eigil Nielsen and Mr. Kr. Skou the author has made experiments in applying this method and is now able to make usable casts of the cone. The casting technique will be mentioned briefly.

The raw materials are polyvinyle chloride (a white powder) and dibutylftalate (an oily fluid). These ingredients are stirred to a dough and then gradually to a fluid. The oil is added in small portions, all the time carefully kneaded and stirred in the powder to avoid that the polyvinyle chloride gets lumpy. The process is entirely the same as when wheat flour and water is stirred to a thickening. The proportion of the mixture of these two ingredients is decisive of the solidity, the cohesive force, and the elasticity of the finished product. For most purposes the ratio P:D = 2:1 is good.

When casting minor objects, the mixture of P/D is poured directly into the mould and then baked in the oven. The rate of polymerization, the external expression of which being the rate with which the paste stiffens and reaches its properties of elasticity, increases with the temperature. We ordinarily applied an oven temperature of 130–150° C, and the cast was baked till it assumed the colour of amber which indicates the maximum suitable baking time.

The cast should be evenly baked all over, and therefore the method must be modified when large and more complicated casts have to be made. If the rock is porous or destilling residuum is emitted, it may be necessary to heat the rock so that disturbing gas is driven off. The hot stone is then afterwards given a coating of P/D. A pre-heating is also necessary in cases as the present one where the mould is deep-seated as the rock must have acquired oven temperature in order that an even baking may be obtained all over the mould. However, it was not possible to fill up the interior scale moulds in a satisfactory way after the heating of the stone as the mould goes very deep in the large boulder, the size of which is abt. $^1/_4$ m^3. It was therefore necessary before the heating to fill up the individual scale moulds. The filling of the deep-seated and narrow scale moulds is made by means of a long plastic pipette, and great care should be taken that no bubbles are left after the filling. Attempts of filling the scale moulds after the heating of the stone miscarried as P/D hardened during the introduction both in the pipette and in the mould where it was impossible to avoid bubbles and also to have P/D spread out on the interior parts of the mould before the hardening began.

When the interior parts of the scale moulds were thus filled up with the casting agent, the boulder was heated in the course of a day to abt. 150° C; only several hours after the boulder had reached this temperature the scale moulds were filled entirely up with P/D, and the first layer was applied as a coating by means of a brush to the periphery of the hollow space so that the scales were connected. Each time the latest coating was baked until translucent, a fresh coating was applied, and gradually the cast was extended through the entrance at the basis of the cone mould, the mixture being spread on the sides of the opening and round it on the surface of the stone in a broad zone. As the hot air involved rapid baking on the surface of the boulder, it did not take us long by repeated coatings to get a solid "collar" as basis. This was necessary in order to get a handle in which to pull when the casting was to be removed through the narrow opening after finished baking. The process lasted for the first fine casts several days and nights as the temperature during the night time in our absence was regulated down below 100° C. This part of the process proved especially useful to get the deep-seated parts baked thoroughly in order to acquire the necessary viscosity.

It must however be emphasized that the baking time, i.e. the reaction time of P/D, has proved to vary for the various kinds of manufacture, and even manufactures of the same quality may vary from shipment to shipment.

It should therefore be recommended that attempts are made in advance when more complicated casts are to be carried out.

In order to have the cast detached the texture must be viscous and durable as it should be pulled out through the narrow opening alone by pull at the outer cast that had been made round the mould entrance. When the cast had acquired the colour of amber, the stone was cooled slowly. After about 12 hours' cooling the boulder would be removed from the oven. Not until it has reached room temperature, will the texture have obtained its necessary viscosity. At this point it was possible to loosen the outer "collar" and the other accessible parts of the cast (the basal parts of the cone). To let water ooze in between the stone and the cast permitted an easier removal from the mould.

By this long process we succeeded in making a cast which in its entirety could be pulled out of the cavity. The result was surprising in detail, and with regard to some of the specimens we got a complete cast of a Pinus cone of considerable size as discribed in the following.

With the more quickly reacting P/D and the better knowledge of the process, it is now possible to make a big and complicated cast as the one just described in one day (abt. 14 hours).

Description

PINUS HERNINGENSIS *n. sp.*

The mould, 19 cm in length, is almost complete and forms an oblong cavity in the stone with entrance on the lateral side close to basis so that the very basis of the cone itself is preserved. The mould is exceedingly detailed, and the long scales, which have often an important free apical part, make the mould complicated. The cone is oblong, symmetrical, with evenly pointed apex and obtuse basis. The terminal part may also be described as conical. The diametre at the broadest part (abt. the middle) is 6–7 cm, while at basis it is 4.5 cm. It is thus of comparatively slender and fully symmetrical build. No peduncle is left on the cone, the articulation scar lies in a groove surrounded by the bases of the basal scales. Phyllotaxis is almost definite: spiral is uniform over the basal two thirds of the cone, but becomes a little steeper terminally.

The scales: The scales of the cone are large and relatively few compared to the size of the cone. No scales are free in their full length on the cast, but one is exposed 4 cm, and has hardly exceeded 5 cm in length. Apophysis increases only slightly in breadth towards umbo, the transverse diagonal being the broadest part of the scale (2 cm: scales in the centre of the cone). The scale is convex. The apophysis is sculptured with discrete parallel ribs and furrows and on the dorsal side with more developed ridges where the side margins of the lower seated scales have fitted. The apophysis has been 3–4 mm thick on large scales on the central part of the cone. Umbo is terminal (subterminal?) and forms on the dorsal side a quadrangular area the two sides of which form the front margin of the scale. The front margin of umbo is wedge-shaped (may be somewhat rounded) the margins making a large angle (normally abt. 90°, in the terminal part of the cone 45–90°). The point consists of a terminal thickening with a tubercle. Umbo is divided by a longitudinal ridge on the dorsal side. On the ventral one umbo consists of a crescent-shaped-saggittate area separated from the thicker apophysis by a bead which takes the course of a convex curve or obtuse angle (according to the shape of the front margin of the scale) and is the very end of the apophysis. The basal scales are provided with a very short apophysis which is shorter than umbo.

The basal part of the cone is closed while the scales have parted somewhat in the terminal half. Thus it appears that the umbos are free (the crescent-shaped ventral part of umbo is free).

On a scale which is exposed for a distance of abt. 33 mm two flat impressions are seen side by side 27 mm from the point and ventrally on the apophysis, and a corresponding impression is seen on the dorsal side of the scale in front. Whether it is an impression of the wing of the seeds or the seeds themselves is not possible to determine finally. There is hardly room enough for a wing of normal size as is known from winged recent Pinus seeds. There is a probability that it is a flat wingless seed. To this can further be added that in all placed where it has been possible to see large parts of the apophysis only the unbroken ornamentation of the parallel grooves and ribs are visible. This pattern would have been disturbed by the impression of the wing and therefore easy to distinguish if winged seeds had been present.

Leaves: At some places on the cast there are remnants of needles with triangular cross section which must be Pinus leaves and belong to a species with more than two leaves in each fascicle. This appears from the triangular cross section which consequently forms the sector of a circle considerably less than 180°. Pines with only two leaves in the fascicle have a cross section which is rather semicircular, i.e. a sector of abt. 180°. This is supported by a bundle of 5 leaves found on one of the last casts including extended parts of the surface of the boulder around the cone entrance. Whether these needles belong to the large cone cannot be ascertained as moulds are known from the same kind of boulder of a small Pinus cone which definitely belongs to another genus with for example a dorsal umbo. But if the determination of P. herningensis as belonging to Cembra is correct, it must be expected with 5 leaves in each fascicle. So this observation has a value as the small cones mentioned above rather belong to Pineae all of which have binate leaves.

Affinity

The cone described in this paper is in all structural features closely related to the group of the species *Pinus* which SHAW (1914) designated *Haploxylon* which is covered by the term "Soft Pines". In favour of this can be mentioned the primitive shape of the cone (subcylindrical construction, uncomplicated spiral, only a few large scales, terminal umbo (possibly subterminal) etc.). As primitive characteristics SHAW (1914) considers the definite phyllotaxis which is not quite pronounced in the fossil. This seems to stand intermediary between the definite and the indefinite phyllotaxis though nearest to the definite. The cone is symmetrical and the scales are thin even if they seem a little thicker than in the recent species of "Soft Pines" in general. The terminal umbo will refer *Pinus herningensis n. sp.* to SHAW's subsection *Cembra.* In this connection it may be remarked that the dorsal part of the umbo being larger than the ventral one and the umbo being free may indicate a tendency towards the dorsal umbo. But to judge from the specimen in question it may be justifiable to determine umbo as terminal. Even if the cone shows several primitive features there are nevertheless signs of a position in a succession which means it cannot be said to be pronouncedly primitive.

If the seed is wingless, and if it further appears that the cone has been dehiscent, we shall refer it to the group of *Flexiles.* If the seed has had a wing which is doubted on account of observations, it may be referred to the group *Strobi.* On looking through the collections of cones in Kew Gardens' Herbarium and the Botanical Museum of the University of Copenhagen I did not find any recent species the cones of which are fully identical with the fossil described. Very near are the cones of *Pinus Armandi* the scales of which are of the same shape, perhaps somewhat thinner and without distinct area with tuberculum. But a rudimentary area is present. SHAW shows (1914 pl. IX fig. 96) a specimen where the point of umbo is more thickened and in this way nearer to the cone from Herning than the dried specimens in the herbarium I have seen. The basal, reflected scales of *Pinus Armandi* remains on the peduncle at the dehiscence, *but* the peduncle is left on the tree. The basis of the cone will then assume the appearance which is demonstrated in pl. 5 showing a somewhat weathered specimen found on the ground, consequently in a condition which must be assumed to be near to the one which the fossil has passed before the covering (concerning loc.: ref. Kew Garden'sHerbarium label No. 2300 (pl. 5). The same basis is seen on the fossil specimen which is no doubt shed without peduncle in a similar way. The scales of *Pinus herningensis* show a slight tendency to reflection, a characteristic which Shaw mentions in his description of *Pinus Armandi,* in which I did not find it very pronounced. In the other species of the group *Flexiles*, *Pinus flexilis*, this characteristic is, however, very pronounced.

The group *Strobi* comprises the species *Pinus Lambertiana*, *P. ayacahuite*, and *P. parviflora*, which on a superficial view may resemble *P. herningensis* in the exterior. But the scales of the cone of Strobi are thin and without a distinct area (indication in *P. Lambertiana* and *P. parviflora*). The umbo of *P. ayacahuite* is strongly reflected and drawn out into a thin apex. In this group the seeds are provided with a wing which in *P. ayacahuite* and *P. parviflora* is long. The presence of similar seeds are excluded in *P. herningensis*.

The investigation shows that the fossil is nearer to the group *Flexiles* than to any other recent group of *Pinus* as the recent species *Pinus Armandi* and *Pinus flexilis* are the ones the cones of which are nearest to *Pinus herningensis* each of them containing several of its characteristics besides being similar in all general features.

I have not been able to trace any fossil finding which can be identified with the cone described here. Nearest is *Pinus Grossana* described by LUDWIG (1859) from the oldest Tertiary strata in Wetterthal to the north of Frankfurt a. M. It is near to *Pinus Lambertiana*.

Stratigraphy

The species belonging to the group *Flexiles* prefer mild temperate climate and do not stand hard frost. If one may draw conclusions from this, *Pinus herningensis* must belong to Later Tertiary which offers these climatic conditions in northwestern Europe. The Lower Tertiary in which the London Clay flora shows a great content of tropical genera (REID & CHANDLER 1933) offers an unsuitable climate. The coarse clastic rock in which the cone mould was found is also in agreement with this assumption, as in the Cenozoic the coarse clastic content does not become dominating within Danish territory before Later Tertiary. On the other hand, the climatic changes towards the Quaternary glaciation had the effect that the Tertiary flora rich in species which requires a milder temperate climate, could not linger in our latitudes through the Pliocene, and thus an upper limit was constituted. In forming a substantial barrier across the migration direction, the Alpine mountain ridge together with the Mediteranean caused the complete extermination of the Tertiary flora before the maximum glaciation set in. The same barrier has since in a similar way prevented the return of what might have avoided extermination.

This opinion, however, remains a theory as long as it is not known from where the Erratic containing *Pinus herningensis* originates, even if it is probable that the glacier has pitched it up from stationary deposits in western Jutland. If that is the case it must be *Miocene* or *Lower Pliocene*.

As there may be more fossils in the boulders from Herning and Rødding, further indications may appear later, but there is a long way to the fossil flora that will procure sufficient information of the origin and age of these boulders.

Acknowledgements

I wish to offer my best thanks to the Keeper of the Kew Gardens' Herbarium, Dr. W. B. Turrill, and to Dr. R. Melville for kind assistance during my visit to London in 1954 and for specimens of Pinus Armandi which I received later. I also wish to thank everybody in the Botanical Museum, Copenhagen, who have kindly assisted me during this work.

Photo: The Studio, Royal Gardens, Kew (England),
Chr. Halkier, The Mineralogical Museum, Copenhagen.
Drawings: Gunni Jørgensen.
Translation: Esther Jacobsen.

DANSK RESUMÉ

Afhandlingen beskriver et aftryk af en fyrrekogle i en løs, istransporteret blok af kvartsrig, stærkt konsolideret sandsten med konglomeratiske partier mindende om flintkonglomeraterne. Blokken er lånt af Herning Museum og fundet på Herningegnen. En lignende blok fra Salling findes på Universitetets Mineralogiske Museum, København.

Koglens aftryk danner en oval hule i stenen med en lille åbning på siden, således at koglens aftryk for størstedelen er bevaret og gengiver koglens oprindelige form og bygning i de mindste detaljer.

Først efter at det er blevet muligt at udføre afstøbninger i plastic (Polyvinylklorid-Dibutylftalat metoden) ved Mineralogisk Museum, er det lykkedes at fremstille tilfredsstillende afstøbninger af aftrykket.

En sådan afstøbning danner grundlaget for beskrivelsen af koglen: PINUS HERNINGENSIS n. sp.

Koglen er 19 cm lang, symmetrisk og subcylindrisk. Største diameter 6—7 cm. Koglen er afkastet uden stilk, stilkfæstet ligger dybt mellem de nederst bevarede skæl. Skællene er store og relativt fåtallige med stort terminalt-subterminalt umbo med fortykket spids, der yderligere er forsynet med en tuberkel. Et skæl viser aftryk af to frø, der antages at have været uden vinge.

Foruden denne findes en mindre ubestemmelig kogle på blokken og fra den lignende blok fra Salling kendes yderligere en type formodentlig tilhørende Pineae. I blokken med *Pinus herningensis* n. sp. findes aftryk af fyrrenåle, dels mellem kogleskællene og dels på blokkens overflade rundt om koglen. De viser trekantet tværsnit og tilhører en art med mere end to nåle i bundtet. Et bundt med 5 nåle sammen findes.

Koglens bygning stiller den i flg. SHAW's systematik (1914) i section HAPLOXYLON, der dækkes af betegnelsen »Soft Pines«, og herunder i subsection CEMBRA. Ingen identisk nulevende art er fundet ved sammenligning med koglerne af de nulevende fyrrearter, med *Pinus herningensis* n. sp. ligner mest *Pinus Armandi* (Franchet) Shaw, og må kunne placeres i gruppen FLEXILES under *Cembra*. Her findes nålene også anbragt 5 sammen i hvert bundt og selv om de 5 sammenhørende fossile nåle (se ovenfor) ikke kan siges at høre til den samme art som den store kogle, må sådanne kunne ventes at findes sammen med en kogle tilhørende *Cembra*.

Om alderen af blokken kan der ikke på dette grundlag siges noget endeligt, men den formodes at tilhøre *Miocæn* eller *nedre Plioæen*.

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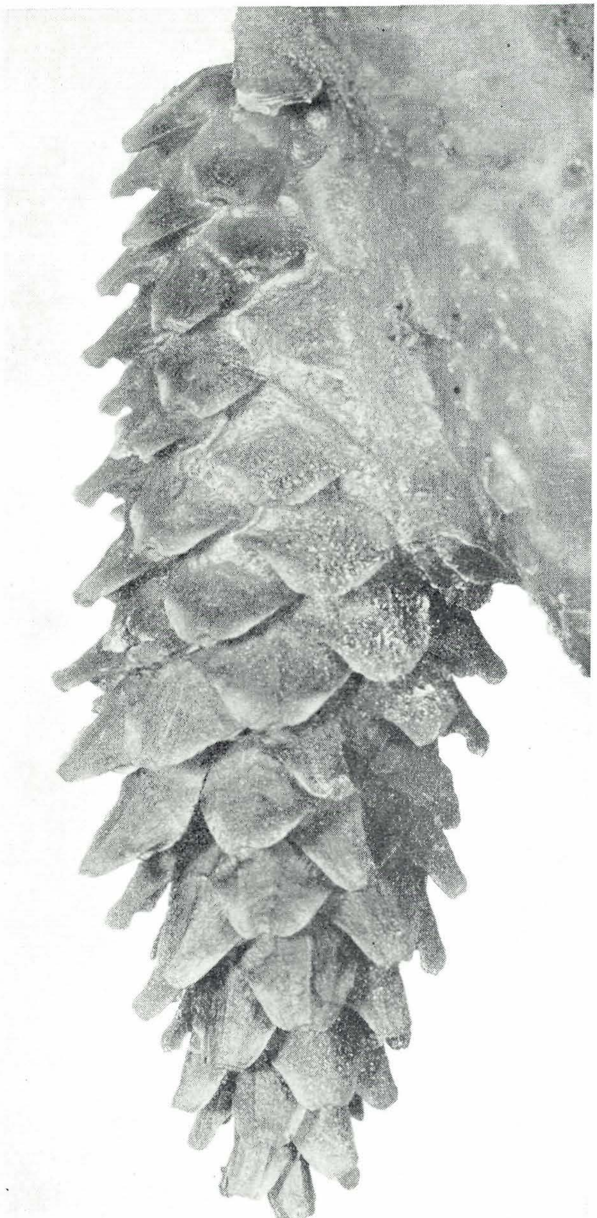
Pinus herningensis n. sp.
Cast seen from above. 8:9. Chr. Halkier phot.



Pinus herningensis n. sp.
Cast in side view. 8:9. Chr. Halkier phot.

Fig. 1

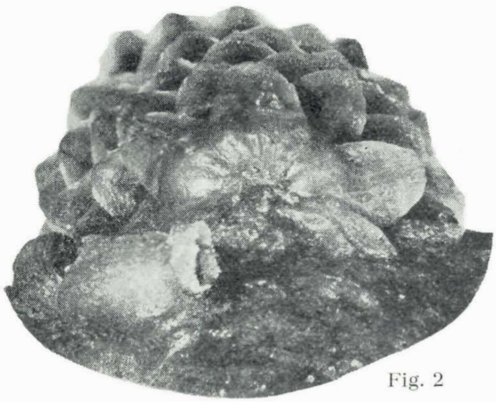


Fig. 2

Pinus herningensis n. sp. (Cast).

Fig. 1: Axial view demonstrating the screw.
- 2: Axial view demonstrating the basis with scars after the peduncle and the shed basal scales.

Plate 4. *Pinus herningensis n. sp.*: The Scales. (Casts).

Fig. 1: Terminal view demonstrating the thin umbo with area and the thicker apophysis in background. 8:9. Chr. Halkier phot.

– 2: Terminal view demonstrating the area with the tubercle. 1:1. Gunni Jørgensen del.

– 3: Dorsal view. Apophysis and umbo. 8:9. Chr. Halkier phot.

– 4: Dorsal view showing the ornamentation. 1:1. Gunni Jørgensen del.

– 5: Ventral view. Apophysis with scar after two seeds. 8:9. Chr. Halkier phot.

– 6: Ventral view showing ornamentation and seed scars. 1:1. Gunni Jørgensen del.

– 7: The neighbouring scales ventrally to that with seed scars of fig. 5. Two scars of the same seeds as distinct on the dorsal surface. 8:9. Chr. Halkier phot.

– 8: Lateral view showing apophysis and umbo. 8:9. Chr. Halkier phot.

Fig. 1.

Fig. 2.

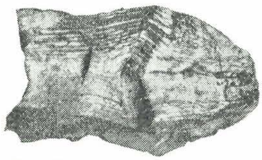


Fig. 3.

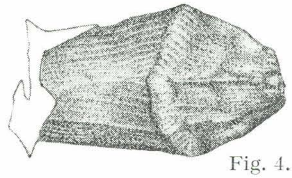


Fig. 4.

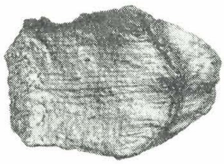


Fig. 5.

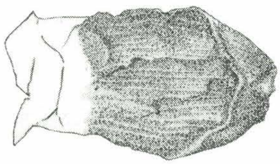


Fig. 6.

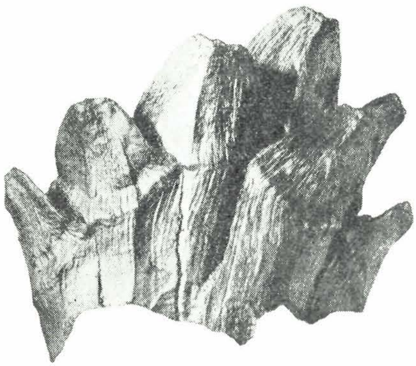


Fig. 7.

Fig. 8.

Pinus Armandi (FRANCHET) SHAW.
Weathered cone found on the ground. Note that it lacks peduncle and basal scales!
8:9. Phot: Studio, Royal Gardens, Kew. (England).