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The Use of Air Photographs in Celtic Field Studies

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INTRODUCTION

In his work on aerial photography in archaeology (Ancient Landscapes, 1957) John Bradford points out that even if air photographs are taken for other purposes they can often serve archaeology as a valuable source of 'intelligence'. In this country aerial photographs are now in common use for planning and development purposes, both in public and in private enterprise. This steadily increasing quantity of photographic coverage provides an abundant source of information and invites archaeological analysis.

The aim of this paper is to demonstrate how the study of Celtic fields may benefit from such data. The paper will discuss some important points emerging from the identification of a large number of Celtic field remains discovered by examining semi-official series of black-and-white vertical air photographs.

In the present context the aerial photographs are regarded as 'documents' that may be analysed independently of time factors and access to the site or area in question, and also in most cases regardless of field reconnaisance and excavation. For the sake of convenience such an application of air photographs may be named an *Airphoto approach*, and it may be regarded either as a method of investigation in its own right or as a method to support results obtained from other, more orthodox methods.

REMAINS OF CELTIC FIELD BOUNDARIES

From Gudmund Hatt's *Oldtidsagre* (Hatt 1949) we know that most Celtic field sites found during his comprehensive surveys and excavations were identified on the basis of boundary banks and lynchets that were intact or only partly destroyed. These remains have survived up to – and in some areas even beyond – the time of investigation because the fields they enclose were laid out in the least fertile areas; and when these fields were subsequently abandoned, little or no tillage took place until they were reclaimed for agricultural purposes. Even in cases where part of the field system was completely levelled, Hatt sometimes succeeded in tracing the outline of the boundaries because the demolished bank or lynchet contrasted in soil-colour with the field they enclosed.

These traces in the top-soil – in the terminology of airphoto interpretation called *Soil Marks* – belong to the kind of archaeological features which are very difficult to detect from ground level, whereas they might be clearly and comprehensively revealed in aerial photographs. This fact is illustrated in figs. 2–4 where the ploughed-over boundary banks and lynchets are clearly visible as a pattern of light-grey bands. The great majority of soil marks in Celtic fields appear as such light traces on a more deeply toned background; in some subsoils, however, this pattern of tone contrast may be reversed.

Acting on the assumption that soil marks need not be restricted to boundaries levelled in recent times but might also occur where banks and lynchets were levelled centuries ago, a preliminary airphoto study was carried out for the area of Vendsyssel. This was done partly to verify the results from Hatt's investigations of nine Celtic field systems recorded in this area, partly to see whether a study of the relevant aerial photographs would reveal additional, unknown Celtic field remains.

Three different airphoto coverages were examined: Basic Cover 1954, 1968 and 1972. The results were highly satisfactory in that it was possible to record more than 300 previously unknown Celtic field systems on the basis of soil marks (fig. 1). The number and distribution of soil marks in fig. 1, together with the whole concept of soil marks, open up fresh pro-

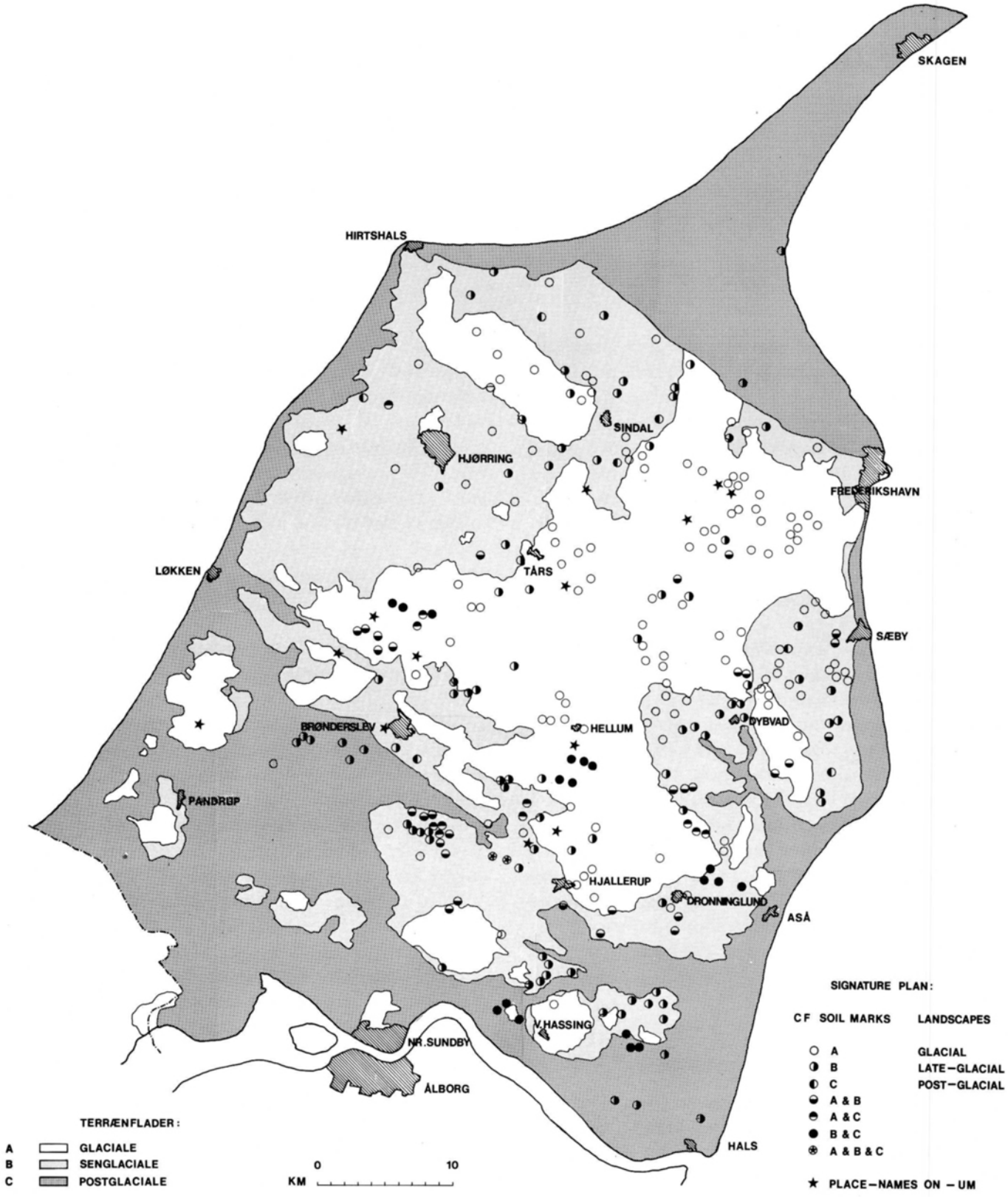

Fig. 1. Map showing the location of Celtic Field soil-marks in Vendsyssel. From an airphoto coverage BC 1954 with a supplement from BC 1968 and 1972.

spects in the study of Celtic fields. Some problems and observations concerning these marks will consequently be discussed in further detail below.

THE CELTIC FIELD SOIL MARK

Two general points may be stressed: 1) all soil marks in Vendsyssel identified from the three sets of air photographs are light-grey (cf. figs. 2–4). 2) There is no discernible difference between soil marks from levelled boundary banks and those from boundary lynchets. In the following we shall make no distinction between these constructions, and Celtic fields will be regarded as enclosed simply by a boundary.

As mentioned above (and apparent in the figures), soil marks are visible only if a distinct contrast in tone is shown in the photograph. Tone contrast depends on the difference in brightness between an image and its background. Brightness is a result of the amount of light reflected, and this reflection in its turn depends on the condition of the soil surface, either bare ground (ploughed and harrowed, for instance) or with only a thin cover of vegetation so that variations in soil colour may still be visible. Accordingly, the photographic image of soil marks cannot appear lighter than that of the enclosed field unless the soil material in the levelled boundary has a sufficient value of light reflection, i.e. brightness.

A discussion of the complicated origin and building of Celtic field boundaries is not intended in this paper. However, from the photographs of the levelled banks and lynchets, it would appear that both constructions consist mainly of a mixture of soil particles which emit a high degree of brightness. It is generally held – if we leave out the more intricate details and parameters of aerial photography – that if the soil consists of fine particles of a light intrinsic colour and has access to perfect drainage, much light will be reflected and a high degree of brightness will result. Most cross sections excavated by Gudmund Hatt (Hatt 1949) exhibited exactly these soil properties and conditions.

To conclude this point: depending on its origin and construction a levelled boundary (ploughed and harrowed) will spread its material over a certain area and leave a light trace on the soil surface. Under certain conditions the trace will be visible from ground level for some time after the levelling, but the great majority will be visible only in aerial photographs.

The individual field systems in fig. 1 cover areas between 2 and approx. 200 hectares. If, as a working hypothesis, we assume that each farm unit (people as well as animals) requires 15 hectares for one year's subsistence and that the crop rotation is 5 years, then the cultivated area works out at 75 ha, as indicated by a circle in fig. 1. The 300 field systems comprise a total of 22,500 ha of arable land exploited for a certain number of years within the period under discussion (roughly delimited, for the sake of convenience, from 400 B.C. till 400 A.D.).

Considering the size as well as the location of the area it is unlikely that it would have remained uncultivated for centuries during the time preceding the large-scale reclamation of moorland. A sizeable part of the most fertile and best located arable land must have been recultivated over at least one period of some duration, which would have initiated the obliteration of the covered boundary traces. In areas where this recultivation was especially intensive and where there may even have been little difference between the soil material of the boundaries and that of the fields, the obliteration may, in time, have become complete, or at any rate so extensive that only a few hectares of remains have survived, as appears from present-day records.

In this connection soil conditions and the duration of recultivation differ in their impact. In the following we shall illustrate the latter factor with a few examples.

The first example comes from the parish of *Albæk* (for a map showing the distribution of moorland in Albæk parish, see *Danmarks Natur*, vol. 7, p. 24). When the 1:100,000 overlay map of recorded fields prepared by the author was superimposed on the parish map, it appeared that 8 out of 10 field systems within the parish were located on light soils on moorland reclaimed in 1830. In other words, the still visible boundary traces have survived the more or less intensive soil working carried out since then.

Another example, the perspectives of which go somewhat further back in time, resulted from a close study of the aerial photograph in fig. 5, supported by information from the Land Register of 1688 and from TRAP's DANMARK.

The air photograph was taken in May 1954 over the manor house of *Langholt* between Ålborg and Dronninglund. There are clear boundary traces (marked with white arrows) in the field. According to the Land

Fig. 2.a. Vertical airphoto of Celtic Field soil-mark type A, scale 1:10,000.

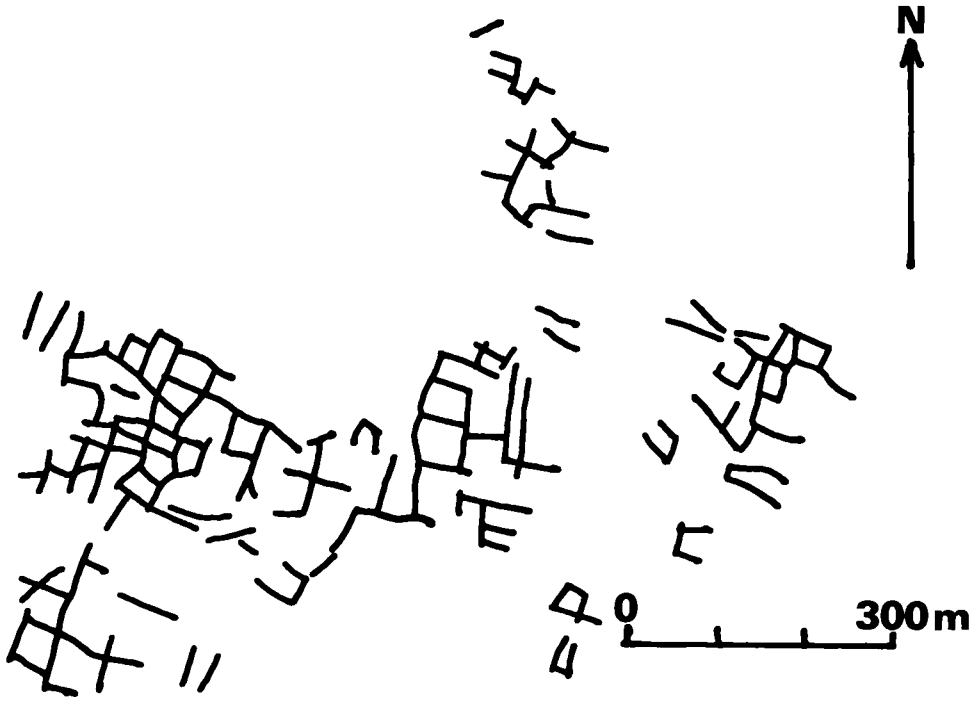

Fig. 2.b. Trace of the soil-marks from a.

Fig. 3.a. Vertical airphoto of Celtic Field soil-mark type B, scale 1:10,000.

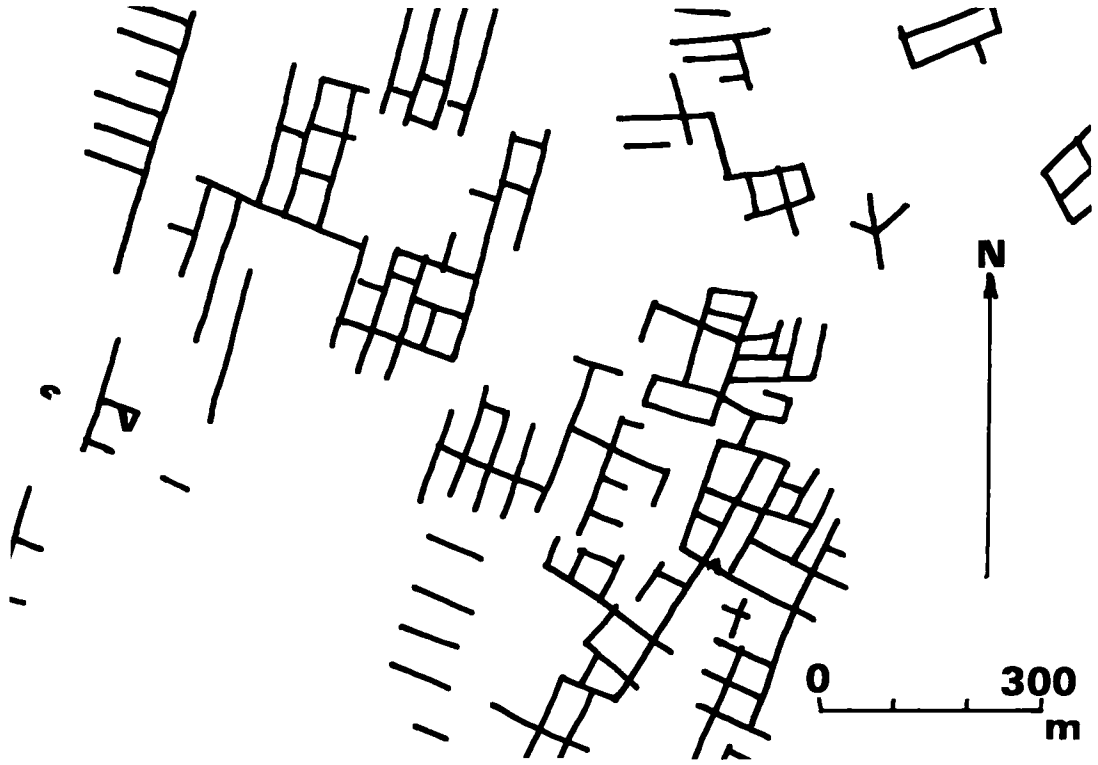

Fig. 3.b. Trace of the soil-marks from a.

Fig. 4.a. Vertical airphoto of Celtic Field soil-mark type C, scale 1:10,000.

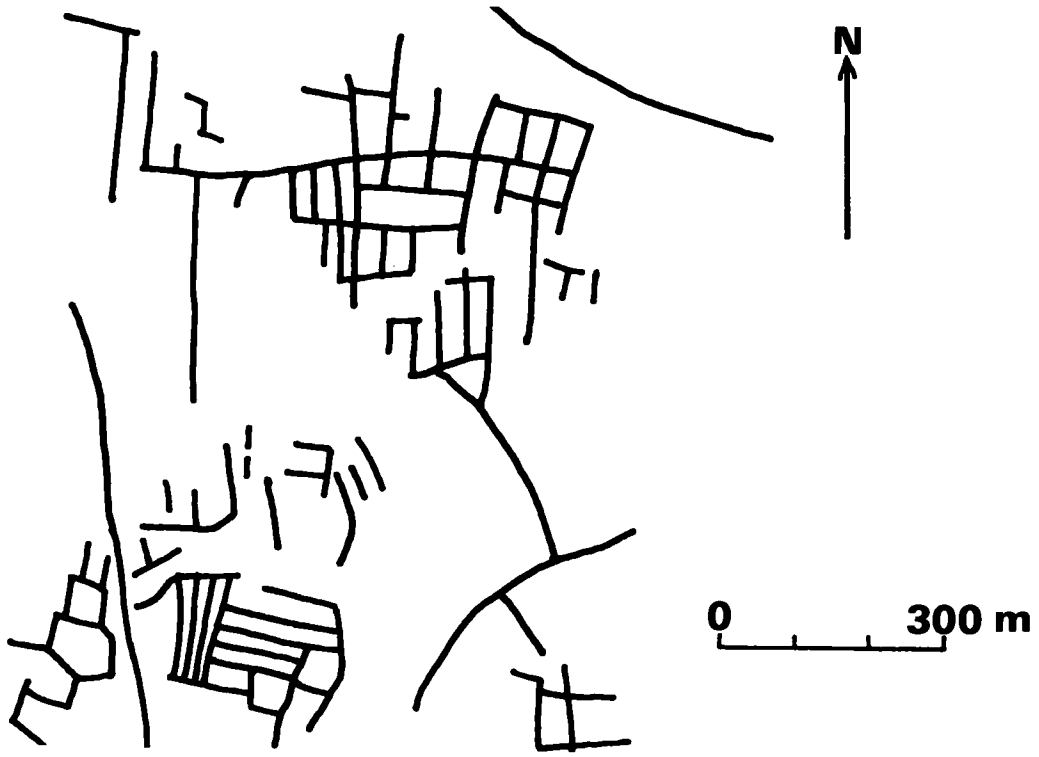

Fig. 4.b. Trace of the soil-marks from a.

Register of 1688 this land included furlongs with high-backed fields (name, number of fields and direction of ploughing are all given in the Land Register). According to TRAP's DANMARK, Langholt Manor has been known from the middle of the 14th century, and we can probably assume that most of the surrounding land has been more or less permanently cultivated ever since. This means that boundary traces from the ancient fields have proved impervious to sustained agriculture of a kind unknown to us, and to a couple of centuries involving the ploughing down of high-backed fields. Furthermore, an air photograph from March 1974 reveals that the traces are as marked as they were in the photograph of 1954, i.e. following twenty years of modern agriculture.

In the same way clearly perceptible boundary traces adjacent to the home farm can also be observed at a number of manors and large farms in Vendsyssel. However, except, in the case of Langholt, there have been no attempts to relate this observation to historical data, for which reason it is mentioned here only by way of information, not evidence.

Until a team of archaeologists, pedologists, geologists and historians carry out a scientific study of the subject, like that of the fields discovered at *Rone* on *Gotland*, we shall probably have to make do with rough and ready working hypotheses like that given above.

Finally, it should be pointed out that fig. 1 does not represent a final recording of the visible traces of fields remaining today. An analysis of other sets of aerial photographs than the three used in this investigation is bound to reveal additional traces. The 1968 photographs, taken during the summer, resulted in 15 additional discoveries and confirmation of several field systems previously recognised. The 1972 photographs, taken in April, May and September, resulted in 45 new discoveries and also revealed that several previously recognised field systems were considerably more extensive than was first realised. Both the season and the crops impose certain limitations on the possibility of recording field systems, though the margin of error is reduced by comparing several sets of air photographs. Thus the 300 field systems must be considered a significant and representative proportion of the systems recognisable from aerial photographs.

CLASSIFICATION OF FIELD SYSTEMS

Having discovered the many field systems and established their exact location in relation to the 1:100,000 soil maps, it may be useful to attempt a systematization, especially as far as various types of agriculture are concerned.

A detailed examination of the boundary traces reveals that a classification of the fields should include not only the shapes of the fields but also other factors, such as the appearance of the boundary remains (width, evenness, visibility) and their layout in the terrain, sub-divisions, and some consideration of circumstances governing their location on the three main morphological types: the moraine, the Yoldia and the Littorina plain.

The preliminary result of the investigation is a division into three main types which may be susceptible of further sub-division after analysis of material of a more comprehensive kind.

To illustrate the three types we have chosen air photographs showing the most characteristic features of each type, regardless of whether the picture is from Vendsyssel or the rest of Jutland.

TYPE A: (see figs. 2a and b)

The fields are very irregular in shape, though there is a visible attempt to achieve a quadrangular form. The course of the boundary marks is irregular, and the variation in width must be due to the fact that the bank originally varied in height and width. The fields are between 0.04 and 0.3 ha in size.

The layout of the field systems appears to reflect the needs of the moment and the conditions of the terrain, rather than any preconceived plan. The irregular course of the boundaries suggests that the builders had to bypass obstacles which could not be removed. Compare in this connection the course of boundary marks of type B and C below.

Type A is represented in all three types of terrain, but there is a distinct concentration on the moraine, where it constitutes approx. 56% of the boundary marks identified here. Furthermore, type A shows a clear preponderance in undulating areas. In comparison with types B and C it tends to be further removed from valleys and swampy areas.

TYPE B: (see figs. 3a and b)

This type is characterised by long and narrow, parallel strips divided into rectangular fields of varying size by transverse banks. Within the same field system the strips vary in width, though 25–35 m seems to be the most common width.

The layout of the field system appears to be based on a carefully conceived plan, and the relatively uniform width of the traces that mark the course of the levelled banks probably indicates good maintenance of the fields during the entire period of cultivation. The air photograph also shows, however, the ability of sand drift to cover and conceal large parts of the system, whether this happened during the period of cultivation and forced the people to abandon their fields or whether it occurred only after the fields had been given up for other reasons. The size of the fields varies between 0.06 and 0.45 hectares.

Apparently the ground-plan of this type of field lends itself best to the fairly level Yoldia and Littorina plains, where most of the identified B-types were indeed discovered. However, some are located on the moraine and some even in slightly undulating terrain. In such types of terrain it is generally not feasible to lay out long parallel strips as shown in fig. 3. However, the strictly rectangular shape of each field has been clearly realised and such systems can therefore undoubtedly be assigned to type B.

Another characteristic of this type is the complete absence of a lengthways division of the individual fields, unlike type C where fields are often sub-divided in a manner that brings the high-backed fields to mind.

Some of the recorded type B remains seem to suggest that this type developed over an extended period of time so that it reached its final shape (as shown in fig. 3) only when the Littorina plains came under development.

An example of a rudimentary layout is the field system belonging to the interesting site at *Kraghede* south of *Øster Brønderslev*. The system is recorded in two sets of air photographs and comprises an area of c. 150 ha of visible remains. The ground-plan shows the same characteristics as that in fig. 3, but both the orientation of the field strips and the varying width of the boundary marks demonstrate its rudimentary form.

TYPE C: (see figs. 4 a and b)

Fields of type C show more clearly than those of type B that they are the result of thorough planning, able workmanship, and firm supervision of labour. An extensive area has been divided into large fields, which are accurately laid out and separated at precise right angles by transverse banks. As the soil marks from this type of land division seem to indicate wider boundary banks, the division into large fields must have existed for some time before the subsequent sub-division took place; cf. Hatt's suggestion that the earlier banks are the highest and widest.

The fields are sub-divided with great accuracy into a number of large sections of equal size. In many cases we have a tripartition, which may reflect the number of households in the settlement (Hatt 1949, *Skørbaekkomplekset*) or may be a division resulting from inheritance. Individual fields may vary in size between 0.04 and 0.7 hectares.

As mentioned above with reference to type B, a different sub-division is characteristic of type C, namely a division of a rectangular field into a number of long and narrow strips which suggest the high-backed fields. An example of this can be seen in fig. 4, bottom left-hand corner.

In the original air photographs the boundary marks are sharply delineated on the ground surface, which would suggest meticulous maintenance of the fields until they were abandoned.

Type C comprises only c. 13% of the field systems recorded, which fact – combined with the thorough planning – may date the type as the most recent. The Yoldia plains are the preferred soil, but several fields are also found in the slightly more undulating terrain of the moraine.

AGE AND TYPE DISTRIBUTION OF FIELD SYSTEMS

The order in which the various types have been discussed and the letters assigned to them suggest their probable order of age. This is, however, a subjective assessment based entirely on the writer's interpretation of photographic data. A more objective assessment of age can probably be had only by comparing the data presented here with e.g. the various find maps and records available on graves, grave

Fig. 5. Airphoto of Langholt Manor, scale 1:10,000, May 1954. White arrows indicate Celtic Field soil-marks. Until 1642 the manor buildings were situated ca. 600 m to the south near the two ponds.

mounds, settlements and artefacts. Compare in this connection the site at Kraghede mentioned above.

Attempts to classify the recorded field remains can only yield reasonable results if a certain degree of generalisation is accepted. Nevertheless, it is surprising that so many field systems lend themselves to definite classification. Only approx. 20 cases were impossible to classify. In some cases two or all three types are found together within the same complex. In such cases they have all been included, i.e. one of each type of system.

Figure 1 shows the distribution of types according to terrain, each type being marked with its particular sign together with the area indication of 75 ha. Since the whole investigation is based on an interpretation of aerial photographs, it would not be valid to attempt a full assessment of the data resulting from the type distribution. Suffice it to call attention to the concentration of B and C types between the *Limfjord* and *Gerå* and the density of type A on the undulating part of the moraine due west of *Frederikshavn*.

Perhaps this density of field remains of type A

suggests that in the area around *Skaerum*, *Lendum* and *Gerum* there may have existed the kind of local interdependence the absence of which Viggo Hansen remarks on in the following passage: "... perhaps it may even be their contemporaries who in Jutland created the familiar ancient fields, the distribution of which is fairly similar to the distribution of settlements with an -um suffix. Though there is no discernible local interdependence, which was not to be expected, yet the geographical context must have been almost the same." (*Geografisk Tidsskrift* 1948–49).

CONCLUSION

Finally a few brief remarks concerning the pattern shown by the general distribution of boundary marks (*not* the types), as illustrated in fig. 1. Although future studies of air photographs will reveal even more boundary marks, the present investigation has made it likely that the pattern of distribution in fig. 1 will not be significantly altered. This is partly because the distribution of new field systems discovered in the photographs of 1968 and 1972 followed this pattern, and partly because there seems to be an acceptable explanation why some parts of the area contain no or remarkably few boundary marks.

For obvious reasons areas with swampy soil, dunes and shifting sand did not come under cultivation. Probably the coastal Littorina plains and the areas along the lower reaches of rivers only became sufficiently well-drained for extensive cultivation at a time when fields were no longer divided by boundary banks. The absence of finds in the moraine region extending from *Dronninglund Storskov* over *Allerup Bakker* and towards the north-east over *Tolne* is probably due to dense, mature forest, cf. the distribution of place-names ending in -holt (Viggo Hansen 1964).

Harder to explain is the near or complete absence of field remains on the glacial islands of the west coast of Jutland and on those at *Hjørring*, *Albaek*, *Hammer* and *Vester Hassing*. According to other find maps covering e.g. graves and grave mounds (Brøndsted III, 1957) the areas were fairly densely populated, but any traces of agriculture are missing. It is possible that the density of settlement entailed more intensive cultivation and thus caused a complete elimination of such traces. This process may have been accellerated by the fact that the soil of the boundary banks did not differ sufficiently from the soil of adjoining fields for durable soil marks to be formed.

There are undoubtedly many problems yet to be solved in the study of ancient fields, but it seems likely that a meticulous study of aerial photographs will help to solve some of them.

Translated by Ole Bay-Petersen

REFERENCES

BRADFORD, J. 1957: *Ancient Landscapes*. London.

BRØNDSTED, J. 1960: *Danmarks Oldtid, III. Jernalderen*. Copenhagen.

Danmarks Natur. Politikens Forlag, Copenhagen 1970.

Geografisk Tidsskrift 1948–49: *Det Kongelige Danske Geografiske Selskab*, Bd. 49. Copenhagen.

HANSEN, VIGGO 1964: *Landskab og bebyggelse i Vendsyssel. Det Kongelige Danske Geografiske Selskab, Kulturgeografiske Skrifter*, Bd. 7, Copenhagen.

HATT, G. 1949: *Oldtidsagre. Det kgl. Danske Videnskabernes Selskab, Arkæologisk-kunsthistoriske Skrifter*, Bd. II no. 1, Copenhagen.

TRAP, J.P. 1961: *Danmark. Hjørring Amt*. G.E.C. Gads Forlag, Copenhagen.