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# A pictish origin for Hnefatafl?

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**Abstract:** *A unique example of Pictish anthropomorphic art was recently discovered in Orkney, incised on the surface of a cattle bone. The find is described and compared with related objects. The carved bone is interpreted as a gaming piece and may, together with other finds from Orkney, hold implications for the origins of hnefatafl.*

> *'Did these bones cost no more the breeding but to play at loggats with 'em?'*
> Hamlet, Act V, Scene 1

## Introduction

From 1987 to 1996, archaeological finds were collected from sand dunes on the island of Burray, Orkney (figure 1, location 1). These finds had been exposed by sand extraction, motorbike scrambling and blow-out eroding the dunes and damaging previously unknown archaeological sites. No controlled excavation of the site has been undertaken but examination of aerial photographs, taken by the RAF in 1946 has indicated the existence of a number of circular features in the finds area, suggesting an extensive Pictish settlement. A large rectilinear ditched feature was also observed to the south that is likely to have been the original Norse 'Bu' but this area has since been destroyed by sand extraction (W. Budge pers comm). The finds recovered are predominantly animal bones but include Iron Age pottery, stone tools and iron-smelting debris and such notable artefacts as a polished stone axe-head fragment and a discoid stone counter. Because the finds cannot be related to any specific archaeological features, their precise dating and interpretation is unknown but the frequency of Iron Age pottery suggests that most are

likely to have been Pictish. These finds are curated by the Orkney Museum, Kirkwall and it was intended that they should be organised into a teaching and handling collection within the Museum. At the beginning of 2004, the author was commissioned to undertake an assessment of the collection and perform the cataloguing and reorganisation necessary, funded through the Community Environmental Renewal Scheme. For the assessment phase of the project, all items were examined and identified and one bone was observed to have a distinctive design incised into its surface.
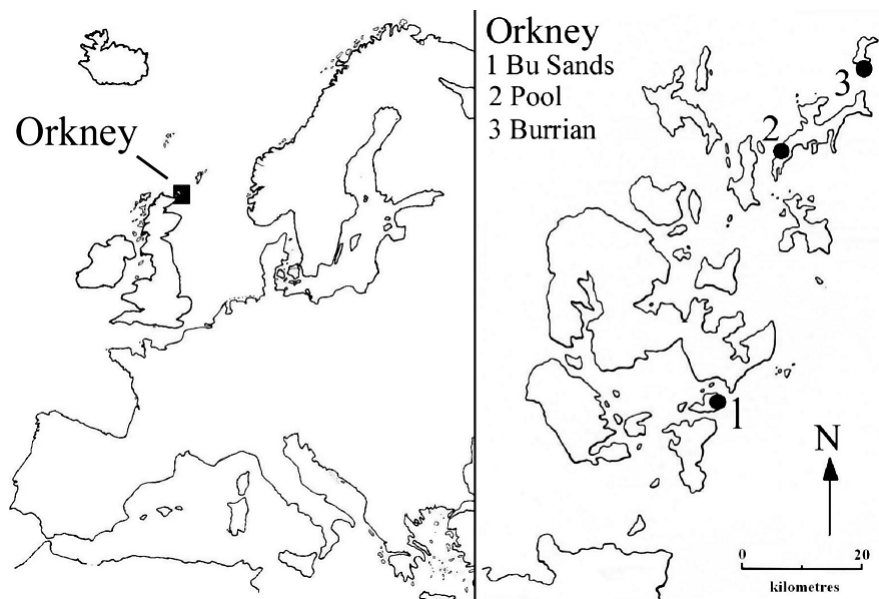


Figure 1: Site Location

The carved bone is the proximal left phalanx (phalanx 1) from the forelimb of an ox over 18 months old at death. It is 53mm in height and 30mm in diameter and was recovered as two large fragments. There is a splinter missing from the front of the carving, possibly from gnawing by a dog in antiquity, and an area of the volar surface has been lost, probably due to modern machining. There are fine cuts present from cleaning the bone whilst fresh but apart from the surface carving, there is no evidence of the bone having received any working. A small area at one corner of the proximal epiphyseal surface is slightly abraded.

The design lies on the sides and back of the bone and demonstrates a high degree of confidence in execution. The main motif is a standing human figure 22mm in height that appears upright when the bone is placed on its
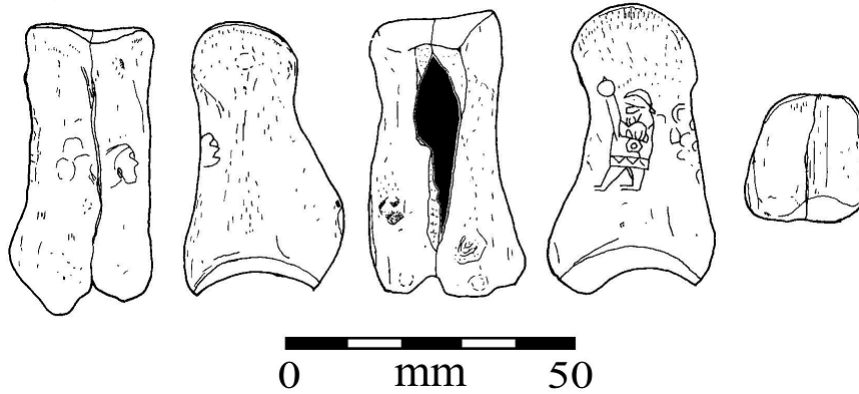
Figure 2: The Bone Artefact

proximal epiphysis. The figure wears a thigh-length tunic showing details such as cloth-folds around the arm and decoration around the hem. The figure clearly represents a warrior wearing a helmet and carrying a shield, with a scabbard at his side, and carrying an unidentifiable weapon, possibly a spear or sword; he also has a ponytail protruding behind and below the helmet. The find has become known locally as the 'Peedie Pict' ('peedie' is a commonly used Orkney word meaning small).
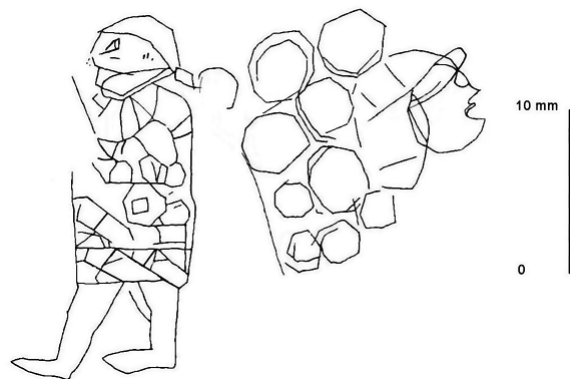


Figure 3: The Design on the Bone

Behind the main figure appears a design of repeated circles that seems largely to be a circular pattern to fill the dorsal surface. This leads to a further human face on the opposite side and has been interpreted as a

helmet crest. The second face is also in profile and also faces toward the volar surface, back to back with the Peedie Pict. This face is executed in a more nave style and has a cartoonish appearance although clearly wearing a helmet; the supposed crest may have been intended to represent hair or even a mere circular pattern.

The three major decorative elements have been shown to result from distinct episodes of carving [25]. This demonstrates a continuity of purpose being maintained over time, as well as the intent to produce a specific object implied by the initial preparation

There is no sign that any further working of the bone was intended: the motifs are completely drawn and fitted within the object's sides without any markings for further cuts. It is likely that this bone represents a finished item, whether as a simple piece of graffiti or as a functional object.

That both figures face the palmar aspect of the bone may suggest that the artefact was intended to have a distinct front and back. The whole arrangement of the carving shows that the bone was oriented with its proximal epiphysis as the base so that both the Peedie Pict and his companion are upright and the 'front' is therefore the palmar aspect. The slight area of abrasion on the epiphysis may demonstrate that the bone stood upright. It is just possible that there was a small carving on the 'front' face of the bone that has been destroyed by the machine damage but no trace remains.

## Comparable Finds

Three other cattle phalanges with incised surface designs are known from Orkney: one from the Pool excavations, Sanday [21] and two from the Broch of Burrian in North Ronaldsay [47, pp. 345 and 360-361] [26, pp. 88-89], the sites shown as locations 2 and 3 respectively in figure 1. Of these three, two bear the well-known Pictish 'crescent and V-rod' design, one with the 'mirror case' on the reverse side; the third has an unclear design but may be the terminal of a 'Z-rod.' All are carved so that the design is upright when the bone is on its proximal epiphysis.

Addyman and Hill [1, plate VIIIc] describe a cattle phalanx 'trial piece' from Saxon Southampton (Southampton Museum finds reference A 1993 .19.71) inscribed with runes of 'Frisian type' [1, RI Page; 86-88]. These runes read 'catÆ' (ibid) and it may not be coincidental that the term 'catt' is associated with the Pictish inhabitants of both Caithness and Shetland, possibly as a tribal motif [48, p. 15] [33, p. 139].

A number of similar finds have been reported from terp mounds in the

Netherlands. Munro [30, p. 104] notes "bones of the foot of an ox are covered with concentric circles, apparently for ornamentation" and this suggests a similarity with the rear part of the carving from Bu Sands and also with finds of horse phalanges noted by Roes [40, pp. 54-57], although such circular marks are a common form of decoration.

One other find type is of cattle phalanges smoothed across the proximal epiphysis and whittled around the margins, notably from Pool, Sanday [21]. This formed a shape similar to that of bone and antler pieces from the Broch of Burrian [26, p. 89] and a stone piece found at the early Christian period site of Kiondroghad on the Isle of Man [15, p. 76], all interpreted as gaming pieces.

Still other examples of the working of cattle phalanges are a perforated type found widely in excavations, including one from Bu Sands. These each have a single small circular hole drilled through the centre of the proximal epiphysis either for use of the phalanx as a handle or to take a peg, permitting the securing of the bone in place on another object.

## Interpretation

The Peedie Pict is clearly Pictish, both from the style of depiction and by association with Late Iron Age pottery as well as by analogy with similar finds from Orkney. At Pool, it was found that altered cattle phalanges only occurred in the Pictish deposits and not in the Norse layers (A. Smith pers comm).

It seems that these decorated cattle phalanges in general did not require significant further shaping to achieve their intended function, although this function may also have been achieved by whittling at the sides in other examples. Their shape is not itself modified in any way although the decoration clearly shows that they are intended to be seen from all sides: they may constitute a class of artefact in themselves. The Peedie Pict is therefore either a piece of repeated casual carving, an attempt at a design in a trial piece, decoration to identify the bone as a particular object, or a figure that has intrinsic meaning. The confidence of execution, initial preparation, repeated episodes of carving and the use of similar bones elsewhere suggest greater intent than might be the case for 'doodling' but such activity cannot be satisfactorily ruled out. Use as a trial piece seems unlikely because better bone surfaces would have been more readily available with the results being more easily transferable. There must be an inherent aspect of the cattle phalanx that makes it particularly well suited to some function that can be

improved by decorative or symbolic carving. Most significant is that the shape of cattle phalanges permits them to stand upright on the proximal epiphysis and the carvings on all the known decorated examples are clearly carved for this orientation.

Ethnographic parallels for uses of whole cattle phalanges are few. The use of cattle phalanges as 'buzz' toys is known among the North American tribes [11, pp. 751-757]. This though requires that cords be attached mid-shaft, which would obscure the carvings and is therefore unlikely as an explanation of the Pictish examples. Another possible use is as the object in a game such as 'handy dandy' or 'neiveie-nick-nack' [16, pp. 189-190 and 410-411] [28, 169 records an Orkney version] 'hide the button' or the American 'hand game' in which an identifiable object hidden in the palm of one hand or the other must be located by an opponent. These finds would probably be too large for such a function, although the possibility of a similar game has been proposed for parallelopiped dice from the Late Iron Age [9, p. 223]. Cattle bones would also probably be too cumbersome for any game similar to *Inukat* or *Inugaktuuk* played by the Inuit using seal phalanges and metapodials [17, p. 163].

The ability of cattle phalanges to stand upright suggests the possibility that the Peedie Pict was used as a piece in a boardgame. Our understanding of this aspect of past societies is particularly limited because much of the archaeological evidence identified so far - the pieces and the boards - is not securely stratified and there are few contemporary records: we must rely largely on anachronistic material and traditions from diverse cultures.

As well as the decorated and perforated examples from Iron Age Orkney, we should consider the finds of cattle phalanges that have been simply altered by having their sides whittled away, for example at Scalloway, Shetland [41, pp. 172-176] and Pool, Sanday [21]. The shape that this produces has a marked similarity to the pawns of the Lewis chessmen and to other supposed gaming pieces made from other materials. Conversely, some stone and glass pieces seem almost to be in imitation of phalanges, such as those illustrated by Murray [32, p. 58] [31, pp. 763-767], which appear intermediate in form between a phalanx and the conical stone gaming pieces discovered at Scalloway [41, pp. 173-175].

Iron Age gaming boards are known from several excavations [37, pp. 60-62] [44, pp. 188-9] and appear to follow a similar design throughout northern Europe and Scandinavia, probably for a game known in the Germanic areas as *tafl*. The main features of the game are particularly well illustrated by two famous finds: the 10th Century game board found in a crannog at Ballinderry, Ireland and the set of 9th Century playing pieces found at Birka,

Sweden [32, pp. 57-60].

The Ballinderry board is made of wood and has a square grid of seven holes by seven, with the central point and the four corners marked out specially. Other boards are known in which the grid is larger but the board is always a square orthogonal grid with an odd number of lines in each direction, often with the centre and corners specially marked. Stone boards such as those from the Buckquoy excavations [36, 7], now in Orkney Museum, are typically marked by such a grid of lines so that the playing positions are defined by the crossing points and movement is along the lines. Helmfrid [18] has made the suggestion that the term *halatafl* used in the Norse sagas specifically refers to a perforated playing board for the game of *hnefatafl*. The occurrence both of perforated gaming boards such as those from Ballinderry, Ireland and Brough of Birsay, Orkney [13, find 274] and of perforated phalanges may be important in this respect.
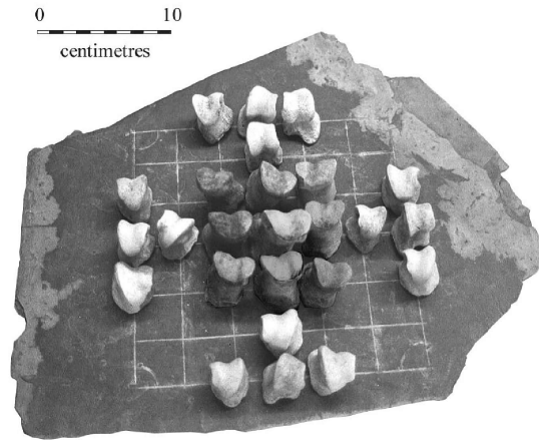


Figure 4: The Replica Gameboard Set for Play

The playing pieces from grave 750 at Birka [4, p. 147] [5, p. 271] are made of glass in two colours: seventeen pieces are light green and nine are dark green. All the pieces have the same plain globular shape about 25mm in diameter except for a single additional dark piece which is tall, decorated and anthropomorphic, wearing a circlet or crown. A similar set made of bone was recovered from grave 624 that showed traces of having had iron pegs in the bases. Other partial sets have been found in graves, all of similar dimensions: the Scar burial on Sanday [34] produced 23 globular playing

pieces of bone for example (now on display in Orkney Museum).

We cannot know whether the rules adopted for play on these boards were consistent within any area or culture but all the available information suggests that the principles were similar [35, p. 197]. The clearest evidence for play is the board design, which is that used in the game of *tablut* recorded in Sweden by Linnaeus in the eighteenth century. Further information can be derived from the Norse sagas and from medieval Welsh and English manuscripts: these have been summarised by Murray [32, pp. 55-64], Bell [6, part I; 75-81, part II; 43-46] and Helmfrid [18]. Two much quoted Norse riddles, from the Herverar Saga, recorded in the 14th Century, are particularly enlightening and bear repetition:

"Who are the maids that fight weaponless around their lord, the brown ever sheltering and the fair ever attacking him?' (Answer: the pieces in *hnefatafl*), and

'What is the beast all girdled with iron which kills the flocks? It has eight horns but no head' (Answer: the *hnefi* or head-piece in *hnefatafl*)." [32, p. 61]

This shows, despite variations between the surviving Old Norse texts and the inherent awkwardness of translations, that the game must have been sufficiently uniform for the answers to be widely recognisable. Parlett [35, p. 201] suggests that the second answer relates to the manner in which the king-piece was carved but it seems more likely to apply to the number of defending pieces around the king, whose regular arrangement radiating from the king in eight directions at the start of the game could readily be likened to the king's 'horns' (if in four directions like *tablut* then only four horns would be present). The riddles also indicate that by the time of their recording at least, the king need not have been anthropomorphic and that the two sides were distinguishable by colour.

The spacing between playing points on known Iron Age game boards varies from about 10mm upwards. Some of the smaller examples such as those from Buckquoy [36, pp. 187 and 198-199] were undoubtedly produced in a very casual manner that suggests that they were not intended for regular use but rather made for an ad hoc game using improvised pieces. A spacing of 25 - 30 mm seems to have been common among the better produced boards, including those from Ballinderry and Wimose and such a size is required to permit the practical use of cattle phalanges as playing pieces; it is also similar to the diameter of many Iron Age counters, including one from the Bu Sands. (Most authors have followed Murray [32, p. 58] in describing the fragmentary board found at Wimose in Denmark as a square hnefatafl board but there is no evidence to suggest that the board was not rectangular.

It is quite possible, given its supposed date, that the board is in fact an import from the Roman Empire or a copy of a Roman original and we might perhaps consider that it belongs rather to the ludus latrunculorum family of games.)

The use of circular motifs on the phalanx recalls finds from Frisian terp mounds that have been interpreted as skittles pins. Roes [40, pp. 55-57], discussing these Dutch finds, reported the modern use of cattle phalanges for skittles and this use is clearly depicted in the elder Brueghel's 1560 painting of 'Children's Games.' MacGregor [27, p. 134] notes the collection and use of cattle phalanges in 20th century Friesland as skittle-like targets in a throwing game. Interestingly, similarities between other bone artefacts have recently interpreted as evidence for strong Iron Age links between the Northern Isles and Frisia [42, pp. 111-115].

One further plausible alternative interpretation is that the carved bones from Orkney are lots for divination (cleromancy), with a meaning when cast based partly on the incised design, perhaps in a similar manner to that recorded among the Germans of the first millennium AD by Tacitus (Germania, chapter 10). This would permit wide variation in the quality of execution without impairing usefulness. The use of an intact bone may have been required by the lack of wood in Orkney or even have been necessary for ritualistic or functional purposes: the use of unworked astragli as dice is well known for instance. In this context, the use of both abstract Pictish symbols and recognisable figures might be explicable, especially if different surfaces can show different meanings. It is possible that although the Peedie Pict is a robust male warrior figure, the other face (which despite being helmeted is relatively graceful with no obvious beard) is intended to be female and this potentially gives opposite interpretations to the two sides and intermediate meanings for the volar and dorsal surfaces. This would fit the suggestion of a dualistic Pictish philosophy (as perhaps overstated) by Jackson [22]. This interpretation of the artefact need not conflict with its function as a boardgame piece, indeed such a dual function would resolve the apparent confusion relating to translations of the Hervera Saga riddles discussed by Helmfrid [18] that appear to describe 'throwing' of the king-piece; a game board could readily act as the field for the casting of lots.

The use of astragli and bone artefacts in this divinatory manner is well known, as for example among the Tswapong of southern Africa [49, especially figure 2]. In this context, the use of both symbols and recognisable figures might be explicable, especially if different surfaces can show different meanings. The simultaneous use of disparate objects as practised by the Tswapong may also suggest a function for the decorated discs recovered from

Pictish contexts such as those from Shetland and Caithness summarised by [46, pp. 45-47]. Culin notably suggested [10, pp. xvii-xxxvi] that a magical or divinatory origin might be a common, even universal attribute of games and although this was not a view held by Murray [32, p. 235], the Inuit seal bone game provides an apposite example [17, p. 163] and the topic remains worthy of discussion (for example [23]). Biblical references (including Proverbs 33, 16) demonstrate that Christian beliefs among the Picts need not have prevented such activities.

## Experimental Archaeology

At a 'Family Fun Day' in Burray, a stone board that had a 7x7 grid of incised lines was used to play *tafl*. The lines were spaced at 25mm and the playing pieces were cattle phalanges from the Bu Sands collection, now used as a handling set. The king's pieces were all phalanx 1 and the other side used phalanx 2, which permitted easy distinction between the sides (phalanx 2 also stands upright on its proximal epiphysis, giving a pleasing shape for a gaming piece but is significantly shorter than the first phalanx). The king itself was a particularly large phalanx 1, which made the piece sufficiently distinct for ready recognition

The experimental games brought home two points that suggest that the carving of the Peedie Pict was not necessary to indicate a *tafl* king. It was noted that on a board of this size, the pieces were so close together that although they could be readily identified by size, any surface marking would probably not have been easily visible. If the Peedie Pict was carved to be a *tafl* king then the other pieces must have been substantially smaller – perhaps phalanx 2 sized, similar in fact to the men from Birka – and the king would then have been recognisable purely by height. It is also clear that the movement of the pieces in tafl does not require the designation of direction on the pieces, which may move in any direction: there is no 'front.' It follows then that the anthropomorphic design of the Peedie Pict carving is unlikely itself to be directly related to tafl play but may indicate a cultural tradition and the (probably male/warrior) anthropomorphism of both the Birka 'kings' and the conical pieces from Scalloway and Mail must be noted in this respect. If the king were usually the only piece from a set of 25 or more to be large and anthropomorphic, then that would also explain the rarity of such finds. If this cultural symbolism was as important to the Picts as to the Norsemen - as the Peedie Pict suggests - and we extend this interpretation to the carved phalanx finds from Burrian and Pool, then to

retain symbolism, the meaning of the well-known Pictish crescent and v-rod symbol might be 'king,' 'warrior' or 'battle-leader.' By the time that the Hervera Saga riddles (above) were recorded, this tradition may have been lost or become purely symbolic, permitting the description of the hnefi as having no head.
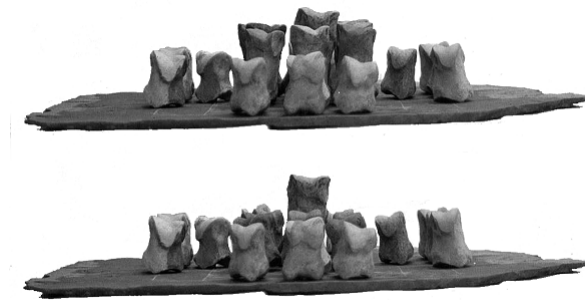


Figure 5: Side View of Board set up for *Tafl* Play with Cattle Phalanx Pieces. Above: the king side all phalanx 1, obscuring the king; Below: the king only phalanx 1, others phalanx 2

The experiments in Burray also used wooden facsimiles of the bone as ninepins. The play was quite satisfactory and suggested that cattle phalanges performed well in this role. Skittles games have a variety of rules, usually permitting two or three throws of a ball, stick or wooden disc (known as a 'cheese') with the pins arranged in different patterns. Some score knocking down a kingpin more highly and others require that the kingpin be knocked over in order to score at all. If the purpose of the bone was to serve as a skittles pin, then the surface carving may be intended to indicate that the Peedie Pict was a 'kingpin.' Skittles lends itself well to social activity with possibilities for team play and drinking games, which we can expect to have been as popular in the past as they are today.

## Conclusion

We do not have any specific evidence to suggest whether the Peedie Pict was intended to represent a particular Biblical or Pictish character, an archetype or an abstract 'warrior.' Although Pictish use of human images as religious idols has been suggested [38, p. 3], an interpretation of the Peedie Pict as a gaming piece or cleromantic lot (or both) seems most likely to be correct.

The degree of finishing that such an article would require may depend on the nature of the game to be played: a set of skittles casually used by children might require less elegance in form than pieces for a frequently played adult boardgame for example. MacGregor's [27] observation of the collection and use of cattle phalanges in 20th century Friesland as skittle-like targets in a throwing game ('*loggats*') is very clearly supported by a detail shown in the elder Breughel's 1560 painting 'Children at Play.' Smith's [42] suggestion that other bone artefacts indicate contact between Frisia and Orkney in the Iron Age may be important because the distribution of carved cattle phalanges seems localised to these areas so far and it would seem probable that such pleasant activities as games should also have become common to neighbouring groups.

The tradition of boardgame playing in Pictish Orkney is attested by the existence of a number of boards made with varying degrees of formality, notably the rough stone examples from Buckquoy, Red Craig [37, pp. 60-62], Ritchie 1977; 187, Brundle 2004) and Howe [44, pp. 188-9]. The *tafl* type of game seems later to have existed in a similar form throughout northern Europe, though almost certainly with numerous minor variations, possibly evolving into *tablut* [32, pp. 55-64] [6, I; 75-81 and II; 43-46]. A distinguishing feature of this family of games though is that just one counter needs to be distinguished from all the others as a 'king,' a role for which the Peedie Pict would be well qualified. The Pictish attribution of the Orkney finds suggests a date of around 500-700AD: earlier, possibly by several centuries, than any of the supposed *hnefatafl* artefacts previously identified (except possibly the Wimose board, which must probably be reconsidered as mentioned above).

Accepting the interpretation of finds of worked cattle phalanges as gaming pieces, if they are all 'kings' from a game such as *hnefatafl*, then the apparent absence of ordinary pieces seems strange. In *tablut* for example there are 24 such pieces to 1 king, as found in grave 750 at Birka. The most likely explanation for this is that the pieces are found but that their appearance is not diagnostic of function. Obvious possibilities include shells, stones and the second phalanx of cattle, which could be used unworked – quite a likely occurrence if so little apparent effort went into producing the king. The most likely explanation for the apparent absence of ordinary pieces is that the pieces are found but that they are casually used items and their unworked appearance is not diagnostic of function.

Both boards and pieces are known from many Norse sites, particularly important examples being the Ballinderry board, the Birka games sets and the Baldursheimur pieces. Their association with *hnefatafl* is extremely plausible and fits with every mention of the game in the Norse sagas. These

Norse examples are typically high status objects, craftsman made and precious to the owner; the Pictish examples in contrast show relatively minor modification of raw materials and are more casual, homely pieces. Apart from the bone pieces, the crudely made stone gameboards recovered from archaeological sites in Orkney, especially the examples from Buckquoy and Howe, are likely to be Pictish yet bear the design of the basic *tablut* board that has been identified with *hnefatafl*. Unfortunately, most early gameboards and pieces potentially attributable to the Iron Age are poorly stratified and, furthermore, many major Pictish sites appear to demonstrate continuity of occupation into the Norse period, probably including Bu Sands [24]. We may however, tentatively conclude that this game was well known to the Picts of Orkney and not a later Norse introduction. If we consider that the Wimose board – probably the earliest known game board from Iron Age northern Europe - may be from a Roman game such as *ludus latrunculorum*, then the possibility exists that the Orkney finds are the earliest evidence of *tafl* so far. The *tafl* games may then be Pictish in origin and later became widely known through trade across the North Sea to Scandinavia and northern Europe.

## Acknowledgments

> *'The lot is cast into the lap; but the whole disposing thereof is of the Lord.'*
> Proverbs 16, 33

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Board Games Studies was first published in 1998, an initiative inspired by the colloquia on board games held at Leiden University, the Netherlands, in 1995 and 1997. Five institutions affiliated themselves with the journal: the Institut für Spielforschung und Spielpädagogik in Salzburg, the International Institute for Asian Studies in Leiden, the Russian Chess Museum in Moscow, the British Museum in London, and the Department of Computer Science at the University of Maastricht. The journal, which was published by CNWS Publications in Leiden on a yearly basis, was partially funded through the assistance of patrons and boasted a modern layout, trilingual summaries and color plates. The broad ambition of this journal required a continuous commitment from the editors, who reviewed contributions in German, French and English, provided translations of summaries for each article and, in several cases, collaborated extensively with authors to develop manuscripts that were to the academic standards of the publication. The journal had a trial run of three years, after which the format, content and review process was evaluated. The authors of the articles integrated wide-ranging literature necessary for a comprehensive understanding of particular games. Contributions from different disciplines — including psychology, computer science, philology, classical archaeology and history — allowed for a better historical and systematic understanding of board games to emerge. Starting in 2000, a section with a translation of primary sources was added. Book reviews and research notes further complemented the multi-facetted contents. Its first ambition, to serve as a platform for the publication of board games research, was met quickly, while gradually the journal gained prominence among researchers by publishing seminal historical overviews. The colloquia continued from 1995 onwards, moving from a biennial to a yearly schedule. The host institution was expanded beyond Leiden to universities and museums throughout Europe as well as Jerusalem, Philadelphia and, in 2013, the Azores. The colloquia continue to gather an enthusiastic group of scholars, players and collectors. Despite the institutional affiliations and a group of patrons, the production of the journal became financially and logistically problematic with CNWS no longer able to serve as a publisher. Reluctantly, the paper version of the journal was discontinued after volume 7 was published in 2004. The possibility of an online version of the journal had been explored with the online publication of the first issues, a decision that greatly assisted the dissemination of knowledge accumulated in those early volumes. The next step, an online journal that operates again as a platform for recent board games research, was not far away but required the skills and enthusiasm of previous and new editors to materialize. In these last fifteen years, the study of board games has gained momentum and this journal will not only showcase new results but, most of all, will encourage and publicize the work of the dedicated researchers in this field.

<div align="right">Alex de Voogt</div>

# To the authors

Board Game Studies is an academic journal for historical and systematic research on board games. Its object is to provide a forum for board games research from all academic disciplines in order to further our understanding of the development and distribution of board games within an interdisciplinary academic context. Articles are accepted in English, French, and German and will be refereed by at least two editors under the final responsibility of the Editorial Board. Please send your contributions in any editable format (Word, LATEX, rtf, . . . ) with a matching PDF file. Please send all the illustrations in separate files.

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