PROCEEDINGS

of the

FIRST
MILL RESEARCH CONFERENCE

1983

CONTENTS

The First Mill Research Conference was held at Luton, on the 22nd October, 1983. Its object was to resent and discuss interim results of work in progress, rather than finished projects.

Participants

Mr D Plunkett - Chairman

Mr A A Bryan

Mr R Cumming

Mrs K Davison

Mr A Freedman

Mr M Harverson

Mr D H Jones

Miss P Norchi

Mr M Organ

Rev L J Turner

MILL POETRY

Phillipa Norchi

Mill poetry is a very varied subject, and I find that such poems can be put into definite categories. The miller's daughter appears to be a 19th century theme, and I consider it was a piece of early sensationalism to attract attention. Reading through Tennyson's poem, there seems to be more reference to the miller's wife than his daughter. The innkeeper's daughter had a similar reputation in literature.

Many poems are about a specific mill. "Outwood Windmill" (which I found in Arthur Mee's Kings England series) is written in the first person and tells how the Great Fire of London was observed from the mill. Other poems relate to more active days in the life of the mill; e.g. Rottingdean Windmill, by Sheila Asch. She also wrote Bishopstone Tide Mills, which comes into the "abandoned mill"category. Wilfred Foreman's recent book contains a very haunting poem which highlights the decaying mill beautifully.

The image of the miller that is portrayed in poetry - generally that of a wealthy and dishonest person - forms a category of its own. The image is also apparent on tombstones, as you will see from the display of epitaphs. On the other hand, a few even mention an honest miller - most unusual! The first two lines of one poem is typical:

I see the wealthy miller yet,
His double chin, his portly size,

Robert Bridges in his poem 'The Windmill'says of His Tireless Merry Slave the Wind:

And doth not much his work o'er look:
He stands besides the sacks, and ranks
The figures in his dusty book.

Chaucer writes of the dishonest miller thus:

A rumbustuous cheat of sixteen stone
Big in brawn, and big in bone,
He was a master hand at stealing grain
And oftentook three times his due
Because by feeling with his thumb,
He new its quality.
By God! To think it went by rote,
A golden thumb to judge an oat!

The majority of mill books contain a poem of some sort. Many have several, especially the old ones. I may find there are further categories to slot them into. The object is to find every mill poem and put them all into a computer - a record for all time!

Discussion

Plunkett — If anyone comes across such items, perhaps they would pass them on to Phillipa?

Jones — What languages are you accepting?

Norchi — Anything - any language.

Jones — I have seen a number in German. I also have a recording of a poem by

a miller in Skye - in English, but clearly thought out in Gaelic.

Organ — Isn't there something by Burns?

Jones — He wrote something briefly using imagery from a mill, in 'Advice to the Unco Guid'. It is about the self-righteous people whose main interest is discussing the failings of their neighbours.

> Whaes Life is like a well-gaun mill
> Supplied wi' store o' water,
> The heaped hopper's ebbing still,
> But still the clap goes clatter.

This is imagery which is already lost for most readers.

Jarvis — I am not happy about using poetry of this sort; it tended to be written by literary people rather than those in the milling trade, so while elements of the truth come out in this, much of it is likely to be imagination on the part of the authors.

Plunkett — This applies to almost any writing; traveller's tales and descriptions of mills can amount to much the same thing.

Organ — There was an element of romanticising about them, beacuse they were romantic poets. For Masefield about ships; beautiful sails on the horizon are an entirely different picture from the poor devils who were working on board them.

Davison — Often anyone with a knowledge of mills can glean something from the Poetry.

Jones — But surely it misses the point to complain that the literary poet was not concerned with accuacy, or lacked knowledge of the subject. It need not be accurate, for the poet is not concerned with strict fact. He can tell us about the attitude to mills, millers, and their trade. If we want technical information, we should seek it somewhere else. We should also remember that not all of it is literary in the narrow sense. Some of it has a practical background. The example I mentioned from Skye was by Danny McLachlan, who was a working miller, albeit a very well-read miller. Also, many of the German examples I have met are similar, and might be described as folk-poetry.

Freedman — I agree; poets are concerned with emotional reactions and if you want factual information you wouldn't go to a poet. As Phillipa pointed out, the two recurring figures are the miller's daughter and the thieving miller.

Norchi — Also the sound of the mill wheel, in watermill poems. Though there are far more windmill poems than watermill ones.

SMALL COMPUTERS FOR MILL RECORD SYSTEMS

A A Bryan

The purpose of a computer in a mill record system is to assist in the production of documentation to support field studies of mills by the classification of sites and the records prepared from them.

So far the following dacumentation has been prepared:

1) County Alphabetic Indices for wind- & watermills, covering England, Wales, Scotland and the Channel Islands.

2) Numeric Indices fo 100 km map squares, covering some parts of England and Wales.

3) Database record systems for wind- & watermills to sieve comparitive information for specific examples of mills where deatiled data is available.

Advantages

It avoids the need to fill the house with paper.
Information files can be readily accessed, edited, and printed.
Special listings can be created by sorting files.
Files can be searched for specific information.
Mill data can be cross checked for accuracy.
Files can be portable, subject to system compatibility.

Disadvantages

Cost.
Complexity; the is a need to know how to operate the machine.
Permanent long term records cannot be kept as magnetic recordings. Storage as a print-out of mature files is the only permanent easily readable method.
Out of date files are not retained in the system (as now operated). As new material is added to files, existing information is overwritten.
Backup copies of disc-stored files must be kept against irreparable disc failure. This doubles the cost of storing the large quantities of information retaind in the computerised filing system.

Storage Systems

At present, two large-capacity storage systems are available; flexible discs, and cassette tape. Flexible discs offer fast access, high capacity, and and are convenient to use, but are relatively expensive. Cassette tape offers high capacity at low cost, but is inconvenient to use , and access is slow.

At the present time some 4 000 entries of the Alphabetic County Index of watermills in England are stored on one $5\frac{1}{4}$" flexible ("floppy") disc, with room to spare. The entries are held in separate county files.

Database

This is a system of constant format records which can be arranged to file data on specific mill sites. The mill information can be gathered from fieldwork, etc entered into the data fields of the record form, filed into the storage system and printed as required. The data retained in the records can be individually edited as desired, by the record holder. Individual records can be readily accessed. The file system can be

searched for examples of mills with certain features (the data fields to be searched can readily be altered).

This is a useful type of program for aiding the study of mills which are fairly completeand/or where details are known. The database program being used is not portable between different computers and will only run on the host or a very similar machine.

Future

The aims are to:

Index as many mills of all kinds as possible.

Analyse the results to produce definitive lists of contemporary mill sites according to condition and location.

Enter details of as many mills as possible into a database type record system so that constructional features can be analysed.

Use the above results to guide fieldwork so that important mills are not overlooked and journeys not wasted.

Develop the index further to include references to the existance of a variety of different types of record and their holders.

Above all, stimulate the study of mills in detail and encourage the keeping of organised records.

The following examples of index lists database froms, etc, were printed on a dot-matrix printer to fit an A4 page. They are printed here at a reduction of 0·7.

Example of a Disc File Directory

```
A: STAT     COM : PIP      COM : GEMPEN   COM : ALPHA    HW1
A: ALPHA    AV1 : ALPHA    SY1 : ALPHA    CM1 : ALPHA    NT1
A: ALPHA    CV1 : ALPHA    CO1 : ALPHA    CU1 : ALPHA    DR1
A: ALPHA    LE1 : ALPHA    DO1 : ALPHA    DU1 : ALPHA    ES1
A: ALPHA    EX1 : ALPHA    GL1 : ALPHA    LO1 : ALPHA    GM1
A: ALPHA    HA1 : ALPHA    CH1 : ALPHA    HT1 : ALPHA    HU1
A: ALPHA    IW1 : ALPHA    KE1 : ALPHA    LA1 : ALPHA    LC1
A: ALPHA    NF1 : ALPHA    NH1 : ALPHA    MS1 : ALPHA    BE1
A: ALPHA    NU1 : ALPHA    NY1 : ALPHA    BU1 : ALPHA    OX1
A: ALPHA    ST1 : ALPHA    DV1 : ALPHA    BAK : ALPHA    SH1
A: ALPHA    SF1 : ALPHA    SR1 : ALPHA    TW1 : ALPHA    WA1
A: ALPHA    WM1 : ALPHA    WS1 : ALPHA    WY1 : ALPHA    WT1
A: ALPHA    SO1 : COUNTY   NUM : COUNTY   IND : ALPHA    BK1
A: $$$      PEN
```

EXAMPLE OF A COUNTY ALPHABETIC LISTING.

WATERMILL INDEX.

COUNTY ALPHABETIC LISTING.

BEDFORDSHIRE.

PLACE NAME	.MILL NAME	. No.	NAT-GRID.	CONDITION.	DATE.	RECORDS
Ampthill	.Doolittle	.177.	TL027465.	Empty	. -73.	KM.PD
Ampthill	.Old Corn	.176.	TL036364.	Traces	. -67.	KM
Apsley Guise	.	.	.SP927363.	House?	. -73.	PD
Astwick	.	.189.	TL217385.	Incompl.	.09-81.	JS
Barton	.Barton Manor	.196.	TL087312.	Traces	. -67.	KM
Barton-le-Clay	.	.199.	TL076312.	Complete	. -81.	KM.PD.JS
Bedford	.Duck	.153.	TL054494.	Traces	. -65.	
Bedford	.Priory,Newnham	.191.	TL066494.	Traces	. -67.	KM.PD
Biggleswade	.Holme	.184.	TL185430.	Wks.Turb	.09-81.	KM.JS.PD
Biggleswade	.Franklin's	.188.	TL187444.	Empty	. -67.	KM.PD
Bromham	.	.152.	TL011507.	Workable	.09-81.	JS.PD
Bromham	.	.179.	TL002510.	Traces	. -67.	KM
Broom	.Stanford	.185.	TL171409.	Traces	. -67.	KM
Blunham	.	.183.	TL157518.	Derelict	. -67.	KM
Blunham	.South	.203.	TL154504.	Derelict	.09-81.	KM.JS
Campton	.	.193.	TL131378.	Derelict	. -73.	KM.PD
Cardington	.Mill Farm	.	.TL075485.	Traces	.09-81.	JS
Cardington	.	.172.	TL079489.	Traces	.09-81.	JS
Clophill	.	.151.	TL085378.	Disused	.09-81.	JS.AB
East Hyde	.	.205.	TL133170.	Working	.09-81.	JS
East Hyde	.New	.206.	TL122181.	Traces	. -67.	KM
Eaton Bray	.Bellows	.	.SP981196.	House	.09-81.	JS
Eaton Bray	.Edlesborough	.	.SP983191.	Derelict	. -72.	PD
Eaton Socon	.Duloe	.	.TL172603.	House	. -67.	KM
Flitwick	.	.200.	TL042347.	Working	.09-81.	JS
Flitwick	.Greenfield	.198.	TL054354.	Traces	. -67.	KM
Great Barford	.Old	.175.	TL128510.	Traces	. -67.	KM
Harlington	.	.195.	TL055313.	Gutted	. -67.	KM
Harrold	.	.	.SP951566.	Traces	.09-81.	JS
Heath and Reach	.Grange	.	.SP910273.	Converted	.09-81.	JS.PD
Holcot	.	.	.SP942383.	House	.09-81.	JS
Husborne Crawley	.	.	.SP964361.	Traces	. -73.	PD
Kempston	.	.155.	TL023476.	Traces	.09-81.	JS
Lansford	.	.190.	TL183413.	Modern	.09-81.	KM.JS.PD
Leighton Buzzard	.	.	.SP918256.	Gone	. -73.	PD
Maulden	.	.178.	TL073373.	Empty	. -73.	KM.PD
Millbrook	.	.202.	TL012386.	Traces	. -67.	KM
Millbrook	.	.	.TL010400.	Traces	. -	.PD
Milton Ernest	.	.204.	TL019549.	Empty	. -67.	KM
Oakley	.	.180.	TL007528.	Traces	.09-81.	KM.JS.PD
Odell	.	.	.SP966577.	House	.09-81.	JS
Pavenham	.	.	.SP988553.	Traces	.09-81.	JS
Renhold	.Castle	.181.	TL092509.	Empty	. -81.	KM.PD
Sandy	.	.173.	TL170487.	Gone	. -67.	KM.PD
Salford	.	.	.SP932393.	Derelict	.09-81.	JS
Sharnbrook	.Stoke	.154.	TL011591.	Converted	.09-81.	JS.PD
Sharnbrook	.	.	.SP999594.	House	.09-81.	JS
Shefford	.	.192.	TL147395.	Traces	. -67.	KM
Shillington	.Otewell	.194.	TL119356.	House	.09-81.	KM.PD.JS
Stotfold	.	.186.	TL224367.	Complete	.09-81.	KM.JS
Stotfold	.Taylor's	.187.	TL222384.	House	. -67.	KM.PD
Tempsford	.Estate Saw Mill	.	.TL157530.	Empty	.09-81.	JS
Toddington	.Mill Farm	.171.	TL022294.	Incomp.	. -67.	KM
Tottenhoe	.Doolittle	.	.SP990201.	House	.09-81.	JS.PD
Turvey	.	.	.SP938523.	Converted	.09-81.	JS.PD
Willington	.Mill Farm	.182.	TL118504.	Traces	. -67.	KM.PD
Woburn	.ParkFarm	.	.SP960332.	Preserved?		.PD

EXAMPLE OF A NUMERIC INDEX PAGE.

GB-WALES.

PANEL SM No.001-050.

WATERMILL INDEX.

INT.NAT. No	.GRID	.COUNTY .OLD-NEW	.PLACE/PARISH .NAME	.MILL .NAME	.CD.	.YR.	.RECORDERS .R1.	.R2.	.R3
001.	752259.	PM -DY	.St. Davids	.	.C	?.	65.	KM	
002.	744250.	PM -DY	.St. Davids	.Bishop's	.B	?.	82.		
003.	806259.	PM -DY	.Solfa	.Middle	.B	?.	82.	FG.	DJ
004.	95 24	PM -DY	.Nant-y-Coy	.	.?		.65.	FG	
005.	924137.	PM -DY	.Dreenhill	.	.?		.65.	FG	
006.	983016.	PM -DY	.Pembroke	.(tide mill)[corn]	.D	?.	65.	FG.	NMR
007.	991010.	PM -DY	.Pembroke	.Grove	.C	?.	68.	KM	
008.	753266.	PM -DY	.St.Davids	.Emlych	.C	?.	68.	KM	
009.	927199.	PM -DY	.Camrose	.	.?	5.	68.	KM	
010.	769273.	PM -DY	.St.Davids	.Gwyrhyd	.C	?.	68.	NMR.	KM
011.	984032.	PM -DY	.Pembroke	.Kingswood Farm	.C	?.	68.	KM	
012.	938087.	PM -DY	.Johnston	.Hayston	.D	?.	68.	KM	
013.	996205.	PM -DY	.Haythog	.	.?	5.	71.	DJ	
014.	997384.	PM -DY	.Dinas	.Hescwm	.A	?.	82.	DJ	
015.	853335.	PM -DY	.Abercastle	.	.	.	.NMR		
016.	942371.	PM -DY	.Fishguard	.Felin Isaf	.	.	.NMR		
017.	888350.	PM -DY	.Granston	.Great	.	.	.NMR		
018.	94350	PM -DY	.Granston	.New	.	.	.NMR		
019.	923137.	PM -DY	.Haverfordwest	.Denant	.	.	.NMR		
020.	959149.	PM -DY	.Haverfordwest	.Priory	.	.	.NMR		
021.	953162.	PM -DY	.Haverfordwest	.Town	.	.	.NMR		
022.	831274.	PM -DY	.Llandeloy	.Felin Wen	.	.	.NMR		
023.	967326.	PM -DY	.Llanfair Nant-y-Gof	.Trecwn	.	.	.NMR		
024.	821315.	PM -DY	.Llanrhian	.	.	.	.NMR		
025.	796310.	PM -DY	.Llanrhian	.Aber Eiddy	.	.	.NMR		
026.	834324.	PM -DY	.Llanrhian	.Aberfelin (corn)	.	.	.NMR		
027.	874223.	PM -DY	.Roch	.	.	.	.NMR		
028.	948198.	PM -DY	.Rudbaxton	.Slouth	.	.	.NMR		
029.	767245.	PM -DY	.St.Davids	.Cher Bwdy	.	.	.NMR		
030.	807245.	PM -DY	.St.Eloies	.Solva	.C	4.	82.	NMR.	DJ
031.	894361.	PM -DY	.St.Nicholas	.Felin Velindre	.	.	.NMR		
032.	809268.	PM -DY	.Whitchurch	.Caer-Forios	.	.	.NMR		
033.	806269.	PM -DY	.Whitchurch	.Middle	.	.	.NMR		
124.	884238.	PM -DY	.Brawdy	.Stooper's	.	.	.NMR		

Mills Research Group.
22-08-83.

EXAMPLE OF A DATABASE WATERMILL FORM.

```
      GRID:      .PLACE/PARISH:                              .COUNTY:
MILL NAME:                    .CONDITION:                     .RECORD DATE:
INDUSTRY:                     .ACTIVITY:                      .DATING:
WATERCOURSE:                  .SUPPLY?        .STORAGE?             .BACKWATER?
BUILDING,WALLS:               .ROOF:                    .FLOORS:  .BINS:
LUCAM:                        .KILN:                            .PEND:
WATERWHEEL:                   .DIAM    M.WIDTH    M.DEPTH    M.CONDITION:
ARMS:          .RIM:        .BUCKETS:        .SOLE:          .SHAFT:        .ADMHT
GEARING:                    .STEPS  .STONES:        .OVER/UNDERDRIFT:
1STGEAR:           .2NDGEAR:             .3RDGEAR:              .4THGEAR:
TENTERING:                  .DISENGAGING:                .STONE CRANE?
AUX DRIVE:                                .SACKHOIST DRIVE:
GRAIN CLEANERS:               .FLOUR DRESSERS:
SIFTERS:                      .ELEVATORS/CONVEYORS:
OTHER MACHINES:
OWNER:                  .USER:                    .RECORDER:
```

EXAMPLES OF COMPLETED WATERMILL DATABASE FORMS.

```
TL 001 GRID:282719.PLACE/PARISH:Houghton              .COUNTY:Cambridge
MILL NAME:Houghton            .CONDITION:Preserved      .RECORD DATE:06-83
INDUSTRY:Corn Milling         .ACTIVITY:Tourism         .DATING:18th C
WATERCOURSE:Great Ouse        .SUPPLY?Good    .STORAGE?Some     .BACKWATER?
BUILDING,WALLS:Weatherboard .ROOF:Tile              .FLOORS:5 .BINS:4th Floor
LUCAM:Yes,2                   .KILN:No                          .PEND:No
WATERWHEEL:Undershot Qty 3    .DIAM    M.WIDTH    M.DEPTH    M.CONDITION:All Gone
ARMS:          .RIM:        .BUCKETS:        .SOLE:_         .SHAFT:        .ADMHT
GEARING:Spurwheel             .STEPS  .STONES:10 pair.OVER/UNDERDRIFT:3over,2under
1STGEAR:Bevel       .2NDGEAR:Bevel        .3RDGEAR:Spur         .4THGEAR:Spur
TENTERING:Screw               .DISENGAGING:Lifting Jacks  .STONE CRANE?No
AUX DRIVE:Crownwheel & bevel from pitwhl.SACKHOIST DRIVE:Slipping Belt
GRAIN CLEANERS:               .FLOUR DRESSERS:Reel,Wire Machine
SIFTERS:?                     .ELEVATORS/CONVEYORS:Convevor
OTHER MACHINES:Sluice governor with speed indicator dial
OWNER:National Trust      .USER:National Trust      .RECORDER:CAWWS
```

Discussion

Freedman — I am concerned with the safety of records kept in this way. What are the risks, in practical terms, of keeping them in magnetic form ?

Bryan — Every time a file is re-written after editing, it is a new record. If when the disk wears it is re-written onto a new disc, it will last indefinitely. The risk is to a mature file which then doesn't move; the thing will just sit there, not being re-written. A horror storey I hear this summer was when a colleague went on holiday for two weeks, leaving a pile of discs on a window sill, in the sun. When he returned, they were unreadable.

Freedman — How about in storage, such as in a cupboard ?

Bryan — I think that is fairly safe. Another thing that happens is if the lubricant dries out; the result can be mechanical seizure which chews up the centre. I think magnetic tape is safer for long term storage. It should be safe for 10 - 20 years without any problems. Beyond 20 years I wouldn't risk it. If we are putting 10 years field work onto one of these systems, we should heed the warnings.

Plunkett — Keep photocopies.

Bryan — The thing to do is to photocopy a printout and distribute a number of copies.

Jones — While we await the optical disc.

Bryan — That is write only; you can't alter it.

Jones — Exactly; that is just what is wanted for a mature file.

Freedman — How much work is it to print out each time ?

Bryan — Very little; an A4 page can be printed in about a minute. I could run the printer faster, but I don't, to reduce wear.

Freedman — How many pages for the whole thing ?

Bryan — So far we have about 1400 windmills and about 4000 watermills, and the maximum we get on a page is 60, so it is currently about 700 pages. The watermill file is likely to grow substantially.

Freedman — So if you made a complete printout every three years or so to make sure it didn't get erased, you would be piling up a huge amount of paper.

Bryan — Yes, but I think that from time to time you have to say, 'This is a mature file', print it, and put it in the file. At that stage, it could be double-sided.

Jones — I am sorry to have to raise the compatibility problem !

Bryan — Yes, that is difficult. I have found that I can often read other people's discs, and re-format and print the information, but there is no hope of writing to them.

Jones — Maybe that is all we need. We are not alone; practically everyone is getting into computer records. There are other groups who could use

our material, but for different purposes, while others have files containing some material we could use. This summer I found three; the Welsh Folk Museum, the Carmarthenshire Museum, and the Royal Commission on Historic Monuments in Wales. The all have computers, all owned privately by members of the staff, and they are all watching results, preparing for the day when they buy an official system. They could all use our complete files in their own areas, but they do not want to process them in the same as we do. Software portability is therefore irrelevant. They merely wish to avoid the vast key-punching job of getting our printed lists into their machine. We could use material from them in the same way. The need is therefore to present the contents of our lists in machine-readable form. Unfortunately, everone will act without reference to anyone else, it is quite unrealistic to suggest otherwise. I don't know what we can do about it.

Bryan — With text files there should not be too much of a problem, but with a database them is not much hope, because the program is resident in the system. Tape is a much sheaper medium than disc, so once the readibility problems are solved, I think that is the way to go.

Jones — I agree. The database should not be too much of a problem, though. Surely the data can always be printed out, and therefore transferred to tape in that format, which is what is wanted. The recipient can always read it. If he then wishes to re-format it to suit his own system, that is his problem, but it can always be solved.

THE RAREST TIDE MILL

David Plunkett

My interest in tide mills derives from my involvement from an early stage in the restoration of Eling Tide Mill, near Southampton. In early 1975 it was a weak shell, but the main gearing and machinery was intact, though bady defective.

The history of Eling is reasonably well documented, due to being in one ownership for the past six centuries. Also, the church registers of St Mary's, Eling, commence in 1537. The freeholders, Winchester College, received it as an endowment, together with a reasonable parcel of land and water, from William of Wykeham in about 1382. He was a man of considerable influence and standing with church and state in his time.

Out of approximately 40 tide mill sites recorded along the south coast of England, only two remain with substantial fabric and machinery. Beaulieu has not been restored to date, but Eling has. The rare opportunity of investigating earlier mill construction at Eling during 1977 and 1978 was not officially recognised. Both existing and ancient sub-tidal construction and foundations were exposed for the provision of modern concrete foundations, but except for minor notes and measurements taken by myself in undercroft areas, very little recording was attempted, nor were many of the odd artifacts retrieved conserved. This was due in part to the known fact that the existing millwrighting is not very old, having been largely regeared and modernised by Armfield's of Ringwood in the 1890's.

The question is; what did the present form of construction and millwrighting replace?

Documentary and constructional evidence suggests a conventional waterwheel of timber construction. But in my opinion, this was not of long duration, being preceeded by a less conventional form of millwrighting.

Investigating an unknown form of millwrighting is plainly difficult, but evidence is available from three sources:

1) Original documented records of Winchester College.

2) Site investigation.

3) Existing tide mill forms in both the UK and Europe.

The first lease/indenture recorded is date 1418. There is then a gap in the information other than a list of leaseholder's renewals until 1675. In this year Lawrence Watts was appointed surveyor of highways for Totton and Redbridge. This would have included the road over Eling causeway, which was then the main road to Hythe and Beaulieu.

Records also exist in the period up to 1720 of an increase in local industry; principally fitting out ships built on the other side of the river at Redbridge, and to a lesser extent at Eling Creek. Exports of oak bark and other New Forest commodities were also shipped out. In 1728 a new watermill near to Eling was constructed at Nursling on the River Test, by Sir Richard Mill Bark, who was also the holder of the lease at Eling.

During the 1740's and 50's considerable damage and neglect resulted in repairs, building contracts, and millwrighting.

In the year 1742 the following items occur:

Surveying at Eling - Mr Switeur

Building contract to John Abbott of Eling: price £96 for bridge, mill house, tumbling bay and hatches.

Millwright contract to 'Willis' for conduit, wheel, etc.

in 1755:

Repairs to tumbling bay, apron and bridge, using Benbridge whitestone (from Isle of Wight).

After what appears to have been an extensive rebuilding phase, the following item occurs:

1785, 1st November; lease to John Chandler, Miller. He to take down and rebuild mill and millhouses.

No site investigation is known at the time of the demolition of the miller's house with its many additions in about 1956, but good photographs exist, including an aerial view of 1949.

Undercroft exposure and constructional excavation for new land bearing foundations in 1977-78 revealed evidence of earlier stone foundations and timber piling. See Fig 1. All the main undercroft walls are generally of brickwork and appear to be of modern construction, or at least after 1785.

The keystone of the inlet culvert to the wheels is incised 1755. The whole of this culvert under the road is of good masoned stone blocks but is not in line with the existing waterwheel.

A small section of circular masonry was found encased in retaining wall brickwork and existing foundation material adjacent to the mill wall. This small wall, vertical in plan, was accurately constructed with small joints and a dressed finish to the concave face. Depth of this stonework was in excess of 800 mm, as the iron bar used as a probe was of about this length.

Architectural survey and recording at Beaulieu Tide Mill has been to visible surface fabric, to date. The existing millwork here probably represents a similar picture to that at Eling proir to 1890, but there do not appear to any circular undercroft walls exposed to date. Reference to both Woodbridge and Carew Tide Mills does not reveal any archaeological or construction records prior to the existing fabric.

So where is this leading us - horizontal watermills in Britain are rare, and horizontal tide mills are unknown! Or could there be a different reason for the circular wall at Eling.

Only a few months ago I obtained a copy of the T I M S Symposium Transactions for 1965, which contains an article on tide mills in Portugal, by Fernando Castelo-Branco. This created new interest regarding the circular wall at Eling.

Portugese tide mills appear to be predominantly of the horizontal pattern. A number are still complete and possibly one or two are still working (Fig 2, 3). The waterwheels are in the region of 1·5 to 2 m in diameter, of either all timber construction or wooden paddles in a vertical iron shaft. The photographs of the wheel at Mourisca Moinho Mare on the estuary of the River Sado has 24 paddles of unusual pattern. One step gearing to two pairs of stones would appear to be the norm in this region.

Without making undue reference to Portugal, it is difficult to convey the practice of horizontal tide mills. I have found no reference to horizontal wheels in any other European coastal areas at this stage.

Reference to Portugese geography and geology has little in common with the south coast of England (Fig 4). In fact, earthquakes and coastal movements in the Tagus and Sado estuary areas aver the past centuries are markedly different from England.

So, what can we conclude from the information gleaned to date?

a) According to Castelo-Branco, 'These are the rarest type of tide mill surviving in the world'.

b) Horizontal tide mills were common in the coastal areas of Portugal, even on the Algarve.

c) No definite information links Portugese tide mills to horizontal mills in England at this time.

That does not rule out the possibility that the use of horizontal waterwheels was more extensive in the UK than would appear at present. I believe that horizontal waterwheels were once commoner than has been recorded for tide mills in the Atlantic and English Channel coastal areas. I recommend that members consider the possibility of older forms of mill when recording existing mills in Britain.

Discussion

Bryan — Most of the horizontal waterwheel remains in the British Isles are on Scottish islands, where I believe there is also a substantial tidal range, so in looking for this type of mill it might be as well to look around the bays and inlets of some of the islands.

Plunkett — Certainly Walter Minchinton said there was even a reported tide mill in the Orkneys. Now if there was, it is almost certain to have been a horizontal wheel - if it is something which has been and gone many years ago, that is.

Jones — But horizontal wheels vary enormously; about the only thing they have in common is that they are horizontal! For example, of those I have seen at first hand, in the Faeroes they are just like those in the Scottish islands; very small, crude, essentially family mills - low output, cheap. The others I have seen in central France. They are much better built, and there are two quite different types. One is rather like the illustrations of Portugese mills, where the wheel is not enclosed and a wooden spout directs water onto it. The other type is placed at the bottom of a masonry pit, with water admitted through a tangential slot. The pit is filled with a swirling mass of water, and the whole bucket area of the wheel is used. They are used on the large rivers, with a massive weir.

Plunkett — I tried not to confuse the horizontal waterwheel type with the tide mill type. What is the relation of the form of the wheel - do they need to be a different form of wheel for a tide mill? It depends on the water engineering before the water gets to the wheel.

Jones — That puzzles me, for the Portugese tidemills appear to be using the wrong type. We can see why the pit-type wheel was developed; it is a high-power wheel using a large flow of water at a moderate head. Those are the conditions we would expect in a tide mill.

Turner — Didn'nt Alan Stoyel find such wheels in Spain ?

Jones — Certainly. What I saw in France was the northern end of its range. A little further north in France, and there are no more horizontal wheels.

Plunkett — Horizontal wheels seem to die out once you cross over the border into France.

Jones — No, the border runs more or less across the centre of France.

Plunkett — I meant horizontal wheels in tide mills.

Jones — Ah, tidal mills are a different matter. We don't know about those between Portugal and Brittany, if there ever were any. But concerning the wheels; a tide mill is a large flow, low head plant, and to make full use of the impounded water, you want to run the pond empty, so for at least part of the working cycle it has a very low fall, but can still use a vast flow if the wheel can take it. Even if it is working inefficiently, it can keep working. For this, the jet-type wheel seems the wrong choice, yet they chose it, presumably for good reasons. They also geared it to the stones, which I have not heard of from elsewhere. Does all this have any bearing on Eling ?

Plunkett — The thing I see as tying it down is that most horizontal wheels are small diameter. The Portugese wheels do tend to be bigger than normal, and a horizontal wheel at Eling must have been large. The peculiarity at Eling is that the curvature of the wall comes within the head race, not the tail race, so it is at high level.

Jones — It could fit the pit-type wheel.

Plunkett — It could have been.

Jones — What diameter is it ?

Plunkett — The Eling one would have been about 2·4 m, from the curvature of the wall.

Freedman — What about the height of the wall ?

Plunkett — The height when I saw it, down to the present breastwork level, would have been about 1·5 m.

Bryan — If it had used horizontal waterwheels at some time one would expect three or four of them in separate channels.

Plunkett — The Portugese mills appeared to be in multiples of two, to get the output.

Bryan — Could the curved wall at Eling have been designed to resist water pressure, or streamline the flow ?

Plunkett — Not streamline the flow, that is certain. It could possibly be designed to help retain the wall for the causeway, but it doesn't tie up with the masonry of the rest of the causeway. But there is a lot of rebuilding. Certainly there was a great rebuilding phase in the 1740's, continuing on the causeway side in the 1750's. When it was leased to John Chandler in 1785 - 'He to take down and rebuild the mill and mill house. For the last 20 years they seemed to be rebuilding it almost at yearly intervals.

Jones — Is this curved wall at Eling still accessible ?

Plunkett — It is under the concrete foundations now; it is one of the piers which support the the floor. Part of it may be visible outside, but you would have to lift floorboards. The top of it would be about 250 mm below the floor joists. Eling is fairly well chronolated, in that most of the walls and floor levels can be attributed to certain phases, and this circular wall is the oldest section I found. It doesn't seem to relate to anything other than some of the masonry blocks which are use as retaining work within the undercroft, and I know they have been out and back again once already. Through all the times this place has been breached and dealt with, this section of wall has been retained.

Jones — If it was a horizontal wheel, could you put any limits to its date ?

Plunkett — It is certainly before 1742. I would say it is likely to be before the construction of Nursling Mill, in 1729. I have been trying to establish if Eling was out of action then, and they had to build Nursling Mill, because they were in the same ownership.

Bryan — They may just have had so much business that they had to have another

Plunkett — Quite possibly; it coming up to a period when the demand for food was increasing, though not so much as in the Napoleonic period, when there was a vast increase. I have some information on the population around Eling, and it did not increase rapidly until just before the advent of the railway. The it really shot up.

Jones — Local population is not a sufficient indicator near a port; provisioning ships could form a large part of their trade.

Plunkett — There was also the army. I am sure there was a big demand there, both for flour and animal feeds. Also, Eling was a minor port, and it was also an embarkation point at various times in history for the military. In fact, the Black Prince's archers left from Eling, before the battle of Crecy. There was also shipbuilding of various sorts.

Freedman — Could Eling Mill receive grain direct from ships ?

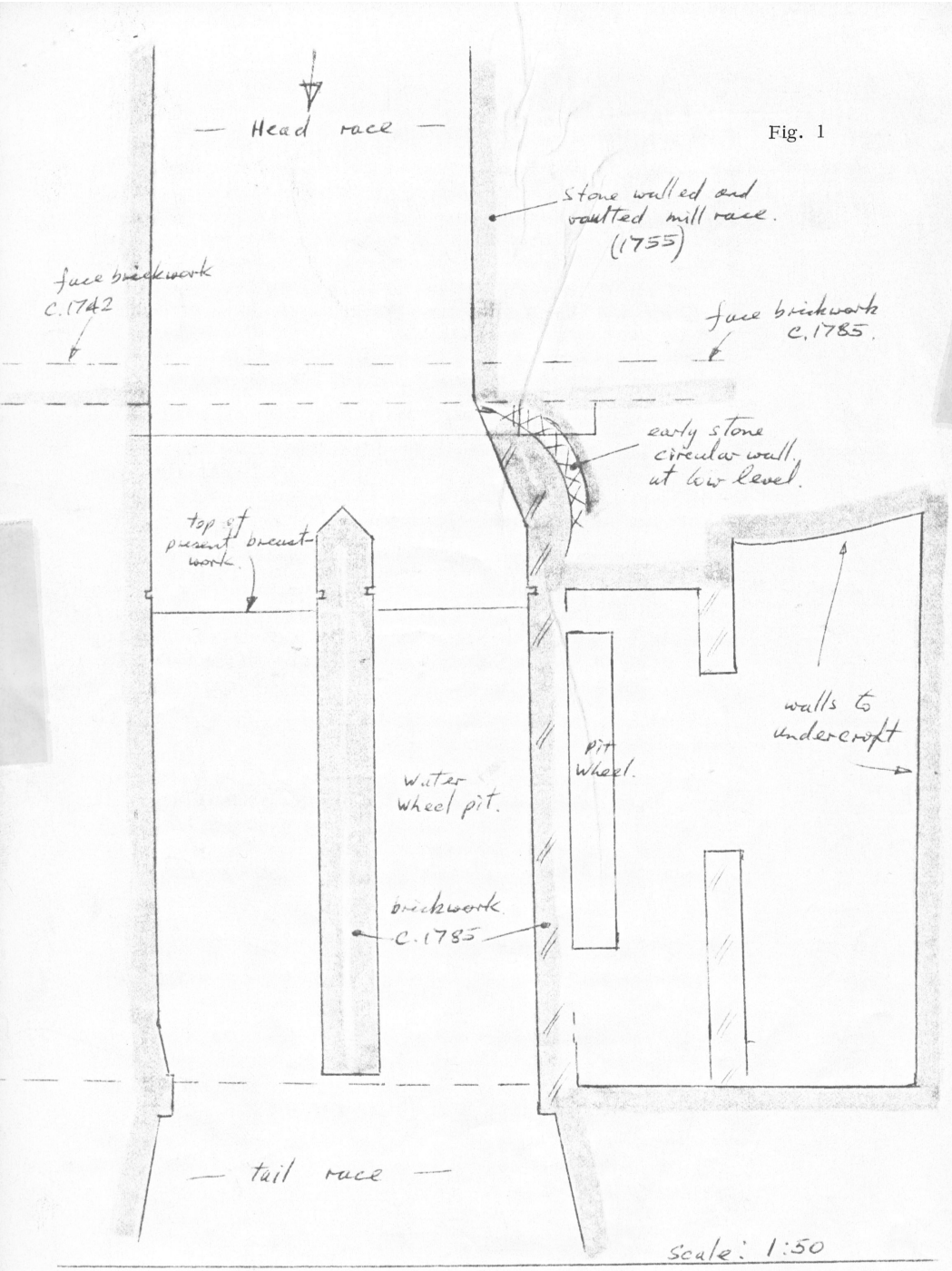
Plunkett — Yes. It certainly had a regular trade with the Isle of Wight.

Jones — That is surprising when we consider the huge milling capacity on the on the island.

Plunkett — The grain surplus there was always large, and it was regularly exported, I believe since Roman times. Another point I should perhaps look into is any possible connection between Eling and the navy; naval victualling ships coming up to Eling - that sort of thing.

Harverson — The period you mention would be a rather dead period - after 1713 until the 1740's. They were times of peace. From the 1740's, rebuild- the navy would be big time.

Fig. 1



ELING TIDE MILL — MILL RACE PLAN. c.1977.

DJP.83

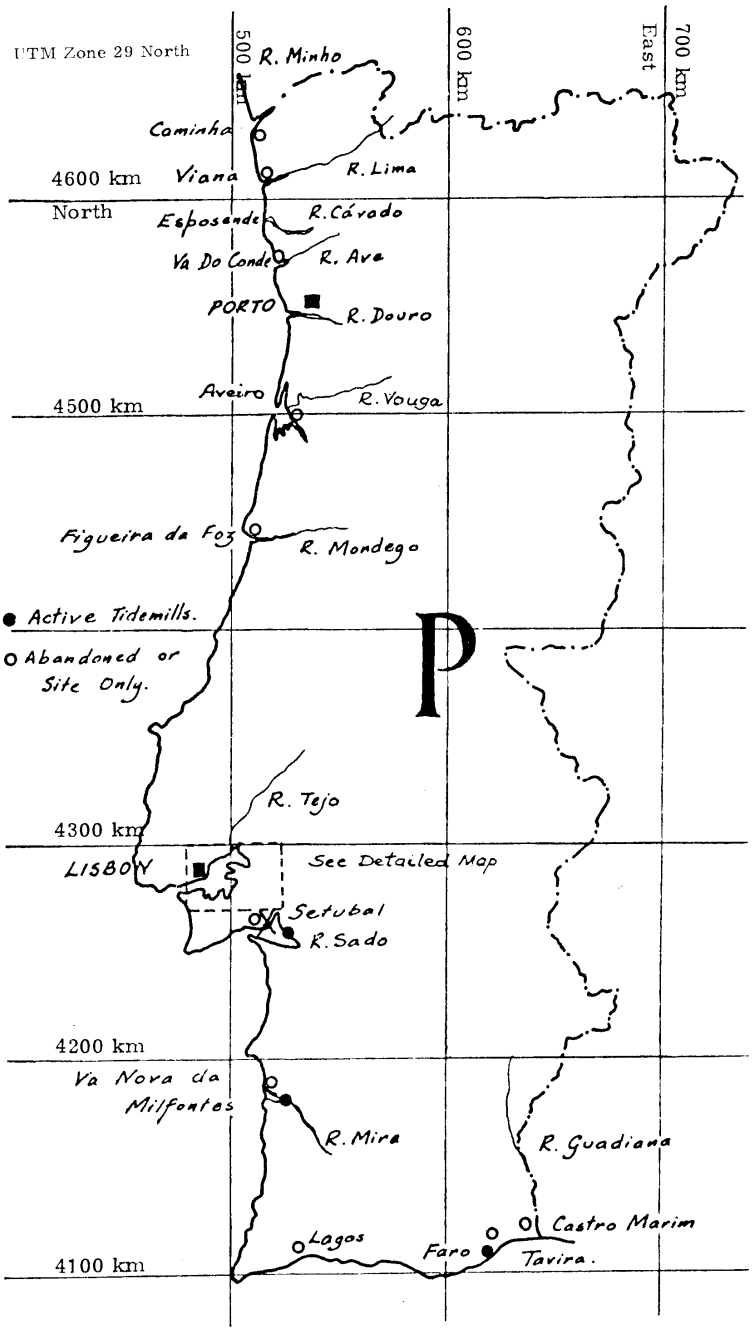
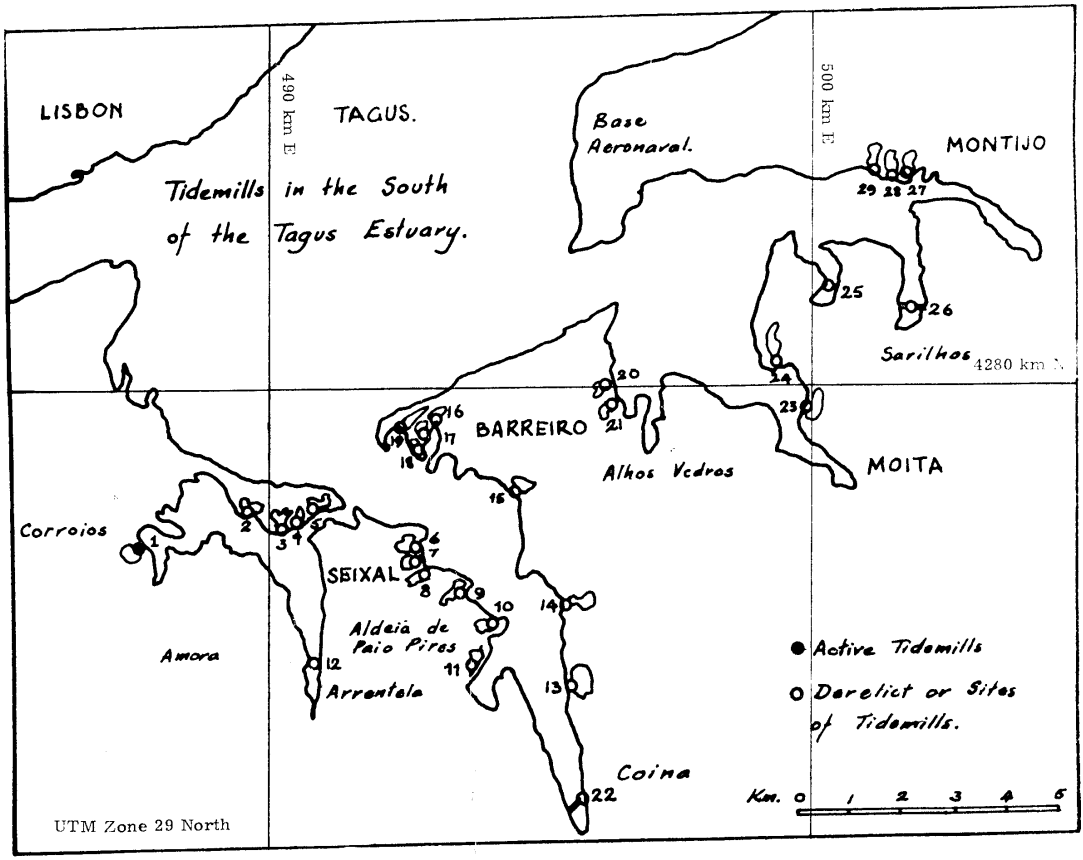

UTM Zone 29 North
500 km
600 km
700 km
East
R. Minho
Caminha
4600 km
Viana
R. Lima
North
Esposende
R. Cávado
Vá Do Conde
R. Ave
PORTO
R. Douro
Aveiro
R. Vouga
4500 km
Figueira da Foz
R. Mondego
Active Tidemills.
Abandoned or Site Only.
R. Tejo
4300 km
LISBON
See Detailed Map
Setubal
R. Sado
4200 km
Vá Nova da Milfontes
R. Mira
R. Guadiana
Castro Marim
Lagos
Faro
Tavira.
4100 km

Fig. 2


LISBON
490 km E
TAGUS.
Tidemills in the South of the Tagus Estuary.
Base Aeronaval.
500 km E
MONTIJO
29 28 27
25
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Sarilhos
4280 km N
20
24
23
BARREIRO
16
17
18
19
21
Alhos Vedros
MOITA
15
Corroios
1
2
3
4
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6
7
8
SEIXAL
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14
Aldeia de Paio Pires
Amora
12
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Active Tidemills
Derelict or Sites of Tidemills.
Km. 0 1 2 3 4 5
UTM Zone 29 North

Fig. 3

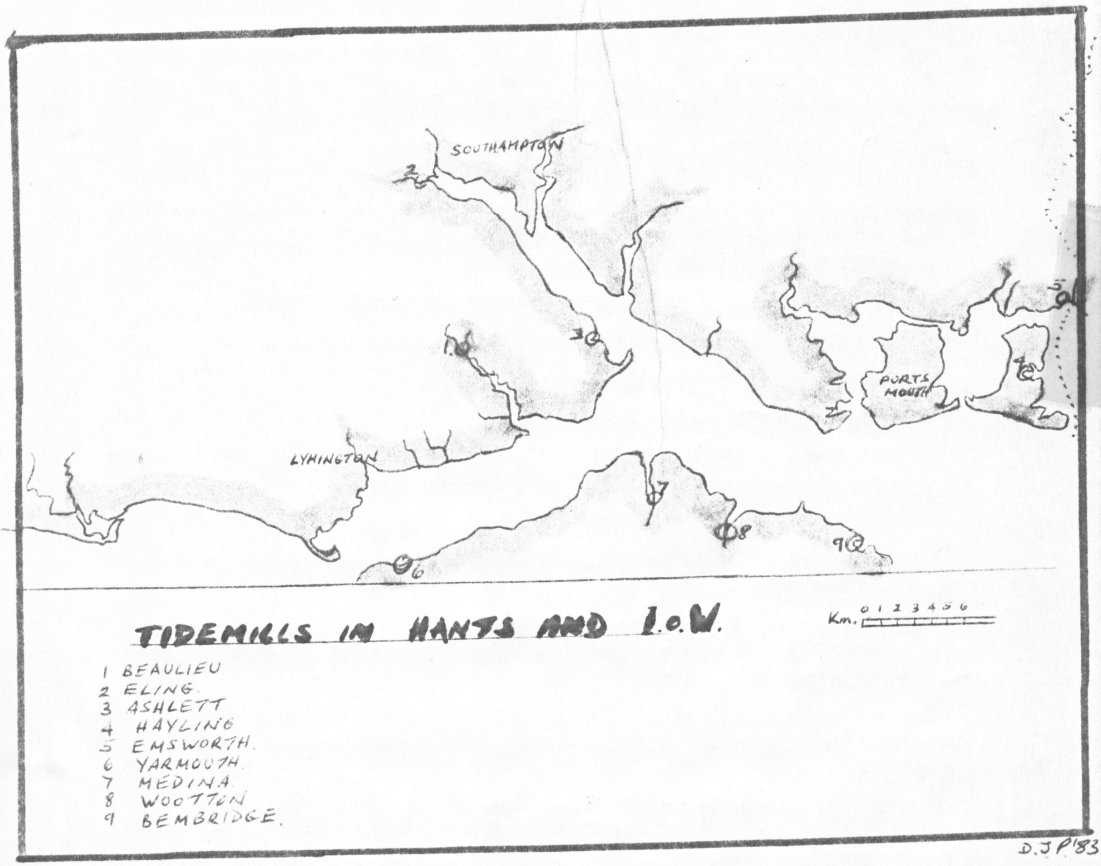

SOUTHAMPTON
PORTS MOUTH
LYMINGTON
TIDEMILLS IN HANTS AND I.o.W.
Km. 0 1 2 3 4 5 6
1 BEAULIEU
2 ELING
3 ASHLETT
4 HAYLING
5 EMSWORTH
6 YARMOUTH
7 MEDINA
8 WOOTTEN
9 BEMBRIDGE
D.J.P'83

Fig. 4

A NOTE ON THE MILITARY USE OF MILLS

Food Supply and Strategic Aspects

Michael Organ

This is a very recent study and I would welcome members' views on possible sources. To date I have collected five items:

1) A contemporary account of the siege of Colchester in the Civil War. It contains descriptions of several skirmishes; all attempts by the Parliamentary forces to capture or destroy mills in order to starve the garrison into submission. It also describes the efforts to counteract this by the use of horses to turn millstones, and by erecting a windmill on top of the Castle. (Carter, Mathew; 'Expedition of Kent, Essex and Colchester in 1648')

2) Description and drawing of a Field or Carriage Mill used by the military in 1735 (Beyer, J C; 'Theatrum Machinarum Molarium, oder Schauplatz der Mühlenbaukunst,' Leipzig, 1735, pp 79 7 80, and plate XXVII)

3) Print of a horse-drawn mobile military mill at thesiege of Lochum (Netherlands) in 1606. (original source not yet traced; plate from Major, J K; Animal Mills)

4) Description and plans of mills installed aboard ships to supply bread to the British forces at the siege of Sebastopol in the Crimean War of 1856. (Transactions of the Institution of Mechanical Engineers, 1858)

5) References in Bennett & Elton Vol 4 to the use of windmills in war:

   Edward III watching the progress of the battle of Crecy, 1346.

   Charles I witnessing the battle of Edge Hill, 1642.

   Charles I witnessing the battle of Naesby, 1645.

   Charles II escaping after the battle of Worcester. After hiding in the oak tree he rode the mill horse of the mill at Whiteladies near Boscobel.

The Field Mill as Described by Beyer

The following abridged description is based on a word for word translation of the original German text.

Field or Carriage-Mills were used by armies in camp where more permanent mills were unavailable. The carriage being drawn by two pairs of horses on the march and one pair when milling.

The mill was supported on a timber frame about 18' (5·5 m) long and 4' (1·2 m) wide which was attached by a swivel to the limber at the front and the wheel axle at the rear.

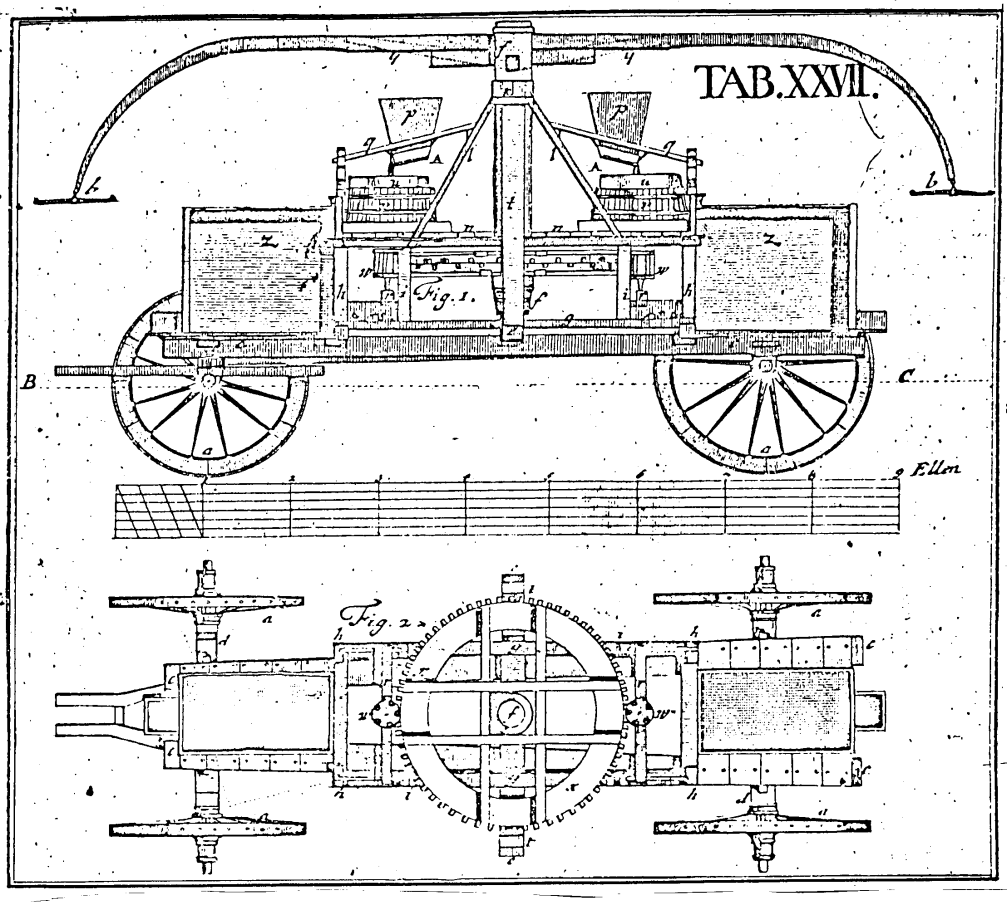
The upright shaft was set in a footstep bearing at the centre of this frame and steadied by a neck bearing, supported by struts about 4' (1·2 m) above the base. The top of the shaft was morticed to take a pair of horse arms. The horse arms curved downwards at their outer ends and were fitted with swingle trees. The diameter of the horse arms was about 23' (7·0 m). When milling, the carriage was sunk in the ground almost to the wheel hubs (line B C in Fig 1) presumably for stability and to and to bring the horse arms down to a reasonable working height.

The drive to the stones was by means of a clasp-arm spurwheel 5·75' (1·8 m)

in diameter with 60 cogs, engaging with a lantern pinion with five rungs each; a ratio of 12 : 1. The two pairs of underdrift stones were on a hurst frame and were about 2' (60 cm) diameter. They were capable of coarse milling only but a sieve was sometimes attached to make fine flour for the high-ranking officers.

On the march the horse arms were dismantled and stowed on the carriage. The hoppers, shoes, and their supporting framework were stowed in the meal bins. The bins and millstones were covered, like all military wagons, with oilcloth.

General Spinola of the Imperial Spanish Army used similar carriage mills in the field more than 100 years previously (to 1735).



Speed: Track diameter 23' (7 m), therefore circumference 72·3' (22 m)
Speed of horses: say 2·5 mph (4 kph) = 220 ft/min (67 m/min), therefore 3 rpm.
Gearing of 12 : 1 gives stone speed of 36 rpm.

Discussion

Organ — I would be interested to hear of any more sources. In particular, I don't know what happened in later wars, up to the time of the South African war. Of course, there was steam and roller milling by that time.

Harverson — Have you considered the effect on milling of this scare at the end of the 18th century, when we had this 'Posse Commitatus' recording milling capacity and mills round the coasts, etc.

Organ — I have only seen mention of it in John Vince'sbook on Bucks mills.

Freedman — It was originally a sort of manpower census.

Harverson — It includes all the mills.

Organ — It is useful for the local mills, but it wasn't a direct milling census.

Jarvis — You didn't mention the boat mill, which was a direct military invention, for countering the Goths besieging Rome in 547 A.D.

Organ — An amusing remark in the contemporary article in the Crimean mills; 'Modern armies render the soldier mor dependant on the cares of the administration than was formerly the case. The French, Spanish and other continental troops can live upon a moderate allowance of vegetable and farinaceous food, and a lump of oil cake will sustain a Russian for a week, but it is very different for the English, who become who become disorganised when their rations fail' !

Freedman — In case this may be relevant; Agostini Ramelli's book of machines contains many watermills, but he was a military engineer, and his book also contains a number of siege machines, so it might be worth searching the work for possible connections between the subjects. He is very theoretical, and says little of his experiences in battle.

Norchi — Are gunpowder mills military ? Most of their output was for this purpose.

Bryan — Presumably the sailing ships might have carried querns to grind fresh meal on board.

Organ — I am not aware that they did. The normal practice on ships of the 17th and 18th centuries was to carry their bread in the form of hard biscuit, even up to the Second World War.

Bryan — So there was no baking on board.

Norchi — And yet, on the last grain race, there was. They had fresh bread on Sundays, and Christmas, baked on board.

Jarvis — There were substantial galleys on the Mary Rose, which I believe included ovens.

Jones — A great deal of food would be needed; it was very heavily manned, with soldiers as well as sailors.

(After odd comments on Fairbairn's mill ships),

Organ — From the hold to the final bagging, all handling was mechanical. They also had something in the bakery which must have been revolutionary at the time - a kneading machine.

Bryan — In the confined space of a ship, mechanisation would have been essential.

Organ — It didn't take the cargo of grain, that was obtained locally. They mention how it had to be cleaned; it was very hard, and full of stones.

Jones — It is easy to see why it was mechanised, but a remarkable achievement in a rush job.

Jarvis — When the government decides it wants something and is prepared to pay for it, wonders can be done.

Organ — They didn't have to build it all - they bought the ship - but design and installation took three months.

DOORWAYS OPENING OFF THE STONE FLOORS IN SMOCK AND TOWER MILLS

Paul Jarvis

A number of Kentish tower and smock mills have external doors, which being well above the stage at meal floor level, open out into 'thin air'. Few mills having this arrangement survive and the use of these doors is open to cnjecture unless positive information is available.

The Evidence

A survey of Benenden smock mill showed a doorway leading off the stone floor. Its sill is some 1' 5" (43 cm) below the stone floor level. Woodchurch Lower Mill, which is currently being reconstructed has a similar which is kept in the new structure.

A study of 122 of the photographs in 'Watermills and Windmills' by W Coles Finch shows this door clearly on one tower mill and eleven smock mills, with a possible one more tower and four smock mills possessing it. As photographs show slightly less than halfway round a mill, these figures should probably be doubled at least.

Their Use

The true purpose of these doors is uncertain, but their use may be surmised. One is lead to presume that the door is in essence a maintainance facility, but that with the clear infrequency of use it could be troubled with rusted hinges etc, besides water ingress problems. It seems likely that the south to west sides were avoided.

One may suppose that the door was used to bring in and out machinery parts which are too big to handle via the stairways or sack hoist route, but the infrequency of this requirement would hardy seem to warrant fitting a doorway for the purpose.

Perhaps a more frequent use was the handling of millstones which would otherwise need floorboards to be lifted for passing them up. However, the doorways do not seem to be well suited to this as the weight would necessitate powerful lifting equipment which requires a good suspension point. Another problem would be to avoid damage to the smock weatherboarding and the even more difficult one of negotiating the stage, which when spring sails or common sails were fitted would typically be some 8 - 9' (2·5 m) wide and even further than this distance from the doorway situated part way the sloping side of the mill. Tere is a possibility of finding a suitable anchor point on the cap if it were turned to an appropriate position.

Unanswered Questions

1) What was the true purpose of these doorways?
2) Why did only a small proportion of mills have them if they were of material benefit?
3) What sort of lifting arrangements were used if millstones were lifted?
4) What is the distribution of mills having this feature - are they confined to Kent or to th south east of England?

Discussion

Plunkett — Did you say that the feature occurs with most types of mill in Kent?

Jarvis — Smock mills and tower mills. I have found one tower mill which is pretty certain, and another which is rather vague. Many of the

pictures in Coles-Finch are of mediocre quality, taken from some distance away, and it ot always certain what markings on the side may be - whether a doorway, a patch of roofing felt, or what. That is why I have a number of possibles rather than certainties.

Plunkett — There is no difference in the position of these doors ?

Jarvis — No, they all appear to be one storey up from the stage, which is always at meal floor level.

Bryan — Are you sure that the level of the stage has not been altered, for instance when sails were changed from common to patent ?

Jarvis — I think it highly unlikely, as photographs exist of the mill when it had a wooden windshaft (though it had spring sails), which was replaced by iron in the 1890's. The joists of the stage were set into the brick- and there is no evidence that they were ever changed.

Davison — Would it be for use in constructing the mill, which would not be used afterwards ?

Jarvis — If such an opening were needed for that purpose, I feel sure they would have left that panel off and boarded it up after the machinery had gone in. The door was equiped with a pair of hinges and a fastner on the inside in the usual fashion of doors of the period.

Norchi — How about access to the sails ?

Jarvis — No, in this mill they came right down to the sails; there was no difficulty in getting to them at all.

Harverson — Was there a trap in the stage under it ?

Jarvis — The stage was in such poor condition when I first saw it, there was no possibility of surveying it properly. I am unaware of any traps in the stage, nevertheless, it is conceivable.

Bryan — What about light and air on the stone floor ?

Jarvis — This particular mill (Benenden) was better provided with light on the stone floor than any other mill in Kent. It has simply enormous windows which show signs of having been increased in size by about one half to a third, from old mortice holes. People have questioned the big windows, but they are shown in pictures of the mill when it had its wooden windshaft, so they are original - or genuine, shal we say.

Bryan — It was usual to work a windmill with the door open for a bit of fresh air -

Jarvis — On the meal floor, yes; not so much on the stone floor.

Bryan — Well, somewhere in the working area, anyway. Some of the post millers used to work with the door open - just the bottom half.

Jarvis — Oh yes, and Benen en Mill had on various floors - I don't remember how many, but probably four or five - little shuttered doors which I would expect to have been used as you suggest.

Norchi — Could it have been for clearing rubbish out ?

Jarvis — Well that is a possibility.

Norchi — Our experienc with a watermill was that it didn't take a lot to get it going, but a great deal of work clear the muck out. There is no other way, except sweeping it out, and in watermills you do get doors leading out to nowhere.

Jarvis — Yes, but a watermill is rather different. With a windmill, a door in this poition is a decided disadvantage from the weatherproofing point of view.

Harverson — Are there any hooks for suspending a ladder, as a fire escape.

Jarvis — No, I don't subscribe to that theory; it is a nice thought, but I very much doubt if it was a fire escape. It would be more reliable to go down the stairway you know than jump out of the upper door.

Jones — When you get to the stage, where do you go ? The only way down is back inside. It seems unlikely to be something that was used every day, as the chances are that the sails might obstruct it.

Jarvis — That wouldn't necessarily be such an impediment, because the prevailing wind came from the south to south-west. The door at Benenden was on the north-east, while the one at Woodchurch appears to be about north-west. The sails don't often come round that side. They pass through, but they don't dwell there for very long, as a rule.

Jones — I am sure that we can agree that this is a question worth answering. We can't dismiss them as a piece of ill-judgement; there are too many of them for that.

Jarvis — Exactly, especially as they were all done by different builders. But has anyone got any idea of whether they occur on mills elsewhere in the country ?

Bryan — We'll look for them now !

Jarvis — Well, it seems that we will have to let the matter rest for the moment, with no solution in sight !

ITALIAN WATERMILLS: PROBLEMS & PROSPECTS

Alan Freedman

There is very little information about Italian mills in English (1). There is not much easily accassible even in Italian, so the first problem is to get some general idea of the distribution and typology of Italian mills, both extant and in the past. For present purposes I shal concentrate mainly on extant remains. Perhaps one

Perhaps one of the most striking and interesting aspects of Italian mills is the importance they had in the late 19th century for the entire political situation in Italy. In 1869, the new Italian State found it was very short of funds and the Finance Minister decided that the grinding of wheat should be taxed in order to make up the deficit. The novelty an 'beauty' of the plan was that the system of taxation was to be based on a meter worked from the revolutions of the millstone, and hence produce a perfectly equable tax. In practice, the system worked extremely badly; The price of bread shot up, while the smaller millers (which meant most of them, in Italy) could not pay the tax and threatened to close their mills. There were inspectors standing around in mills trying to assess or re-assess the amount taxable, and there were riots in which many people were killed. The tax struggled on until 1880, when it was repealed, but it is a striking and unusual example of a direct political and social influence of water mills.

The particular relevance of the tax in this context is that it led to a Royal Commission. It published its findings in 1872, and from these we can deduce that the number of mills in Italy at that time was approximately 74 000. I have made a modest start in trying to work out their distribution, particularly in relation to the type of wheel.

In some Alpine areas such as the Dolomites, particularly in the Cadore area (Fig 1), it seems to me that there are very many examples of corn mills closely associated with sawmills, and frequently, a forge. The sawmill is of the type known as " "Veneziana"; a reciprocating frame saw type in which the logs are fixed to a heavily-built trolley with a back, against which they are jammed with various types of wedges. I have not space to describe this system of sawmill in detail, but there are one or two points of interest in the context of our present discussion. Millwights for this type of sawmill seem to have come from Pusteria, a valley to the north of the Cadore area, which was formerly in Austria. Is this basically an Austrian type of construction? However, the mills of this area seem to have been part of the chain of the supply of timber to Venice; so here is an inherent conflict to be resolved.

I have already mentioned that this type of sawmill seems to be generally associated with a corn mill, and frequently a forge, on the same site. These were all driven by small-diameter waterwheels (average 1·2m) with a steep wooden chute down from a wooden launder, each with its own separate chute and separate mechanism inside. The gearing is almost universally a one-step trundle type.

It is not unusual to find five waterwheels fed from the same launder. A typical arrangement of this kind can be seen in Fig 2, where to the right of the illustration are two mills belonging to two different families; the one with living quarters (note the kitchen, "cucina") and to the left of the sawmill ("**segheria**") belonging to the same family as the first mill. In certain mills built expresly for the use of a particular family or village, the several functions performed by water power have been combined into the one building, and a good example can be seen from the sketch plan in Fig 3. Here, a turbine (dated 1891) drove two pairs of stones, a pair of edge runners for crushing barley, and a sawmill.

The ground floor houses the turbine in a separate compartment with a shaft going through the wall. A gear from this drives the lineshaft, which carries large wooden pulleys, approximately 1·2 m diameter by 300 mm wide. These are connected by belts to the trundle gears for the two pairs of stones (whic are on the floor above), and to the edge runners on this floor. Another belt nearer the turbine drives the crank and pitman of the reciprocating saw. On the first floor we find two pairs of stones with stone cranes, and in a separate room, the six-metre long trolleyof the saw. There is no place here to describe this mechanism in detail.

Other mountain areas seem to have contained large numbers of horizontal wheels. The article by Philip Grant describes a number in Tuscany, while a study of Pistoria in the Middle Ages, of approximately 350 corn mills described in mediaeval documents, there is no discernable trace of any vertical wheels. However, in this area, even in the Middle Ages there must have been vertical wheels in the towns for industry. Indeed, if we look at the old town plans of some of the cities which were well supplied with water, such as Padua (Fig 4), there are clear signs of vertical waterwheels on the watercourses. Many can be identified from street names; for example, fulling mills, corn mills, etc.

In the plain, however, a different pattern emerges. To this day there some (though perhaps not many) waterwheels still working in the Veneto plain, i.e, in the same region as the mountainous area described under sawmills. I found two close by, in this area with Poncelet-type wheels coupled to electric motors (the output was about 35 H.P. from the wheels and slightly more from the electric power). These large vertical wheels in the plain pose the further problem of why these should have survived to drive modern roller mills rather than others. In this case I would suggest that the particular river where these are found furnishes a peculiarly reliable water supply. It is astonishing to find a full river of limpid green water in the height of a very dry summer in August. It appears that the river is never subject to drought or flood as it only arises about 15 km from the first of these mills, emerging from the ground as a series of springs.

Here then we have various types of mill, various systems, and various problems to be investigated. Fortunately some useful serious studies are now emerging; e.g, a detailed study of the grist tax crisis, a recent manual and glossary of modern roller-milling including historical accounts of various parts of milling machinery, and a study of the industry of a valley in Piedmont, including tilt hammers, etc.

In conclusion, I consider that the prospects ar good of being able to construct an overall picture of milling in Italy, based on fieldwork and documents of every kind (including printed works, family histories, archive material), and of course, local informants.


Pusteria
ALTO ADIGE
Bolzano
TRENTINO
Trento
Cadore
FRIULI-VEN.GIULIA
VAL D'AOSTA
Aosta
LOMBARDIA
Milano
Trieste
VENETO
Torino
PIEMONTE
Venezia
Padua
Areas mentioned
EMILIA-ROMAGNA
Genova
Bologna
LIGURIA
Firenze
Ancona
TOSCANA
MARCHE
Elba
Perugia
UMBRIA
Giglio
L'Aquila
LAZIO
ABRUZZI
Tremiti Islands
Roma
MOLISE
Campobasso
SARDEGNA
CAMPANIA
Bari
Ischia
Napoli
PUGLIE
Capri
Potenza
BASILICATA
Cagliari
CALABRIA
Catanzaro
Lipari Islands
Egadi Islands
Palermo
SICILIA

Fig. 1

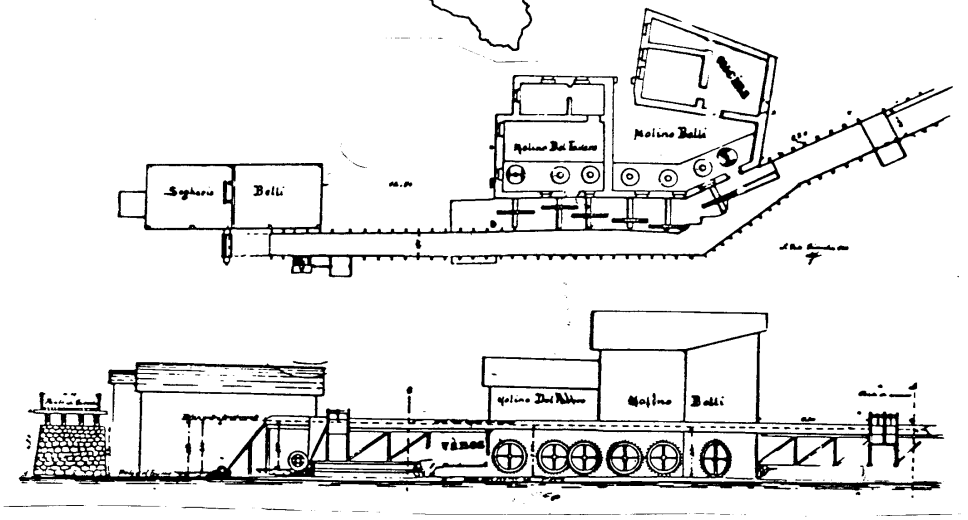

Molino Bolli
Molino Bolli
Molino Bolli

Fig. 2

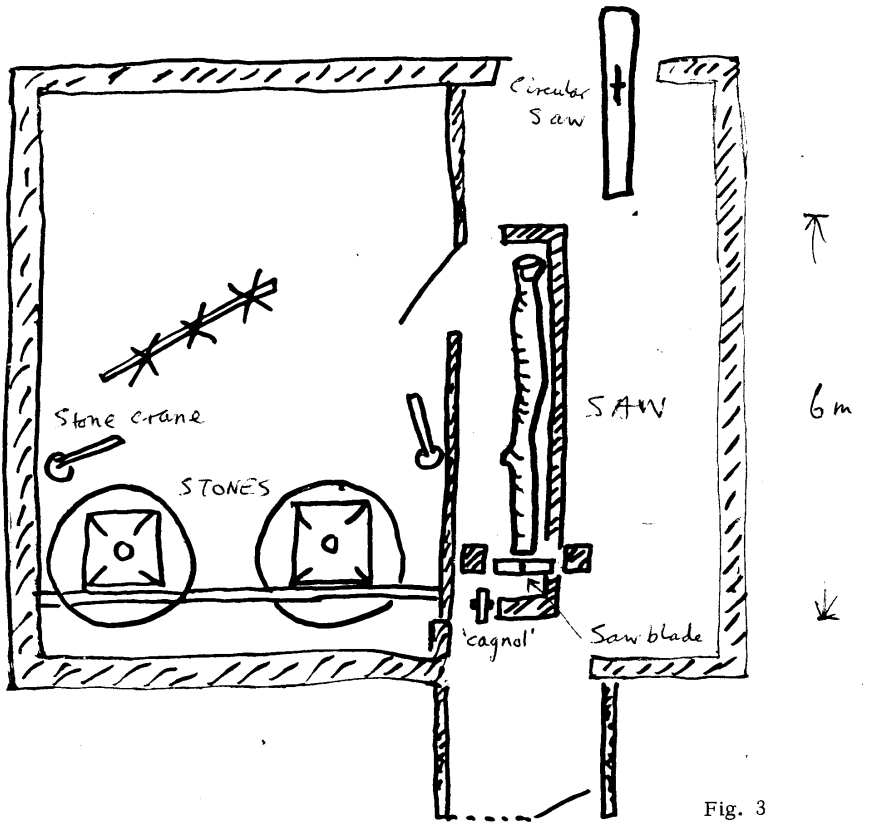

Circular Saw
Stone crane
STONES
SAW
'cagnol'
Saw blade
6m

Fig. 3

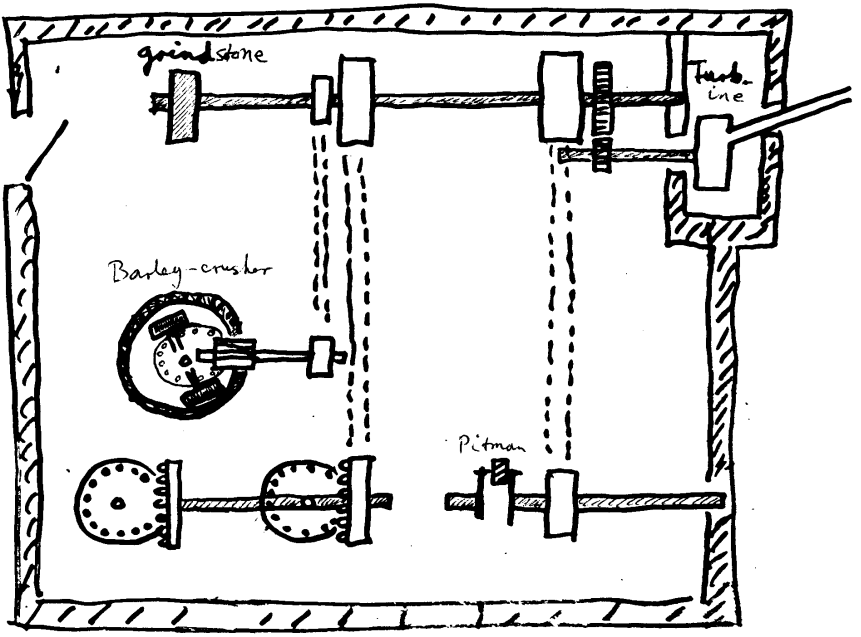

grindstone
Turbine
Barley-crusher
Pitman

Fig. 4. Detail from a town plan of Padua, 1680.

Discussion

Jarvis — I was surprised to see so much wooden gear, such as a lantern pinion driving a shaft to the stones; a lantern pinion makes a terrible drive. It works quite well as a follower, but is abominable the other way.

Freedman — In this area there is so much wood, they use it for everything - if they can avoid using metal, they do. They couldn't really avoid using a metal shaft with plates on the sides of the pulleys. They couldn't get castings for the pulleys - they just didn't have the facilities for it, whereas the local carpenter was used to making anything out of wood.

Bryan — In the early part of your paper you showed some waterwheels which looked more like Alpine wheels; that is, overshot wheels with a trough sloping steeply down to them. Is that what they were ? They seemed to be overshot, but it looked as if they had no sole boards.

Freedman — They are a normal overshot type of wheel, with closed buckets. I thought of it as a primitive turbine; it seemed odd to use such a small wheel to drive a sawmill. Why not use a big wheel, as we do, and gear it up ?

Bryan — That is how Alpine wheels are made; a very small wheel, hit by a very high velocity water jet.

Jarvis — Of course, Italy isn't very far from that sort of country, is it.

Jones — I have seen illustrations of that type of sawmill from Canada to Poland. The thing they had in common was plentiful water and a concern for cheap construction, without gearing. On another point, I wonder if was any Austrian influence in the corn mills. Do any of them have any internal decoration; are any mechanical parts decorated, particularly round the stones ?

Plunkett — You mean carved horse furniture, etc, this sort of thing.

Freedman — No, very little. I don't remember seeing any, and I would have noticed it if there were any. I know the sort of thing you mean; the kind of Austrian baroque floral decoration, scrolls and things. No, it is true that going north, it is quite a divide going over the mountains into the next valley. The architecture changes; it becomes much more Tyrolean, an Austrian type of architecture. In this area you get something similar, but it has an Italian stamp, not so decorated as the Austrian.

WATERMILLS ON THE CRAY AND DARENT

Robert Cumming

According to the Domesday survey, there were about 20 mills on the River Cray, and 35 on the River Darent. Now surviving on the Cray are the remains of four corn mills, a disused paper mill, a working paper mill, and the remains of a silk mill and a former iron mill. On the Darent there ten corn mills, three paper mills and a water-powered roller mill.

The Cray

Working upstream, there were two mills at Bexley. One of these was at Hall Place, a large mansion by the river. This was built in about 1750 and was demolised in 1929. The weatherboarding was white, like most Kent mills, and it had a stone ground floor. A few bricks, a wall, and a millstone are all that remains of it.

Further along the Cray is the Old Mill in Bexley. The Cannon family owned it from 1839 to 1907, and in 1884 they installed a steam engine, but the vibration so shook the buiding that it had to be removed. The mill was destroyed by fire on the 12th May 1966. Schooner Inns Ltd bought the site and rebuilt the mill as a resturant with an artificial waterwheel.

At Foots Cray, near Sidcup, was a fine silk mill. This was built by a Frenchman, Benjamin Harenc, in 1775. It was demolished in 1929 but a small portion remains under the road.

St Mary Cray had two paper mills. One was Joynson's Paper Mills, which were built in about 1820. It stopped work in 1930 and became Veg and Parchment Mills. Now there are only a few walls and outbuildings remaining. The other, called Nash's Mill is working commercially. It was built in 1817.

At Orpington there was a mill worked by the Hodsoll's, a resident family. It was demolished in 1937.

The Darent

The lowest mill on the Darent is at Hawley. I have not yet visited it, but I heared that it is very mutilated and used as a builder's yard. Darent once had a fine old mill, which was demolished, probably about 15 years ago.

There were once three mills in South Darent, of which two remain. The Old Roller Mill - built around 1800 - is now known as the Repitition Works Ltd. It is used for woodworking. Around the corner is Frog Lane Mill. It's apperance has changed completely, and now looks like a 1930's built house.

Going past Horton Kirby Paper Mills, we come to Westminster Mills, Horton Kirby, where ther is a small brick building which probably belonged to a watermill.

The next mill is the fine mill at Farningham. It has little internal machinery, and the stones were removed in 1900. The present building was built in 1790, next to a mansion now known as The Mill House. It is owned by the Colyer family, but is leased. It drove a circular saw until last Christmas and then stopped, but it may begin work again next spring.

Where Farningham borders on Eynsford, there were the Eynsford Paper Mills, which were the third paper mills set up in England. They finally closed in 1952. In the centre of Eynsford, by the Worten Bridge, is a very odd mill, with a barrel roof. It was

Probably converted into a house in Victorian times, but there seems to be no record of this.

We now take a long leap to Shoreham, where ther were once many mills at work. The Old Mill at Shoreham, built in 1826, is very picturesque, and was once thatched. It was converted into a house about 15 years ago and has no machinery left except the millstones. At Watermill Farm in Shoreham there is a Mill House which was once a large paper mill.

At Otford, near Shoreham, are the remains of a watermill. Half of it was burnt down in 1926, but the other half was saved and remained derelict until 1978, when it was converted into a house, with an upper storey added.

Chipstead, near Sevenoaks, has what is called the Old Mill. I have not yet been able to visit it, but I am told it has been converted into a house. At Brasted there is a mill built in 1881, now house converted. Nothing else is known about this mill and no machinery survives.

Finally, we come to Westerham, where because there were so many rivers, there were four mills. The last of these stood until about 1970, when it was controversially pulled down overnight. The river was dammed up, and now only half a wall survives. The Westerham Society are now considering rebuilding it.

I hope this survey proves that the Kent watermill index requires revision.

Discussion

Plunkett	I got the impression that most of the mills in this area are house conversions. Is that so ?
Cumming	Yes, the are all house conversions, apart from Farningham Mill.
Bryan	Does that have a wheel, or is it a turbine.
Cumming	I haven't seen a turbine, but if it was working up to last Christmas, it must have some power source.
Bryan	If there was a large waterwheel, surely the owner would be sure that he had it !
Cumming	He is not sure what he has. The visible drive shaft is like a horizontal wheel.
Bryan	In which case it would be a turbine.
Jones	It is a very ornate building; presumably a lot of that decoration is fairly recent.
Cumming	It was built like that in 1790, and hasn't really changed at all.
Jones	Even with the birds on either side ?
Cumming	Oh, they have always been there.
Jones	This is really a most interesting item, as that sort of elaboration in mill buildings is so unusual.
Freedman	Is it brick and weatherboarding ?
Cumming	Timber framed. Many mills in West Kent are timber and white weatherboarding.

UNDERGROUND MILLS IN IRAN

Michael Harverson

This contribution forms part of the study of the question : how much water to drive the mill ? Most of the examples, at first hand or drawn from the literature on the subject so far as the Middle East is concerned, are horizontal mills in Iran or Afghanistan.

Few traditional mills work here now, except in villages remote from main roads, unconnected to the electricity grid and too poor to afford the fuel (Iran's major product, after all) that would power simple mechanical mills. Once, however, water had to be husbande and organised to produce the flour needed by a nation of bre d-eaters like the Persians. How much science, in their bones rather than in any books, went into the arrangement of a horizontal mill in a Persian village or town ? And, viewed from an almost archaeological standpoint in 1983, how efficiently did they make use of their water supply ? Figures are hard to come by and very few mills have been recorded in Iran. Now it is almost too late: there is no enthusiastic and confident small watermilling fraternity in Iran as ther is in Britain and other parts of Western Europe.

My currently unresolved questions are to do with the establishment of a head of water and the power provided by a traditional penstock, especially when these are required by a genuinely subterranean mill. Apart from the authorities quoted, I have yet to include and consider properly the Cretan findings of N G Calvert. A useful study of the underground water system of Iran appeared in last year's journal of the British Institute of Persian Studies and has been briefly referred to here. Additional fieldwork in Iran and Afghanistan has been well-nigh impossible for about five years now, owing to the political situation in both countries, so one theorises on very incomplete and inadequate evidence !

A century ag the British consul in N. E. Iran recorded during his travels in west Afghanistan, 'At Sadat I found a curious watermill. The water channel, which was on the surface, dropped some fifteen feet down a brick well and turned the mill in a hole in the ground at the bottom, the water running on underground in a fresh channel until it came to the surface again lower down" (Yate, C. E; Khorasan and Sistan, Edinburgh, 1900).

An interesting, though disused example of just such a horizontal mill was seen by me in 1977 near the village of Salameh in east Iran. This mill had two brick-lined wells at the end of a long leat. One was for wheat, one for barley, I was told. How much thought went into sinking the two, rather than just one ? One clue may be that it was an estate mill, since it is near the big house with its former population of family and servants and their needs as a predominantly bread-eating community.

The water supply, open to evaporation over a surprisingly long distance, came from either a subterranean conduit or a stream below the dam. This lofty stone dam, five or six km further up the valley, represented a good power source, yet unused. Surely it would have been easier to take donkey loads of grain to a mill beside the dam rather than go to the great labour of excavating and shoring up safely this spacious subterranean millhouse ? Spreadeagled on the shallow mud dome, I squinted through the aperture at its centre into the murk below and estimated seven to nine metres to the floor.

A further puzzle is the arrangement of the tailrace. The land was certainly

dropping perceptibly, but the tailrace tunnel must have continued for a long way before before it reached the surface. My failure to carry out more observations must be put down to the heat and the dire effects of the excellent meal the estate steward provided me with in the big house. He was far more interested in horses than disused mills and gave me little information.

At the beginning of the twentieth century, when the village numbered only five hundred inhabitants, the surplus of corn grown locally and exported was remarkable, yet at the same time the dam, capable of irrigating a hundred ploughs of land, was in a ruined state. (Adamec, L; Gazeteer for Meshed and N E. Iran, Graz, 1981). Perhaps the mill was built at that time.

I imagine only one pair of stones worked at any one time, if for no other reason than that the long open leat and complicated arrangements for water distribution would only supply the mill with a limited amount of water. The "sang-i asiab", the amount of water needed to turn a mill (without benefit of a penstock) was reckoned at 280 l/s (Noel, E; R C. A.S. Journal vol 31, 1944, p192). The two penstocks here, comfortably wide enough to climb down and repair, would have held enough water at a good height, but who knows how often the water was in fact below the optimum level for such a penstock? Avitsur recommended 4-8 m (On the History of the Exploitation of Water Power in Eretz-Israel: Tel Aviv, 1960, p viii). As the water supply slackened, the miller should have inserted smaller bore nozzles in the jets if he worked his mill on the pattern described by Hans Wulff, a respected authority on Persian technology in the 1930's and 40's. He gave teutonically detailed figures to link head of water, bore of nozzle, power output, speed of stones and grain throughput in a Siraz mill, though how reliable the figures are and how he measured them remain unknown. The head of 7·6 m remained constant; in the winter and spring a 115 mm diameter nozzle permitted 164 rpm, ca 10 hp (7·5 kw) and ca 150 kg of grain ground per hour, whereas at the drier end of the summer a 76 mm nozzle reduced the power output to 4·5 hp (3·3 kw), speed to 151 rpm, and throughput to ca 70 kg per hour (Traditional Crafts of Persia, M I. T, 1966).

Persian penstocks do not caontain the waterwheels and so are not turbines. What then is the relation between the kinetic energy and pressure when the water head emerges at the base of the penstock to hit the wheel in a jet? Presumably the velocity of the jet is what matters in the creation of power? The velocity is conditioned by the head and the diameter of the nozzle and then exerts its own pressure on the blades of the wheel. In Persian examples these blades are only very roughly and shallowly scooped, if at all, to utilise the weight of the water in addition.

Two final considerations before leaving the mill at Salameh. Firstly, perhaps the running of several pairs of stones simultaneouly in any but a tide mill is and was the exception rather than the general rule. Water supply is only one possible reason for this. I am reminded that the water stored in the millpond at Lode, an English watermill, will only last for about two hours when running the mill at full capacity; it must be run lighter and one pair of stones is dropped out. Secondly, on a big estate where the landowner's word was law experiments with milling might have been carried out, even in Iran. It certainly happened in 19th century Hungary. Water measurement has been got down to a fine art by Persian peasants; they would know how much water to expect in that long leat unless the winter had been very dry and short on snow. They may have sensed that this grand double-welled mill - dreamed up in the landlord's Tehran office rather than a local pragmatic notion - was doomed to become a white elephant before long.

Water above ground is unusual in Iran. It is kept below the surface for as long

possible, to avoid evaporation. It seems that mills were placed partially or even completely within a system of coduits or 'qanat', which tapped natural reserves of water deep below a mountainside, for the sake of agriculture, 15, 25, even 30 km away (see diagram 39, Beazley, E, & Harverson, M; Living with the Desert, Warminster, 1982). Watermills within the system are referred to briefly by Wulff (op.cit, p.282) and by Bonine, M E; in Iran XX 1982, p 148. The average flow in the qanats of Iran has been estimated at 42 l/s (Noel, op.cit. p192). You will recall that the sang-i asiab was 280 l/s. Therefore a sharp fall within a qanat is essential to create sufficient power to turn a mill. To obviate damaging turbulence at this point (if a sudden fall of several metres is incorporated into the qanat) and for some distance down the millrace section of the qanat, hoops of fired clay must have been carefully inserted. This is common practice when tunneling a qanat in unstable soil. Would the water have fallen down a chute, or would the qanat have been greatly enlarged to form a penstock, or would the mill and penstock have been built in a bypass tunnel ? I find the last suggestion most likely. I say 'must have been' and query the method of water supply at the mill because I have yet to come across a mill within a qanat, as opposed to one near the exit, or to one at the start, as at Salameh.

Did this modern geographer invent the system he described 25 years ago ? For what follows sounds more Roman than Persian engineering. "Where the slope of the ground is sufficiently steep, the qanat canal may continue as an elevated aquaduct until it is some ten feet (3 m) abouve the ground level when the water is dropped to operate a grain mill, half underground. The water may then continue, first in a qanat tunnel and again in an aquaduct to operate a second mill. Sometimes there is a series of mills, all underground, where the qanat stream does not appear above the surface at all" (Cressey, G.B; Geographical Rewiew 48, New York 1958, p29). He gives no sites or references. I should be glad to be convinced, but seeing must be believing. At present, in Khomeini's Iran, where much is expected to be taken on faith - Islamic faith - that would be a hazardous undertaking.

There are very few references to definite mills in qanats in travel literature; one seen near Natanz in the 1930's at a depth of 6 m had its stones 'propelled by the force of the stream underneath acting upon a paddle wheel' (Filmer, H; The Pageant of Persia, London 1937, p129). But the tourist did not examine the mill in any greater detail.

The maximum flow quoted for any qanat in the most recent book on the subject is only 226 l/s (Goblot, H; Les Qanats. Une Technique d'Acquisition de l'Eau. Paris 1979, p 42). The author also says that he has come across no mills turned by qanats still working in Iran. Since the usual gradient is 0·5% it would seem that somehow a penstock would have to have been constructed within the qanat. The fall need not have been more than a few metres; Alan Stoyel has recorded a Spanish horizontal wheel, under a 2 m head, driving a sawmill, and measured another fall of only 75 cm. (Spanish Watermills, SPAB Section meetings, November 1978 and 1979). Avitsur estimated that a 2 m head and a 55 cm pair of stones would require a flow of 85 l/s for adequate operation (op cit. p viii); quite within the capacity of a Persian qanat (which was not in his mind at the time). An arubah penstock of the standard 4 - 8 m size would power 100 cm stones and require a flow of only 15 l/s.

It would be interesting to know the flow that fed the Cretan penstock at Zaros visited last year by Frank Gregory; its height was 12 m and its diameter 900 mm. Over a century ago Fairbairn noted that a small diameter penstock needs a greater head to overcome friction, but that it also requires a far lower rate of flow; thus a

900 mm pipe and a 1 900 mm head needed 8·5 l/s, whereas a 1 800 mm pipe and a 970 mm head needed 37 l/s. What happens to the friction factor if an attempt to increase velocity (in Fairbairn's case, 2·1 l/s) the head is raised and the large diameter is retained ?

No Persian peasant building or operating a mill is likely to ask himself precise questions about friction. If the mill has been modelled on others in the neighbourhood he expects it to work with tolerable efficiency and minimum maintainance. That is all he asks for. The water supply, so often from qanats in Iranm except in the mountains, has set bounds to that efficiency. If it fails or decreases, the miller will lessen his expectations and seek other means to eke out a living. God gives man water. Improving on performance by the concious application of hydraulics seems to him a fantasy; more of one that waiting for electricity to arrive or going down to town with one's grain in a jeep to pay for it to be ground by a diesel-powered mill.

What interest me is the manner a limited water supply was still being used 30 to 40 years ago, when other options opened and watermilling began steadily to lose ground and give way without a fight - and scarcely even lamented. Does this sound very much like England a century ago ?

Discussion

Freedman — Do these qanats have to pass through rock ?

Harverson — They do at times, or more often, go round rock. It is mainly through alluvial soil; it's got to be soil through which little water is lost. The water they have tapped must go the whole way down to where it is needed. The loss of water into the surrounding soil even on a very long qanat - say a 30 km one - is reckoned to be not very great.

Plunkett — 30 km on the same gradient ?

Harverson — Yes

Plunkett — It must be very well engineered.

Freedman — It must be a very impervious kind of soil; with most the loss would be enormous. It must be lined with clay, or something of that kind.

Harverson — They normally only line the feeder channels at the head - that is the mountain end - for the first few km.

Freedman — Don't they use masonry at all, where there is any fall they can use slabs of stone.

Harverson — They could use it, but normally there is no need for it, until they get to the exit of the qanat. In the main part of the system there is no masonry at all.

Bryan — Were they able to actually dam the water in the wells so that they operated only part of the day from stored water, and so gain much more power for a short time ?

Harverson — If they were used now, the answer would be yes, for the qanat belongs to the person who has done the work; it is generally a big landowner who wants water for his village, and if he cares to install a mill, and rent it to a miller, then they agree on terms, and there is no problem.

Bryan — Did you say you have seen one ?

Harverson — I have seen where they were, and this puzzled me, for they have this huge drop of nearly 9 m, and to get that water back to the surface they would have had to take it on over a mile it must have been - I never did get to the exit. From where I was standing I couldn't imagine it reaching the surface at all. No one could reach there dry, and I did wonder then whether the whole thing might have been an elaborate white elephant.

Turner — What was the frequency of these mills, as far as you were able to judge, because surely every village would require one?

Harverson — That is very difficult to judge, like your Italian mills; you can almost walk over a watermill in Iran, and not know it is there. They are very often tucked down, and the same colour as the surrounding earth. To answer your question, the village I was staying in when I went up to this place hed windmills. It had 50 windmills and 5 watermills (this was in 1900) and a population of about 10 000. Then there were about 15 000 semi-nomads in the surrounding country, but they also had access to other windmills not very far off.

Bryan — With these watermills, are we talking about a single pair of stones and a waterwheel?

Harverson — Yes, a horizontal waterwheel.

Bryan — And the windmill would also have a single pair of stones? Nothing like the capacity of a European windmill.

Harverson — Yes. The generally-quoted figure for both wind- and watermills is 300 kg a working day. That's an average.

WATERMILLS OF SOUTH WALES

Interim Results from a Partly-completed Survey

David H. Jones

The place of Welsh mills in the national pattern has been known for some years, based on a survery in North- and Mid-Wales (1). The geographical conditions which influenced their design are not so different in South Wales, so it seemed reasonable to assume that the mills there were similar to those in the north. However, as there are significant differences between North and South Wales - cultural, linguistic, etc - it seemed likely that their mills might differ in style, even if their functional design was the same. In any case, the assuptions had to be checked, and a mill survey of South Wales was long overdue. It was one of the largest areas of Britain, outside Scotland, where the mills were almost completely unknown.

The area selected for this survey could be loosely descibed as 'Carmarthenshire and south Cardiganshire', but except for the deliberate exclusion of Pembrokeshire, administrative areas were ignored. Instead, the limits were set on National Grid lines, determined by the immediately available maps. Tracing mill sites in upland regions requires fairly large scale maps; the 1 : 25 000 is the minimum, and it was chosen for the economy as the total area was large - 2100 km^2 - and required many sheets.

The area finally chosen was as shown in Fig 1. Searching these maps revealed 181 probable sites (excluding the concentration of woollen mills Drefach-Felindre). The watermill indexshowed that 21 of these had so far been reported, together with a substantial number from Pembrokeshire (hence its exclusion from this survey). Those within this survey area had all been reported by the Royal Commission on Historic Monuments in Wales, and enquiries there showed that one of their main systematic survey projects was the industrial buildings in the South Wales coastal region. This work was dealing with the few mills remaining in this thoroughly urbanised district, which was therefore omitted from this survey. Other known surveys of parts of South Wales were judged to be too remote or too restricted to influence these plans (2, 3).

This year, 78 sites were visited, including four farm wheels not originally identified from the maps. The sites were deliberately chosen as scattered patches over as much of the survey area as possible, as this will still give a good overall view of the regional trends even if circumstances should prevent this survey being completed.

These 78 sites may be classified under condition as:

Traces only	12	Derelict	8
Conversions; no information	24	Complete	11
Conversions; some information	14	Working	5
Ruins; some information	4		

These categories are poorly defined, but give an adequate impression of the survival rate. As sources of information on mill design, the first and second categories offer none, the third and fourth provide some, and the rest are practically complete.

Applications

The uses of water power in this region were for corn mills, woollen mills, pandai, sawmills, and farm wheels. Two of the corn mill sites had at one time been iron forges, but nothing had survived from this period. No other applications have yet been found during this survey.

The corn mills were very numerous, and received most attention. Woollen mills were also common, but had been the subject of a previous study (4), so they were generally ignored. They tended to built in groups (42 in the village of Drefach-Felindre) and only isolated examples received any attention this time. Pandai had long been disused; only three empty buildings were noted, so many must have been demolished or absorbed into later woollen mills. Sawmills were surprisingly scarce. Only three were found, all associated with corn mills. Farm wheels were once very numerous, but few seem to remain, and they are extremely difficult to find. They were treated as peripheral to this study; any found accidentally were recorded, and local information followed up, but no attempt was made to trace them systematically.

Siting

Most of the survey area is drained by one of two rivers; the Teifi, flowing west into Cardigan Bay, and the Towi, flowing south-west into the Bristol Channel. The Afon Cothi, which joins the lower course of the Afon Towi, is the only tributary comparable in size to the main rivers.

As is usual in upland regions, these rivers do not power mills. Instead, the mills are sited on the small streams feeding them. Here the flow is adequate, if not always very constant, while the steep gradients enable a fall of 4 m or so to be concentrated at a mill site at a moderate cost in earthworks. The main rivers flood very easily and are too dangerous to use, unless controlled by massive and expensive structures.

The one apparent exception is Cenarth Mill (22/100), which stands on the bank of the Teifi beside a natural waterfall. At first sight it appears to be an obvious location for a mill, with a ready-made weir, but inspection shows it not to be what it seems. The mill is high above the normal river level, and the fall is hardly used. The head race is well above the normal level immediately above the fall - a level attained by a long leat tapping the river higher up.

Cenarth Mill operates with a small fall as the ample water supply drove an undershot whell, the only one seen during this survey. Otherwise it is like all the others; a leat tapping the natural watercourse and then following the contour of the bank until the natural course is far enough below it, where the mill is sited.

Farm Wheels

Only four intact examples were four intact examples were found, and in each case the machines the drove had been removed. They were all very similar; small iron overshot wheels placed in the open, with the drive taken from cog rings attached to the arms. The power was transmitted to the farm buildings by lengths of iron shaft joined by Hooke's couplings. Wheel diameters varied from 2·84 to 3·4 m, and widths from 0·61 to 0·77 m. They were lightly built, and generally cross-braced. One was fed by a cast iron trough, and the others were wood. Two wheels carried the makers name - 'Thomas Jones, Carmarthen' - and one of these was dated 1897.

Only one owner could give any information about the machines it had driven. He listed a thresher, a winnower, a sawbench, a grindstone and a butter churn, though not all were in use at the same period.

Corn Mills

In most respects the initial assumptions have been confirmed. The functional requirements of this region are similar to those of North Wales, but the mills are somehow 'different'. However, there have been a few surprises, and some of the differences seem to be due to something more than "style".

The most significant difference is probably in the kilns. They are just as universal adjunct to mills as they are in the north, and they are generally attached to the mill building. Internally, most had square vertical-sided brick stoves, topped by the kiln floor, standing in an open room. Generally only one side of the stove was against the wall. Often a narrow section of floor spanned the open section of the room, to facilitate loading the kiln floor.

The most striking difference is in the size. Nearly all are the same size - 1·8 m square. This is half the size used in North Wales, or in Northern England. This is the more remarkable when we remember that this means one quarter of the area. In a given time, they could only have done a quarter of the work.

This difference is too great to be without significance. The most likely explanation is that oatmeal is likely to formed a smaller part of the output of these mills than it did for those further north. It would be worth seeking independant evidence for this.

These corn mills can classified into five groups, which are best described by examples.

GB-22/104; Felin Newydd, Crug-y-Bar

National Grid: SN663385 Now working (1983)

This is typical of a very numerous class of mill in this region. It froms the end of a range of buildings which originally consisted of the kiln and the house. It is driven by an external overshot wheel fed by a leat from the Afon Annell.

Two pairs of stones are driven by spurwheel gear, but the upright shaft ends below the first floor. An oatmeal machine stands against one wall, driven by a belt from one stone spindle. A bevel pinion engaging the side of the pitwheel drives a pulley on a layshaft, with a belt to a countershaft set low on the first floor. Belts from this drive two wire machines through angle gears; one ordinary machine clothed as a flour dresser, and the other built as a grain cleaner, with a fan in its base.

An attic floor has been inserted into part of the roof, but it has very little area or headroom. Its only uses could have been storage of a few sacks, and providing easier access to the wire machine hoppers. The sack hoist is in the roof ridge; it is driven by a slack chain from the waterwheel shaft, tightened by lifting the bearing in a wooden slide. A second manual hoist is fitted in the opposite end of the attic, with its chain running over an external pulley above the doorway.

Except for the manual hoist, the incomplete mill at Felin Gwm Isaf (22/109) appears to be identical. Many other mills are broadly similar, although this type of grain cleaner has not been found elsewhere.

GB-22/205; Cleifion Mill, Sant Clêr

National Grid: SN286164 Complete, and under repair (1983)

A mill much nearer to English practice. It is freestanding, with an external backshot wheel at one end. The kiln is detached. The spurwheel gear drives two pairs of stones, with a crownwheel for the auxiliary drives. An attic floor well below eaves level gives good headroom, although one low collar beam restricts it unnecessarily at one point. The sack hoist, built entirely of cast iron, is in the attic and driven by a slack belt from a shaft from the crown wheel. It is fitted with a latch, which is released to engage the drive. The attic also contains rudimentary bins, feeding the stones and the flour dresser.

Other machines included a wire machine and a smutter (?) on the first floor, and

an oatmeal machine on the ground floor, but only fragments remain. All the plant is cast iron, except for a wooden upright shaft.

GB-22/095; Felin Wen, Abergwili

National Grid SN463214 Working (1983)

This mill was remodelled in the late 19th century by S Kelly of Cardigan. The overshot wheel drives three pairs of stones by a lineshaft, parallel and level with the waterwheel shaft. The oatmeal separator stands beyond the end of the lineshaft, with its fan driven from a countershaft geared to the end of the lineshaft and the sieve driven from a pulley on the stone spindle. A pinion driven from the top of the pitwheel provides belt drives to the flour dresser (a centrifugal) and the sack hoist. The hoist is a friction type, operated by forcing two wooden wheels together. An elevator raises meal to the centrifugal. An attic floor, set well below the eaves, carries small bins to feed the stones.

Two other mills - Felin Geri and Trewen Mill, both near Newcastle Emlyn - are almost identical, except for having only two pairs of stones.

GB-22/108; Felin Marlais, Brechfa

National Grid SN518312 Complete but disused (1983)

The only complete example among the five single-geared mills so far found. The overshot wheel is fed by an inclined, enclosed wooden trough with a bypass trough behind the wheel. The stones are on a hurst, standing lower than the first floor. There is no attic floor. The hoist is in the roof ridge, driven by a slack chain from the waterwheel shaft. The 'miller' - only uses the attached sawmill, but remembers the corn mill working - declared that it only made oatmeal, and never ground wheat. Certainly there is no trace of a flour dresser. The oatmeal separator stood in front of the centre of the hurst; it was a rectanglar box design, with a fan driven from a layshaft geared to the side of the pitwheel (a shaft later extended to drive the sawmill). The sieve was belt driven from the stone spindle. The gearing is cast iron, and designed as face gears. The stone nut can be disengaged by lifting it with two hooks hung from a forked lever. Until recently, the waterwheel shaft ran in stone bearings, which are still on site. The far end of the building contained the kiln, but this has been removed to make way for a joiner's workshop. A sawmill has been built behind the mill, under a lean-to roof, which was driven from the waterwheel via the layshaft.

The other four sites with this type of mill are:

GB-22/105	Felin Clettwr,	Grid SN477468
GB-22/106	Melin Castell Howell,	Grid SN440480
GB-22/107	Rhyddlan Mill,	Grid SN494431
GB-22/218	Rhydcwmerau Mill	Grid SN578389

Although it has been remodelled as a 2-pair spurwheel mill, GB-22/211 Abergorlech Mill shows clear signs of having once been a single-geared mill, and still has the pitwheel from that period.

Felin Clettwr has had all the wheels removed quite recently. Melin Castell Howell is derelict but retains it gear and stones; it is dated 1802, cut into the hurst timbers. Rhyddlan Mill is a ruin and Rhydcwmerau Mill has been largely stripped, but in each case just enough remains to establish the gear type.

GB-22/075; Forge Cŷch

National Grid SN248410 Largely gutted (1983)

This is one of two mills with gearing arranged as in Fig 2. It has a low backshot wheel, made by W & T Thomas, Cardigan. The flour was a wire machine, and the kiln was in an attached lean-to. The attic floor contains hoppers to feed the stones and the wire machine. The mill is now too incomplete to determine any further details.

The other mill with this gear layout - GB-22/079, Pen-y-Bont, Trellech - is too ruinous, and too dangerous, to show more than the gear layout and the remains of a centrifugal flour dresser.

Conclusions

As yet, very little can be concluded, apart from the kilns, as already discussed. There is certainly some variety, particularly in gearing, but the material so far gathered seems insufficient to determine their distribution within a region as small as this. So, although this approach is likely to yield significant results, it must await further field work.

Two patterns of oatmeal separator have been found, both different from the designs used in the north. Each pattern is so standardised as to suggest the work of a maker specialising in such machines. None are named, but it might be worth searching records to see if this can be established.

Finally, there is the question of style. It certainly exists, and after this experience it is possible in many cases to place a mill as 'North Wales' or 'South Wales' on inspection, but by intuition rather than understanding. It is not yet possible to actually define the difference.

References

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3) Coates, S D, & Tucker, D G; Watermills of the Monnow and Trothi; Monmouth

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Discussion

Freedman	These single-geared mills were just the result of the survey so far?
Jones	Yes; there may be more waiting for me, but I don't expect to find many.
Bryan	Those uf us who went on the West Midlands tour would know that some features you found are fairly common there too, such as latching hoists, a fair number of lineshafts, spurgeared pitwheels. After all, it is only next region going eastwards from the one you were in.
Jones	Yes, it is, although these mills are certainly the work of local millwrights, and most of them came from from right over on the western side.
Turner	Did you encounter anything very old, or was it mostly 19th century?
Jones	I don't think there was anything very old; the oldest dated mill I saw was 1802 - no, I saw an older one, about 1780.

Plunkett — Weren't any of the single-geared mills even older?

Jones — I think not. One of them was dated 1802, and they were all alike in their details.

Jarvis — But could that be an updating of the single gear of a previous machine generation?

Jones — I am sure they were. Whether they were completely rebuilt, or just rebuilt internally, I don't know. They all had cast iron wheels which appeared identical - probably off the same patterns. There was one other, at Abergorlech, which now has conventional spurwheel gear, but which clearly began as a single-geared mill, because there were traces left from that period. First, the pitwheel was a face gear casting identical to those in the single-geared mills. The wooden cogs had been specially shaped to run with a bevel wallower. Second, there was a ledge on the wall which had obviously supported the rear timber of the hurst, which was far below the present hurst. It was just above the wallower; just right for single gear. Obviously everything had been rasied, up to and including the roof.

Plunkett — So the age of the building, as opposed to the age of the mill, for which you quote 1802 as typical, could well be older in a number of instances, but you were unable to date them.

Jones — How do you date rubble masonry?

Plunkett — Very difficult. You really need other datable material round it. For example, I have been trying to work out something about the chronology of the masonry and brickwork at Eling Tide Mill, and the only real crossover point appears to be the start of the brickwork and the finish of the stone. It is like the stone bearings; when did the stone bearings finish and everyone turn over to metal ones?

Jarvis — But stone bearings never finished, did they?

Bryan — They are still common enough in Holland.

Jarvis — We still have two windmills in Somerset with stone bearings in them.

Jones — There is nothing very remarkable about stone bearings, except finding examples. When they disappeared in Britain, they did so very completely.

Jarvis — I wonder what the life of a stone bearing is ? That could be the answer to the question. When they wore out after a certain date, they were replaced by metal.

Plunkett — It depends on the load on it. If you have a 75 mm steel shaft revolving in a stone bearing with a load of three tons or so, it is not going to last very long.

Bryan — The Dutch find them very troublesome, and they are always renewing them. They de-laminate; it picks up a piece of stone which makes a cavity under the shaft, and it starts to break up after that.

Jones — On the subject of stone; I found a millstone there which I had not noticed before. It was a conglomerate, almost certainly of Welsh origin. It was very common; nearly every mill had a pair. Indeed, the only types I saw

were burrs and this conglomerate.

Plunkett — There was a burr-type quarry in this area, was there not?

Jones — Yes, somewhere near Bridgend.

Plunkett — That's it, on near Bridgend and another further north; near Usk, I believe.

Jones — This is not a burr-type material; it has very large inclusions in it, like pebbles.

Plunkett — I think we saw something like that on the mid-Wales tour.

Jones — But it is the exception there; down here it is the norm.

Plunkett — Then when they wanted good quality flour, they imported French burrs. Were they made up locally, or did they come from the big London importers?

Jones — Most of them were not named. Of those that were, none were either local or London. Several were from Liverpool, including the names Thomas & Son, and Davies & Snead, while one pair was by Whitaker of Bristol.

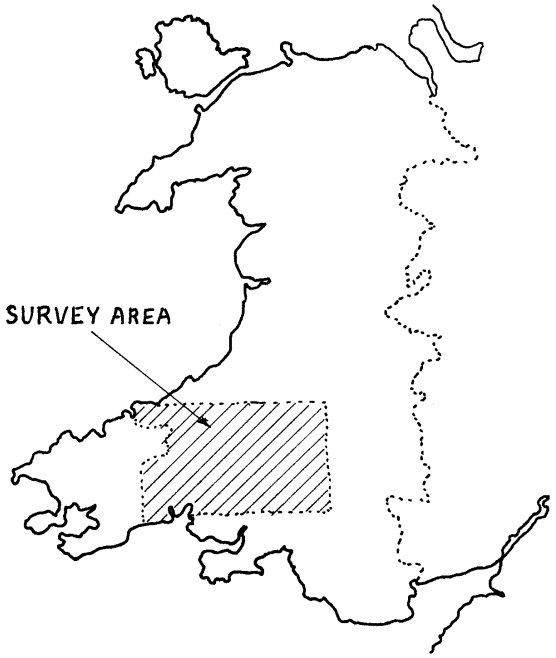

Fig.1

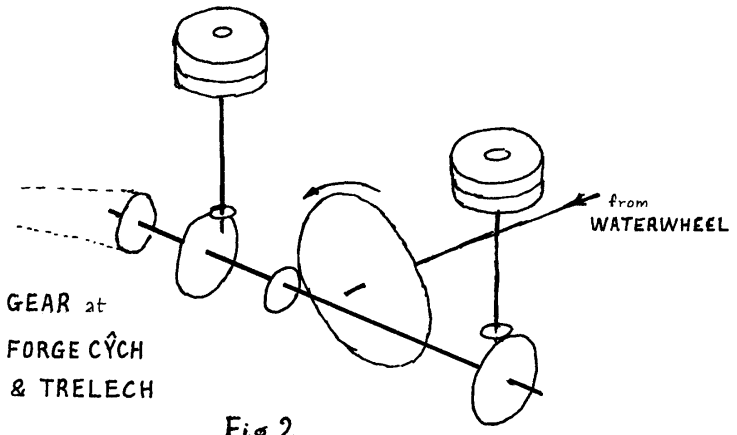

Fig.2