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Carbonized cereals and associated weed seeds from Roman London A.D. 60

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Summary

The paper records the analysis of a sample of cereal grains and associated weed seeds preserved by carbonization in a London building burnt in A.D. 60 during the Boudiccan revolt.

The sample was part of an exceptionally large grain deposit up to one metre thick and is of unusual value having been dated to a particular year and of special interest because it is associated with an early stage in the economic and agricultural colonization of Britain by the Romans who are considered to have been responsible for the introduction of many plant species,which are now well established members of the British flora,as seed in imported grain.

The analysis revealed a mixture of wheat species (i.e. emmer,bread/club wheat, spelt and einkorn),hulled barley,rye,wild oats,rye grass,chess,corncockle, lentils,vetches,corn gromwell,umbellifers,cleavers,corn buttercup,bramble and grain weevils.

Representitives of many of the species present had germinated prior to carbonization and part of the grain deposit may have been intended for distribution as 'seed corn'.

Evidence provided by spikelet parts and germinated seeds indicates that two separate crops may be involved;one of spelt with its associated 'weed' seeds and one of emmer with bread/club wheat and 'weed' seeds.

The unusual species composition of the deposit suggests that the spelt 'crop', at least,was possibly imported from southern Europe or the eastern Mediterranean region.This is the earliest record for corn buttercup in Britain,a species which may have originated in the Mediterranean area.It is also the first record for einkorn in Roman Britain in the form of about one hundred times as many grains as that comprising the whole previous British archaeobotanic record.

Representitives of the main components of the sample have been measured and illustrated by photographs or drawings.

The archaeological and historical context of the carbonized grain deposit

The deposit of grain,of which the sample examined in the present study was only a part,was uncovered in the course of redevelopment of the site of I62 Fenchurch Street and 23 Lime Street in the City of London(see Figs.I and 2) in I976.The site was a 'watching brief' for the Department of Urban Archaeology,Museum of London,and known as Forum South East I976 because younger deposits on the site preserve remains of the south-east corner of the Roman Forum built between 80 and 90 A.D..

The deposits which include the grain have been interpreted as part of the destruction level recognized in several areas of the City associated with the burning of London by the forces of Boudicca in 60 A.D..

London(Londinium) was founded only seventeen years before the revolt and by A.D. 60 the "town did not rank as a Roman settlement,but was an important centre for businessmen and merchandise" (Tacitus,Annals XIV). The area of London in which the grain was discovered is thought to have been the centre for trading and other activities in the London of the first century A.D..

Tacitus describes the destruction of Camulodunum(Colchester),Londinium and Verulamium(St Albans) by the Boudiccan forces in A.D.60 and levels of burning associated with the events have been recognized by archaeologists in all three towns.Webster has recently reviewed the written and archaeological evidence for the revolt of the Iceni and other tribes led by Boudicca and the reasons for it(Webster,I978).

Excavation work by the Department of Urban Archaeology on the Forum South East site and adjacent sites has revealed a building or range of buildings orientated east-west with a portico along the southern side facing the street which was the main street of London in 60 A.D..

The grain,carbonized by the heat of the fire that destroyed the building was found in a room at the eastern end of the building(see Fig 2).It appeared to be heaped against the eastern side of an internal mudbrick wall faced with brickearth(context 254) baked by the fire(see Plate I).

The deposit of grain(context 253) was 0.I2 m thick at the point shown in the photograph although it was seen to be I.0 m thick at its maximum as it was cut through by the heavy machinery of the site developers and it extended between I.5 and 2.0 m away from the wall.The state of preservation of the grain itself varied considerably,having been reduced to a black powder in parts of the deposit and resembling fresh grain,except for its colour,in others.Small amounts of wood charcoal were present.The grain overlaid a deposit of heat shattered flakes and fragments of brickearth and mudbrick(context 259) deposited against the bottom of the standing wall.The grain was overlaid by a layer of burnt mudbrick(context 258) up to 0.42m thick with a variable amount of mixing of the two contexts at their junction.

The grain sample which is the subject of this paper was collected after cutting away the section shown in Plate I.Unfortunately the conditions pertaining on the building site only allowed the collection of a single large bulk sample from the whole thickness of the deposit where the grain appeared to be well preserved.

Treatment of the sample

The sample of carbonized grain was already dry when it was passed on to the author in I979 for examination.After testing the effect of water on a small amount of the dried grain a simple form of flotation in water followed by wet sieving was applied to the sample in order to clean the grain and other 'seeds' and seperate inorganic and fragmentary carbonized material from the better preserved material.

This was achieved by sprinkling small quantities of the sample into a basin of tepid water removing the material that floated after a few seconds. The carbonized material that sank was seperated from the inorganic fraction (mostly burnt mudbrick) by a process that was repeated several times involving gently swirling the contents of the bowl with sufficient water to seperate the less dense carbonized material from the denser inorganic material and decanting the less dense fraction into another container.In this way three fractions were seperated according to their densities.

The inorganic fraction was examined to ensure that it contained no sub-fossil material and the two fractions of carbonized material were each gently washed through I.68mm,I.00mm,0.7Imm and 0.25mm aperture brass test sieves.The material that passed through the 0.25mm aperture sieve was not retained but the material retained by each sieve was allowed to dry at room temperature on polythene sheeting in order to prevent undue disintegration of the grains and other remains through too rapid drying.

The whole of the material retained by the I.68mm aperture sieve was systematically sorted to recover all spikelets,spikelet forks,einkorn wheat, barley,well-preserved examples of the other cereal components,other grass seeds,dicotyledonous 'seeds' and larger pieces of wood charcoal.The material that remained from the two fractions(the denser and less dense carbonized fractions) after the components referred to had been removed was recombined and subsamples taken from which the approximate proportions of the main cereal components in the sample could be assessed.

The other grades of carbonized material were also examined to determine their character and composition.

The volume of carbonized material was measured using measuring cylinders and the weight measured on a chemical balance.

Grains,seeds and other remains were examined and measured with a Leitz Widefield Stereoscopic Microscope equipped with an eyepiece graticule.

Summary of the analysis of a sample from context 253, Forum South East 1976

Total weight of carbonized material ------------------------------ 3·40 Kg

Total volume of carbonized material ------------------------------ 6·85 litres

Weight of carbonized material retained by I.68mm aperture sieve ---- 2.II Kg

Volume of carbonized material retained by I.68mm aperture sieve ---- 4.4I litres

N.B. the material retained by the I.68mm sieve consists of the more or less intact cereal grains and other seeds.

Calculated number of grains and 'seeds' -------------------- approx.I30,000

Plant species list

Gramineae

Triticum monococcum L.	einkorn wheat	690 caryopses	
Triticum dicoccum Schubl.	emmer wheat	40-50% *	approx. I27,000 caryopses
Triticum spelta L.	spelt wheat	20-25% *	
Triticum aestivum /T.compactum	bread wheat/club wheat	25-30% *	
Hordeum vulgare L.	hulled barley	III5 caryopses	
Secale cereale L.	rye	2 caryopses	
Avena fatua L.	wild oat	44 caryopses	
Bromus secalinus L. or B.mollis	chess	24 caryopses	
Lolium sp.(c.f. L.perenne L.)	rye grass	28 caryopses	

Leguminosae

Lens esculenta Moench	lentil	38 seeds
Vicia sp.c.f.V.sativa	common vetch	30 seeds(approx.)
Legume c.f. Vicia	indeterminate 'vetches'	12 seeds(approx.)

Caryophyllaceae

Agrostemma githago L.	corncockle	730 seeds

Boraginaceae

Lithospermum arvense (L.) Hill	corn gromwell	33 fruits

Umbelliferae

Umbellifer species A		9 seeds
Umbellifer species B		2 seeds

Rubiaceae

Galium aparine L.	cleavers	7 seeds

Ranunculaceae

Ranunculus arvensis L.	corn buttercup	I fruit

Rosaceae

Rubus fruticosus agg.	bramble	I seed

* natural variation within the caryopses of wheat species,distortion of sprouted grains and fragmentary grains prevent each grain from being assigned to its species.Attempts at real counts of the species did, however,allow the relative proportions of the species indicated to be estimated.

Associated faunal remains

Coleoptera

Sitophilus granarius(L.)	grain weevil	2 specimens

General comments on the examination and state of preservation of the material

The state of preservation of the cereals and other 'seeds' varied considerably and this is reflected in their behaviour when placed in water. Undoubtedly a small proportion of the dry 'seeds' disintegrated when placed in water but it seems unlikely that this would significantly change the results. A proportion floated in water (about one third) and this fraction contained a high proportion of the naturally more inflated types (e.g. bread/club wheat), those grains that had 'puffed' in the heat of the fire, the more or less whole spikelets, Lithospermum nutlets (being hollow) and detached cereal plumules (the latter in the fraction between 1.0 and 1.68mm). The material that sank in water contained most of the dense leguminous seeds, a high proportion of the other weed seeds and also sprouted grains which having shrivelled as they sprouted had become denser.

This clearly shows that one must consider the carbonised fraction as a whole and not place too much reliance on the proportions of different seeds in carbonised material recovered from sites by simple incomplete flotation.

The whole of the fraction retained on the 1.68mm aperture sieve was sorted to ensure recovery of the rare seeds and fruits and also because it was found that 'spontaneous sorting' took place within the bags of washed, dried sample with the denser, rounded weed seeds (particularly the legumes) concentrating themselves at the bottom of each bag.

No complete seeds were recovered from the fraction that passed through the 1.0mm aperture sieve and very few from the fraction passing through the 1.68mm aperture sieve retained on the 1.0mm aperture sieve. The former fraction consisted almost entirely of small grain fragments and fine 'chaff'.

Representatives of many of the species present in the sample had sprouted before carbonisation. In many of the cereal grains the plumule was still attached to the grain but large numbers of detached plumules were also recovered. As noted below a high proportion of the Agrostemma seeds had begun to germinate, rupturing the seed coat and exposing the expanding plumule inside while detached Agrostemma plumules were not uncommon.

The Cereals

Cereal caryopses, spikelets and spikelet forks made up by far the larger part of the sample studied. Approximately 129,000 cereal caryopses were examined of which most were wheat.

The wheat included Triticum monococcum, T. dicoccum, T. spelta and T. aestivum/compactum. While it was possible to separate the Hordeum and T. monococcum fairly readily from the other cereals it was not possible to assign every grain to a particular species. However, it was possible to select well preserved 'typical' examples of the species present for further study, measurement and illustration.

The grains were distinguished on the basis of their morphology utilising features summarised in Fig.   and discussed below. 75 grains of each species were subsequently measured. Three dimensions were measured on each grain: the length (not including the radicle point), the breadth and the thickness. Two indices were calculated for each grain: the L:B index $(\frac{\text{length x 100}}{\text{breadth}})$, and the T:B index $(\frac{\text{thickness x 100}}{\text{breadth}})$.

Minimum, average and maximum values for these dimensions and indices are given   and frequency distribution graphs have been constructed for length, the L:B index and the T:B index. The author agrees with Van Zeist (1970) that the representation of such basic data in graphical form is very desirable whenever preservation is adequate as it allows more accurate comparisons between samples to be undertaken. The author has illustrated the caryopses in a set orientation to allow visual comparison between individual grains of the same species and grains of different species.

The illustrated grains form the majority of those measured. A sample of spikelets, spikelet forks and glume bases have also been measured where appropriate. The relevant measurements for these are the articulation breadth (dimension A) and the glume base width (dimension B)(see Helbaek,1952 a,p. 216 or Renfrew,1973 p.58).The ratio between the two measurements was also calculated as this seemed to be a significant discriminatory factor (i.e. $\frac{\text{dimension B x 100}}{\text{dimension A}}$).

Triticum monococcum L. einkorn, small spelt

690 'typical' einkorn caryopses were recognised in the grain sample. These represent only about 0.5% of the total number of wheat grains. 7 spikelet forks which may be attributed to the species were also found.

The spikelet forks were much more gracile in every way than those of the spelt with basal rachis fragments described below which they superficially resembled. The dimensions and indices clearly show the difference. Those for the einkorn were as follows:-

	dimension A	dimension B	B:A
min.	I.63	0.56	33
av.	I.8I	0.65	36
max.	2.I4	0.76	40

These measurements may be compared with those given by Helbaek (I952 a, p.202) for recent einkorn and emmer :-

	dimension A	dimension B
einkorn	1.48 -2.01	0.61 - 0.87
emmer	1.79 -2.89	0.84 - I.25

Einkorn would seem to be indicated.

The dimensions and calculated indices of 75 caryopses were as follows :-

	L	B	T	L:B	T:B
min.	4.69	I.38	2.24	208	I08
av.	5.50	2.05	2.68	27I	132
max.	6.I7	2.70	3.II	35I	I70

The caryopses of einkorn are fairly distinctive and typical ones and cannot be easily confused with those of other species (see Fig.). However it has been frequently noted by other workers (e.g. Van Zeist 1970, Renfrew 1973) that samples of T. dicoccum include grains which originated in single-seeded spikelets and such grains are reminiscent of T. monococcum. They have a convexly curved ventral side like T. monococcum and are compressed laterally. Such emmer grains have been found during the present study. The occasional two-seeded spikelet of einkorn contains grains which resemble emmer grains from single-seeded spikelets.

Renfrew (1973) states that the T:B index is the decisive detail in distinguishing between two-grain einkorn and emmer caryopses and quotes the index range for emmer as 75-95, in einkorn 100-179 (average 132). In fact emmer grains with T:B indices up to 119 have been found in the present study and Van Zeist (1970) also records maximum T:B indices for emmer of about 120 from several samples. However the range of T:B indices for einkorn from the present study is 108-170 with an average of 132 so agrees remarkably well with the figures given by Renfrew for einkorn. The frequency distribution graphs for T:B indices of einkorn and emmer from this sample clearly support the identification of the two species.

The grains illustrated in plate had to be shown in lateral view as they are too compressed laterally to stand up in the same orientation (dorsal view) as the grains of the other species illustrated.

Helbaek (1952a) states that, in Britain, einkorn was always a more or less fortuitous component of the emmer field, and that there is no evidence to indicate that the species was ever cultivated intentionally or separately in this country. He also considers that, in prehistoric times, einkorn accompanied emmer in the regions east and north of the Mediterranean(Helbaek,I953a).It was however grown as a seperate crop in some parts of europe and the eastern mediterranean and the greek 'tiphe' is thought to refer to einkorn(Percival,I92I).

The record of einkorn in prehistoric sites in northern and western europe is as meagre as that for Britain and was,as in Britain,probably never cultivated as a seperate crop(Helbaek,I953a).

Helbaek recorded einkorn with emmer,spelt and six-row barley from the excavation of the first century B.C. Forum Romanum site in Rome which he considered were originally introduced into Italy from the Balkans or the Danube Basin(Helbaek,I953b and I956).He mentions that he identified einkorn in first century A.D. deposits from Bornholm in the Baltic(Helbaek,I953a) but does not subsequently report on the species in his paper describing those deposits(Helbaek,I957).

Helbaek (1966) considers that cultivated einkorn was first developed about 6000 B.C. Hubbard (1976) provides a diagram showing the history of einkorn cultivation back to 8000 B.C. with its almost universal decline from the late Neolithic onwards and apparent disappearance from everywhere but S. E. Europe by the first century A.D.

However in quite recent times einkorn has shown its propensity as a weed in cereal fields. Percival (1921) mentions the fact that in 1871 it was reported as a troublesome weed in cornfields near Montpellier in France. This problem arises because the ears of einkorn are very brittle and it sows itself among other crops in which it becomes established and difficult to eradicate. It resembles wild oats in this respect.

The einkorn present in the London grain was probably a harmless weed of the wheatfield but the absence of records for einkorn from other Roman grain deposits from nothern Europe suggests that the grain comprising the deposit may have originated elsewhere, possibly S. E. Europe.

The previous record for T.monococcum in Britain amounts to less than a dozen definite identifications (mostly spikelet or grain impressions) with no definite identifications from deposits younger than Bronze Age with one possible Iron Age occurrence (see Jessen and Helbaek 1944,Helbaek 1952 a,Godwin 1975 for details). The present sample has yielded about one hundred times the number of grains or spikelets of einkorn as the rest of the British archaeobotanical record.This new record is therefore of considerable interest.

Triticum dicoccum Schubl. emmer

This species probably comprises the largest proportion of the cereal deposit (perhaps 40-50%) but it is only represented by caryopses (plate).

The dimensions and calculated indices of 75 grains were as follows:-

	L	B	T	L:B	T:B
min.	4.39	1.73	1.63	171	74
av.	5.53	2.56	2.47	218	97
max.	6.94	3.26	3.21	274	119

The caryopses exhibit considerable variations in shape and a few individual grains may be confused with other species. However the cross section of typical grains is more triangular than either spelt or einkorn and the lateral view more triangular and with less blunt apices than spelt. The anterior surface of the typical emmer grain tends to appear concave in lateral view.

Emmer was the most important species of wheat in prehistoric Britain but was apparently largely replaced by spelt by Roman times (Helbaek 1952a). However emmer was the major component of the Colchester grain deposit (see below) and emmer continued to be grown in the Netherlands until early medieval times (Van Zeist 1970).

Triticum spelta L.   spelt

It is difficult to assess the precise importance of this species in the deposit but it possibly comprises 20-25% of the cereal grains.It is represented by I56 more or less complete spikelets (see plate   ),approximately I200 spikelet forks (see plate   ),glume fragments and isolated caryopses (see plate   ).

Spikelet material of spelt is fairly readily identified.The glumes are more robust than those of eincorn or emmer and strongly nerved.The spikelets of spelt generally seperate from each other in such a way that a rachis fragment(internode) remains attached to the face of each spikelet rather than at the base of each spikelet as in emmer or eincorn.However it is not uncommon to find spikelets in recent spelt material with the internode attached in the manner of einkorn or emmer and there may even be a second rachis fragment(from the spikelet above on the spike) attached to the face of the spikelet in the normal spelt manner.24 specimens with emmer-like rachis fragments were found in the London material and these included specimens with a second rachis fragment.

75 well-preserved spikelets and spikelet forks were measured and their dimensions and indices were as follows:-

	dimension A	dimension B	B:A
min.	I.78	0.92	44
av.	2.37	I.25	53
max.	2.96	I.68	62

The dimensions compare well with measurements given by Helbaek(I952b,p.IOI) :-

dimension A	dimension B
I.82 - 2.89	0.9I - I.52

I3 well-preserved glumes were 6.32 - 7.34mm(av.6.90mm) in length.

The dimensions and calculated indices of 75 grains were as follows:-

	L	B	T	L:B	T:B
min.	5.I0	2.40	I.78	I60	70
av.	5.87	2.95	2.34	200	80
max.	6.63	3.57	2.75	245	95

The caryopses show considerable variation in shape but typical ones tend to be dorso-ventrally flattened with somewhat blunt apices. Examination of typical spelt spikelets revealed some very atypical caryopses resembling those of bread wheat. Some caryopses even resembled rye (Secale cereale) and indeed some isolated caryopses are reminiscent of rye. Van Zeist (1970) observed very similar features in material from Valkenburg 8448 (100 A.D.). It may therefore be that some grains attributed to Triticum aestivum/compactum in the assessment of proportions of different species in the sample may be spelt so that the importance of spelt in comparison with bread wheat may be underestimated.

The grains selected for illustration and measurement included only those grains with features generally accepted as 'typical'.

Spelt was first introduced to Britain in the Iron Age and became the most important wheat in Roman times (Helbaek 1952).

Triticum aestivum /T.compactum bread wheat / club wheat

It is also difficult to assess the precise importance of this aggregate of species but it probably comprises 25-30% of the cereal grains.It is represented by naked grains (see plate).

The dimensions and calculated indices of 75 grains were as follows:-

	L	B	T	L:B	T:B
min.	4.39	3.06	2.24	130	68
av.	5.47	3.51	2.71	156	77
max.	6.63	3.98	3.16	191	90

In contrast to the three species of Glume wheats discussed already 'bread wheats' and 'club wheat' are Naked free-threshing wheats the caryopses of which are readily released from their spikelets on threshing. In the absence of spikelets the accurate identification of the Naked wheats is uncertain. However the grain of either bread or club wheat is plump and rounded and the embryo is placed in a rather steep position. Triticum compactum has shorter plumper grains than T. aestivum but precise separation is impossible so that they are considered as one group here.

A third species,T.durum(hard wheat),is commonly found in Near East deposits and this species cannot be readily seperated from T.aestivum sl.(Van Zeist and Heeres 1973). The possibility that T.durum is present in the London deposit cannot be excluded but there is no positive evidence for it.

T.aestivum sl. is known in Britain from Neolithic times.

Hordeum vulgare L. hulled six-row barley, Bere

III5 caryopses of barley were recovered from the sample representing less than I% of the total cereal grains. All could be attributed to the hulled form of H.vulgare and several grains were found with the palea and lemma or fragments of them still tightly clasping them (see Plate). In most cases, however, the palea and lemma had been completely burnt away leaving 'naked' grains (see Plate). These may be distinguished from true naked barley by their shape which is somewhat angular in cross-section and they also lack the fine transverse wrinkling on the surface of the grains that is characteristic of true naked barley (Van Zeist I970).

Two-thirds of the grains should, theoretically, be somewhat lop-sided and twisted in six-row barley as they represent the outer pair of each trio of florets on each rachis internode. The author has not attempted to count the number of lop-sided grains to test this but such grains are much in evidence as may be seen in Plates and .

A horseshoe-shaped depression in the better preserved lemma bases indicates that the grains belong to the lax-eared form of H.vulgare with a nodding spike rather than an erect one. This is sometimes given the misleading name of 'four-row barley' (H.vulgare tetrastichum, H.tetrastichum (Kcke

A sample of 75 caryopses had the following dimensions and indices:-

	L	B	T	L:B	T:B
min.	4.69	2.40	I.84	I76	72
av.	5.70	2.80	2.24	204	80
max.	6.63	3.47	2.86	24I	90

It is interesting to note that these caryopses are larger in all respects than those whose measurements are given by Helbaek (I952a) or Van Zeist (I970).

It seems that H.vulgare hexastichum (H.hexastichum L., dense-eared erect-spiked six-row barley) was largely replaced by H.vulgare tetrastichum throughout Europe in the Iron Age (Godwin, I975).

The barley in the London grain may have been, in effect, a weed in the wheat crop having perhaps grown from seed left in the field after a previous barley crop had been gathered but the barley may have been a fairly constant contaminant about which the farmer **may** not have been unduly concerned.

Secale cereale. rye

This cereal species is a minor component of the grain deposit and only 2 caryopses were identified with absolute certainty.However the species may have been under-recorded as rye grains were suspected among the distorted cereal grains and a number of other grains were reminiscent of rye.

The distinctive features of the rye caryopses were their slender shape with pointed embryo,truncated apex,more or less distinct dorsal keel and,in addition,one grain had retained the characteristic corrugated surface while the other had the characteristic twist that is often seen in rye caryopses.

The measurements and calculated indices of the two grains were as follows:-

L	B	T	L:B	T:B
5.46	I.84	I.78	297	97
5.6I	I.94	I.84	289	95

Rye first appeared in Britain during the Iron Age and has been identified from its pollen as well as its grains(Godwin I975).It first appears in quantity in Roman deposits in which it has been found with spelt suspected of having been imported(e.g.Verulamium (Helbaek,I952a) and Isca(Helbaek,I964)).

There is no reason to suppose that the rye in this case was anything more than a weed of the wheat crop.

Other grasses

Avena fatua L. Wild Oat

This species is represented by well-preserved florets, spikelet forks (see Plate) and isolated caryopses equivalent to 44 florets.

Several florets have preserved the characteristic oval basal articulation scar of the species(see Jessen and Helbaek I944).

22 isolated caryopses had the following dimensions:-

	L	B	T	L:B	T:B
min.	4.I8	I.48	I.I8	243	66
av.	5.I9	I.85	I.47	28I	79
max.	6.I7	2.I4	1.84	326	94

There is no evidence for the presence of cultivated oat in the sample although naked caryopses of the cultivated A.sativa or A.strigosa can only be distinguished from A.fatua when their size is greater than the maximum size of caryopses of the latter species(Helbaek I952a)

A.fatua and other oat species were apparently introduced to Britain with spelt wheat in the Early Iron Age.

Wild oats are frequently a serious weed in modern cereal fields and were probably weeds in the crop of which the sample discussed here is a part.

Bromus secalinus L. or B.mollis Chess

This aggregate of grass species is represented by 24 caryopses.The two species cannot be seperated on the basis of their caryopses(Helbaek I952a)

18 caryopses had the following dimensions:-

	L	B	T	L:B	T:B
min.	5.00	I.27	I.07	32I	69
av.	5.49	1.5I	I.23	366	82
max.	6.07	I.73	I.33	426	I00

Helbaek suggests that this 'species' came to Britain with imported spelt. Its seeds are common in Iron Age and Roman grain deposits.It was probably a weed of the cereal field.

Lolium sp.(c.f. L.perenne L.,perennial rye grass)

This species was represented by 28 more or less complete fruits.The lemmas and paleas or fragments of them were still fused to the caryopses in most cases and the lengths given below closely approximate to the length of the lemmas.The lemmas were apparently awnless,oblong or ovate-oblong with a blunt or slightly pointed apex.The paleas were the same length as the lemmas and their surfaces were minutely rough.

The dimensions and calculated indices of 24 caryopses were as follows:-

	L	B	T	L:B	T:B
min.	2.24	0.87	0.5I	2I8	50
av.	3.05	I.I0	0.7I	278	65
max.	4.03	I.27	0.87	345	85

L.perenne L.,L.remotum Schrank,L.tementulum var. arvense Lilj. and L.rigidum Gaud all possess awnless fruits and all are annuals except L.perenne (see Hubbard,I968).The species may show considerable variation in size and morphology of the fruits.

The dimensions and indices above do not correlate well with published data for L.tementulum (e.g. Van Zeist and Heeres,I973,Helbaek,I956) although Renfrew(in Renfrew I973) illustrates a smaller-grained form of the species which superficially resembles the London specimens.The tips of the lemmas where preserved in the London fruits are not emarginate as in typical L,tementulum or L.remotum (see Renfrew,I973,fig.II9).

Carbonized fruits of L.perenne were identified by Helbaek in Roman grain deposits at Verulamium(Helbaek,I952a) and at Isca(Helbaek,I964).His three specimens had dimensions which come within the size range of the London grains.

However the veins which are prominent in the lemmas of L.perenne are not apparent in the London specimens and the general morphology of the fruits does not seem to conform exactly to typical fruits of the species.A hybrid may be involved.

The author has not been able to trace any archaeobotanic records for L.rigidum to provide comparison.

L.perenne is widespread in Europe,temperate Asia and N.Africa;L.tementulum and *L.rigidum* are native of the Mediterranean region while *L.remotum* is native of Central Europe(Hubbard,1968).

Whichever species of *Lolium* is involved here it was probably a weed of the wheat crop.

Legumes

Legumes are represented in the sample by approximately 80 seeds.The seed coat with its diagnostic hilum was absent in all the seeds recovered so that positive identification was impossible in all but the lentil.Differences in shape between seeds in a single pod make identifications based merely on general morphology of a seed uncertain at best.

About 38 lentil seeds were present and most of the remaining seeds may be attributable to the common vetch,Vicia sativa.

Legumes of various types are frequently mentioned by Columella and Pliny in connection with their use as human food,fodder for livestock,medicines, and in improving the soil.They were often used in rotation with cereals and other crops as they were considered of great value in enriching the soil exhausted by previous crops(Columella II,xiii;Pliny XVIII,L and Lii).

The species present in the sample may all be interpreted as weeds within the cereal crop.It is possible that they were present within the crop because they had been grown on the land in a previous year and grew in a subsequent year from seed shed before that crop was gathered.

Lens esculenta Moench cultivated lentil

26 whole specimens of the characteristically circular,flattened biconvex seeds of lentil were recovered from the sample with isolated cotyledons representing up to I2 more seeds.The testa was absent or almost completely absent in each case.

The diameter and thickness of each whole seed was measured.Although virtually circular,few seeds were exactly so and two measurements of the diameter were made at right angles to each other and the mean value calculated for each seed.The dimensions of 26 seeds are as follows:-

	Mean diameter(mm.)	Thickness(mm.)
min.	2.09	I.I2
av.	2.62	I.52
max.	2.96	2.I4

The small size of these seeds is compatible with the dimensions quoted by Renfrew(I973) for Lens esculenta sub-species microspermae Barul to which most prehistoric finds may be attributed.However,Zohary and Hopf(I973) and Renfrew indicate that it is impossible to differentiate between such small forms of cultivated lentil and wild species on the basis of seed morphology.

The earliest record for lentil in Britain,previously,was for that included in grain from the Roman legionary fortess of Isca,Caerleon,Wales, dated to between 80 and I30 A.D.(Helbaek,I964).This is also the only record, other than the present one from London,in which it is associated with grain. Helbaek suggested that it represented either a pathetic attempt at cultivation in Britain or that its occurrence in the grain was accidental. The Isca lentils were slightly larger(2.50 - 3.84mm,mean 3.00mm) than the London examples.

Murphy(I977) recorded lentils from a Boudiccan fire level in Colchester but they were not associated with grain and were in a different building to that which contained the grain deposit.They varied in size from 2.5 - 3.0mm and were found with other vegetable and herb seeds.

Lentils have been recorded from London from waterlogged deposits in Southwark(Willcox,I977).They were late second century in date and larger than those described here(4.0 -5.0mm,mean 4.3mm) but as they were not carbonized they would be slightly larger in any case.

Renfrew(I973) has reviewed the archaeobotanical record of lentil in the Near East and Europe and Zohary and Hopf(I973) have described its origins and the history of its cultivation.Zohary and Hopf comment on the close association of lentil with the early cultivation of einkorn,emmer and barley and Hubbard(I976b) provides a diagram illustrating the record of lentil through ten thousand years of cultivation which is remarkably similar to his diagram illustrating the history of einkorn.The presence of einkorn as well as lentil in the deposit may therefore have some significance as far the origin of the grain deposit is concerned.

Columella(Columella II,x,I5) and Pliny(Pliny XVIII,xxxi) make the requirements of lentil for dry conditions clear so that any lentils found in archaeological deposits in Britain are very unlikely to have been grown here as the present climate at least is quite unsuitable.

Lentil was however frequently grown in rotation or association with other crops in southern Europe and the eastern Mediterranean area and the presence of lentil in the London grain may therefore support the idea that the grain was imported into Britain from that region.

Legumes cf. Vicia spp.

42 small leguminous seeds were recovered of which about 30 appear to conform in general size and shape to those of Vicia sativa L.,the common vetch which is among those legumes mentioned by Columella and Pliny as being grown as a forage crop.However the definite identification of these seeds was impossible as all lacked the seed coat or sufficient to preserve the diagnostic hilum.

Other weeds.

Agrostemma githago L. corncockle

This species is represented by 730 whole seeds but pieces of seed coat and plumules from germinated seeds were also common within the sample.

A sample of 30 well-preserved seeds had the following dimensions:-

	L	B	T
min.	2.04	I.53	I.94
av.	2.40	I.80	2.24
max.	2.9I	2.24	2.75

Corncockle was formerly thought to be a Roman introduction(see Godwin,I975 p47) but seeds have been recovered recently from a late Iron Age context in Oxfordshire (M.Jones pers.comm.).

Helbaek(I964) considered the species to be specially associated with the spread of rye(Secale cereale) across Europe but rye was uncommon in the London deposit and,in any case,corncockle frequently occurs elsewhere in the absence of rye.

Corncockle is a cornfield weed but perhaps causes more concern than others because its seeds are poisonous due to the presence of saponins and they may become dangerous to livestock and humans if they contaminate flour in any quantity(Polunin I969).They also destroy the physical properties of wheat flour(Clapham,Tutin and Warburg I962).

The species is thought to have originated in the eastern Mediterranean region(Polunin I969).The comparitively large number of seeds in this sample, making it by far the most important broadleaved weed in the sample,could have caused quite a serious infestation of the crop if the grain had been sown.These two points may tend to support other evidence that the London grain originated in south eastern Europe or the eastern Mediterranean area where the weed may have been more common than in northern areas in the first century A.D..

Lithospermum arvense (L.) corn gromwell

33 characteristically 'warty' nutlets of this species were recovered. The dimensions of 28 specimens were as follows:-

	L	B	T
min.	2.75	I.73	I.53
av.	3.II	2.I0	I.84
max.	3.57	2.45	2.04

The earliest record for this species is Iron Age(see Godwin I975). It is a typical weed of cereal fields and other arable ground.

Umbellifers

Seeds(half-fruits or mericarps) of two species of umbellifer were found. They proved difficult to identify as they do not seem to conform to descriptions or reference material of north european species.For this reason drawings, measurements and indices are provided and the species designated 'species A' and 'species B'.The indices have been calculated as the relative proportions of a seed are important in identification of umbellifers.

Umbellifer species A

9 seeds of this species were recovered.They are very distinct being oval-oblong in outline,strongly compressed dorso-ventrally and with three inconspicuous dorsal ribs separated by resin canals.Two furrows extending the full length of the seed representing the dorsal resin canals are the conspicuous feature in most of the specimens,the seed coat having been burnt away.The margins are slightly thickened.There is no evidence of 'wings' but they could conceivably have been lost.

Several umbellifer genera possess flattened seeds but most have wing-like lateral extensions.Species A may therefore belong to the genus Tordylium which contains about I6 spp of annual plants which are found in Europe, N.Africa and temperate Asia (see Clapham,Tutin and Warburgh,I962).

The dimensions and indices of 6 seeds were as follows:-

	L	B	T	L:B	T:B
min.	3.82	2.I4	0.4I	I59	I3
av.	4.72	2.48	0.75	I9I	3I
max.	5.6I	3.II	I.I2	236	47

Umbellifer species B

2 seeds of this species were recovered.They are basically ovoid but recurved with fairly prominent dorsal ribs.

Their dimensions and indices were as follows:-

L	B	T	L:B	T:B
2.80	I.02	0.7I	275	70
2.65	I.02	0.6I	260	60

The species was not identified.

Galium aparine L. goosegrass,cleavers

7 seeds of this species were recovered.They are sub-spherical in shape with a large aperture.The hooked bristles which would have covered the half-fruit have been burnt away but the seed preserves the finely corrugated surface which is characteristic of G.aparine (see Renfrew I973,p.I72).

The dimensions of 7 seeds were as follows:-

	L	B	T
min.	I.73	I.63	I.38
av.	2.I3	I.99	I.63
max.	2.35	2.I9	I.78

This species appears to be a native one but is also found in Europe and west and north Asia (Clapham,Tutin and Warburgh,I962 and Godwin I975).It is often particularly associated with man-made habitats.From personal observation it provides serious competition for cereals when growing in association with corn gromwell among the crop.

Ranunculus arvensis L. corn buttercup, corn crowfoot

The single characteristic bristly achene of this species recovered appears to be the earliest record from Britain. Although it is now a common and widespread weed its archaeobotanic record is meagre. It has been recovered from two other Roman contexts in Britain (at Alcester - S. Colledge, pers.comm. and Farmoor, Oxfordshire - M. Robinson, pers.comm.).

Korsmo (1935) states that the achenes are spread in grain and Clapham, Tutin and Warburg (1962) describe the species as being long established as a cornfield weed. It is common in the south of England becoming rarer northwards and in Ireland. It is found throughout Europe (except in the far north), in North Africa and Western Asia to India. The species probably has an east mediterranean area origin.

The presence of this species, albeit a single fruit, in the London grain may support the other evidence for its importation from the Mediterranean region.

The achene measured 3.52mm x 2.50mm x 1.84mm.

Rubus fruticosus agg. Bramble

A single seed of this species was recovered.

This native species, the seeds of which are particularly abundant in archaeological contexts, is widespread and common and need have no special significance to this sample.

The seed measured 1.94mm x 1.48mm x 0.97mm.

Associated faunal remains

Sitophilus granarius (L.) a grain weevil

Two carbonized specimens of this beetle were recovered from the sample. One specimen consisted of abdomen, thorax and part of the head (lacking the rostrum) and the other specimen consisted of the abdomen and part of the thorax.

No further evidence of infestation was noticed in the form of cereal grains containing holes or other damage caused by the adult beetles or their larvae.

This species is one of the most common pests of stored grain in temperate countries and has frequently been recorded from grain deposits in archaeological contexts (e.g. see Osborne 1978, Kenward in Kenward and Williams 1979).

A comparison of the London grain deposit with one of the same date from Colchester

Excavations carried out by the Colchester Excavation Committee have yielded grain and other plant remains carbonized in the burning of Colchester by Boudiccan forces in A.D. 60(see Murphy,1977 and Webster,1978,115)

The most relevant sample is that comprising a small but almost pure deposit of carbonized grain on the floor of a building burnt in A.D.60 exposed on the site of the Cups Hotel,Colchester in 1974.This sample (sample 950) consisted of the following:-

Triticum dicoccum	emmer wheat	534 caryopses
Triticum aestivum sl.	bread wheat	114 caryopses
Hordeum vulgare	barley	17 caryopses
Cereal fragments	equivalent to approx.	2000 caryopses
Vicia/Pisum sp.	vetch/pea	1 seed
Agrostemma githago	corncockle	12 seeds
Caryophyllaceae indet.		2 seeds
Bromus secalinus/B.mollis	chess	12 caryopses
Avena sp.	oat	1 caryopsis
Gramineae indet.		3 caryopses

The author is grateful to Philip Crummy,Director of the excavation and Peter Murphy who reported on the plant remains for allowing him to quote these results which have not yet been published in full.

The sample has several species in common with the London one but it lacks einkorn,spelt,lentil and several of the weed species present in the London deposit.Unlike the London deposit there is nothing to cause suspicion that the Colchester grain might have been imported and all the cereals and weeds represented in the sample were established in Britain before the Roman conquest(except possibly the "vetch/pea").

A consideration of the general agricultural significance of the London grain deposit.

The character and composition of a grain deposit such as that described here are the products of a large number of factors the importance of which may often defy assessment but which may have included :-

(i) agricultural practices such as crop rotation and regularly leaving land fallow for a year or more(see Columella II,xiii and Pliny XVIII, L and Lii);

(ii) incomplete recovery of seeds of the previous crop and the degree of weed infestation in the previous crop;

(iii) purity of the 'seed corn' sown and the possible practice of sowing mixtures of species;

(iv) weeding of the crop;

(v) the method of harvesting(see Varro,I,L and Liii,Columella,II,xx,I-4, Pliny XVIII,Lxiii) and whether gleaning was practiced and the gleanings combined with the rest of the crop;

(vi) pretreatment of the harvested cereals,e.g. artificial heating to make the threshing of 'glumed wheats'(einkorn,emmer,spelt) easier (see Pliny XVIII,x);

(vii) selection of ears prior to theshing for 'seed corn'(see Varro,I,Lii and Columella II,ix);

(viii) the method of threshing used(see Varro I,Lii,Columella II,ix and xx,4-6,Pliny,XVIII,x and Lxxii);

(ix) the method of winnowing used and the selection of heavier grains for 'seed corn'(see Columella,II,ix and xx,4-6,Pliny,XVIII,Liv);

(x) the use of sieving to remove small grains,weed seeds and insect pests(see Columella,II,ix);

(xi) contamination of grain with other seeds on the threshing floor;

(xii) hand sorting of seed intended for use as 'seed corn';

(xiii) contamination of the grain in transit or during storage;

(xiv) contamination of the grain deposit caused by fire and collapse of the surrounding building;

The original composition of the grain deposit may also have been modified by differential burning, some constituents having possibly been burnt away and some constituents may have disintegrated preferentially in the course of collection and laboratory processing.

Grain deposits are often difficult to interpret and preserved remains may not necessarily represent the original crop. They may, in fact, sometimes represent the waste products of crop- or food-processing activities. Dennell (1974 and 1976) and Hubbard (1976a) have discussed some of the problems associated with interpreting such archaeobotanical remains.

The main 'weed' seeds recovered from the sample could all have been derived from plants growing with the cereal crop. The very presence of weed seeds of the species represented provides some evidence for the method of harvesting and threshing employed. All the weed species would have been capable of growing at least as tall as the wheat. Of the various harvesting methods described by Varro, Columella and Pliny only those involving the gathering of individual wheat ears would have produced weed-free grain. It seems probable that the whole or a large part of the stalk was gathered with the ear using a hook or scythe and that the fruiting stems of weeds were collected in the process. Bundles of the reaped material could then have been threshed in one of several ways which would automatically have produced grain contaminated with weed seeds. The wheat ears were evidently not cut off prior to threshing.

The absence of whole seeds less than 1.00mm across and the rarity of those less than 1.68mm across in the sample suggests that the threshed grain may have been sieved to remove the majority of weed seeds (and perhaps insects) prior to storage. This feature and the comparitively small variety of weed species in the sample may tend to support an assumption that the grain deposit is part of a single crop and that it has not been contaminated after harvesting.

At first sight the London grain deposit could be thought to be the remains of a single if rather mixed crop of wheat with its associated weed seeds that was awaiting utilization as food or seed corn when it was burnt and buried in the ruins of the building in which it was stored. However, on closer examination,there is evidence to suggest that at least two seperate crops are involved which may have been mixed on purpose in the store or become mixed accidentally as a result of the collapse and destruction of the building.

The evidence is based upon the concept that it was necessary to artificially heat glumed wheats(i.e. einkorn,emmer,spelt) to make the spikelets more brittle to assist threshing or prevent germination of the grain during storage(see Pliny,XVIII,x,6I and Helbaek,I952 a and b).Grain of the glumed wheats intended for use as seed corn or for malting was not heated and,if sown,was sown in its spikelets.

Therefore when cereal or weed seeds are recovered which clearly sprouted before carbonization and if any glumed wheats involved are represented by spikelets,spikelet forks or glume fragments the material was probably not heated or thoroughly threshed.It should be noted however that grain may start to sprout in the ear before harvesting if reaping is delayed because of wet weather.

If the presence or otherwise of spikelet parts and sprouted seeds is taken into consideration it is possible to divide the species present in the grain deposit into three categories as follows :-

(a) cereals and grasses with spikelet parts and germinated caryopses plus germinated seeds of broadleaved weeds;

(b) cereals without spikelet parts and without sprouted caryopses;

(c) weed seeds which show no signs of germination but which could be associated with (a) or (b).

Some of the weed seeds are present in small numbers so that a lack of sprouted seeds in such small samples cannot really be used to argue that they were associated with a crop of heated grain as only a proportion of any seeds in the deposit will have found suitable conditions for germination and certain species may not be inclined to germinate except in soil at all.

Some species may have been present in both crops but as a proportion would not have germinated in any case it is only possible to provide positive evidence for the presence of the species concerned in the unheated grain and only if some had sprouted.

Spikelet material and/or germinated seeds of spelt,einkorn,barley,wild oats, chess,rye grass,lentil and corncockle were found.Spelt was numerically the most common type of sprouted grain in the sample although a few grains reminiscent of emmer,bread wheat and rye were sprouted they are also thought to be spelt.The vetches were not well-preserved and could have lost any expanded radicles or plumules they had.The seed coats of the vetches may have been more susceptible to loss because they had been ruptured through germination The radicle was missing in many of the vetch seeds.

No undoubted spikelet material or sprouted caryopses of emmer or bread/club wheat grains were found.None of the corn gromwell,umbellifers,cleavers,corn buttercup or bramble were sprouted either but their numbers are small and the lack of sprouted grains need have no significance.

Taking the features discussed above and the possible geographical origin of the species into account one may postulate that the two crops had the following species composition :-

crop A - an unheated,unthreshed crop of <u>Triticum spelta</u> with the following associated 'weeds' :-

<u>Triticum monococcum</u>

<u>Hordeum vulgare</u>

<u>Avena fatua</u>

<u>Bromus secalinus</u>/<u>B.mollis</u>

<u>Lolium</u> sp.

<u>Lens esculenta</u>

<u>Agrostemma githago</u>

<u>Ranunculus arvensis</u>

Umbellifer spp.

(<u>Secale cereale</u>)

(<u>Vicia</u> spp.)

(Lithospermum arvense)

(Galium aparine)

(Rubus fruticosus)

crop B - a heated, threshed crop of Triticum dicoccum with Triticum aestivum/T.compactum plus any of the other species as all of them included unsprouted individuals.

However, a species composition similar to that of the Colchester grain deposit would be perhaps most likely.

As the Boudiccan revolt probably took place in the spring or early summer of 60 A.D. the grain had probably been harvested in 59 A.D. and with the rising temperature of spring after the A.D.59-60 winter began to sprout because the conditions under which it was kept were too damp.

Sprouted grains have been found on several occasions(e.g. at Verulamium, Helbaek 1952a; at Caerleon, Helbaek 1964; York, Kenward and Williams 1979). In the case of Isca, Caerleon Helbaek suggested that the grain had been induced to sprout intentionally in the preparation of malt for brewing but there is no evidence for this in the London example.

While it is impossible to pinpoint the locality or localities in which the cereal crops were grown the species composition of crop A as described is so unlike that of any other grain deposits found in Britain or northern Europe known to the author that those areas may possibly be excluded as probable sources for part of the grain deposit at any rate and that part was possibly imported from southern Europe or the eastern Mediterranean area.

Godwin (1975, p 479) lists 57 species of weeds and ruderals which first appeared in Romano-British times. A few of these(e.g. Agrostemma githago L.) have since been recorded from Iron Age deposits but further species have been added to Godwins list including Ranunculus arvensis L., recorded here for the first time. Godwin (p.480) also lists 29 species of economic and crop-plants which first appear in Roman deposits in Britain and recent work has also added to this list (e.g. see Willcox,1977).

The Romans were clearly responsible for the introduction or importation of a large number of plant species which were previously unknown in the Flandrian of Britain and which originated in the Mediterranean region.However it is also clear that many new species were introduced earlier,during the Iron Age,through increased trade between the continent of Europe and Britain.Many of these introductions during the Iron Age and Roman times were accidental taking the form of seed in grain imported for or at least used as 'seed corn'.Thus rye, wild oats,chess,corncockle and corn gromwell among others appear to have been first introduced in the Iron Age and may have been associated with the importation of spelt wheat which also first appears then.However this introductio of new species was clearly accelerated during the colonization of Britain by the Romans after 43 A.D. and species which may have been uncommon or local in the Iron Age were re-introduced in greater quantities and other species introduced for the first time with Roman grain.

The London grain deposit probably represents an example of the type of grain importation which was responsible for the introduction of new species to the British flora.It is of great interest as it is the earliest Roman grain deposit so far examined from Britain (except the Colchester one of the same age but which was probably not imported),of unusually large size and remarkable in being dated to a particular year,60 A.D..

It is tempting to postulate that the very circumstance,the Boudiccan revolt, which led to the preservation of the London grain may have helped accelerate the spread of Roman seed grain with its associated weed seeds.Tacitus (Annals,XIV in describing the aftermath of the defeat of Boudicca referred to the food shortage experienced by the Britons during the winter of 60-61 A.D. "for they had neglected to sow their fields and brought everyone available into the army, intending to sieze our [the Roman] supplies".This suggests that the British seed-corn stocks were probably eaten during 60 A.D. and not sown so that seed-corn supplied by the Romans would have been required to supplement,at least,the seed-corn needed for sowing in the spring of 6I A.D..

As the London grain deposit is connected with such a significant period in the ethnobotanical history of Britain it has been the subject of more detailed study and illustration than has sometimes been so with studies of other grain deposits described in the literature.

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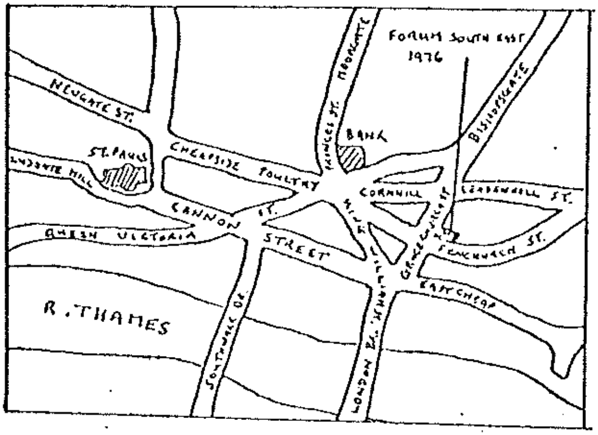
FORUM SOUTH EAST
1976
NEWGATE ST.
ST. PAULS
CHEAPSIDE
POULTRY
BANK
MOORGATE
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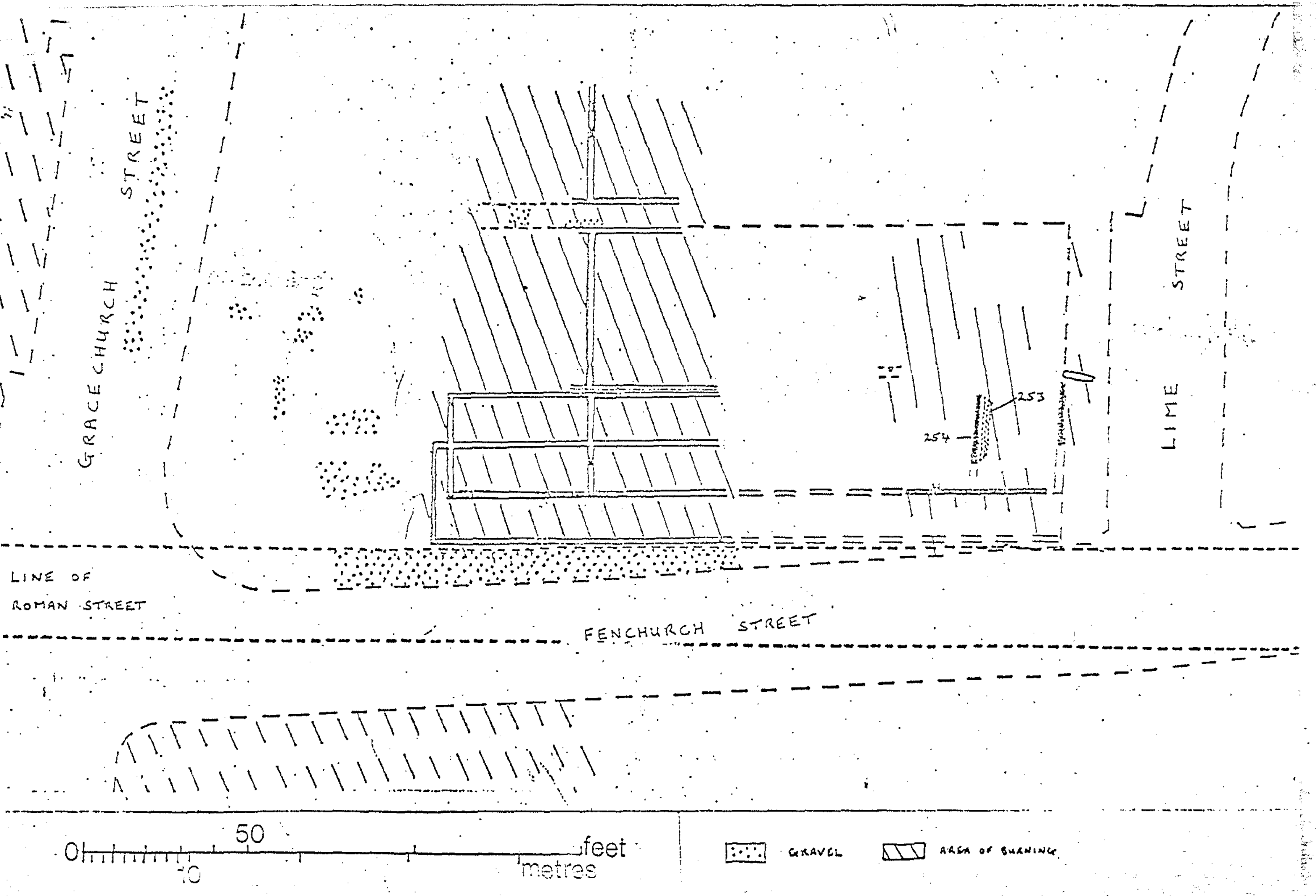
BISHOPSGATE
CORNHILL
LEADENHALL ST.
CANNON ST.
STREET
QUEEN VICTORIA
FENCHURCH ST.
EASTCHEAP
R. THAMES
SOUTHWARK BR.
LONDON BR.

FIGURE 1


GRACECHURCH STREET
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LINE OF ROMAN STREET
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feet
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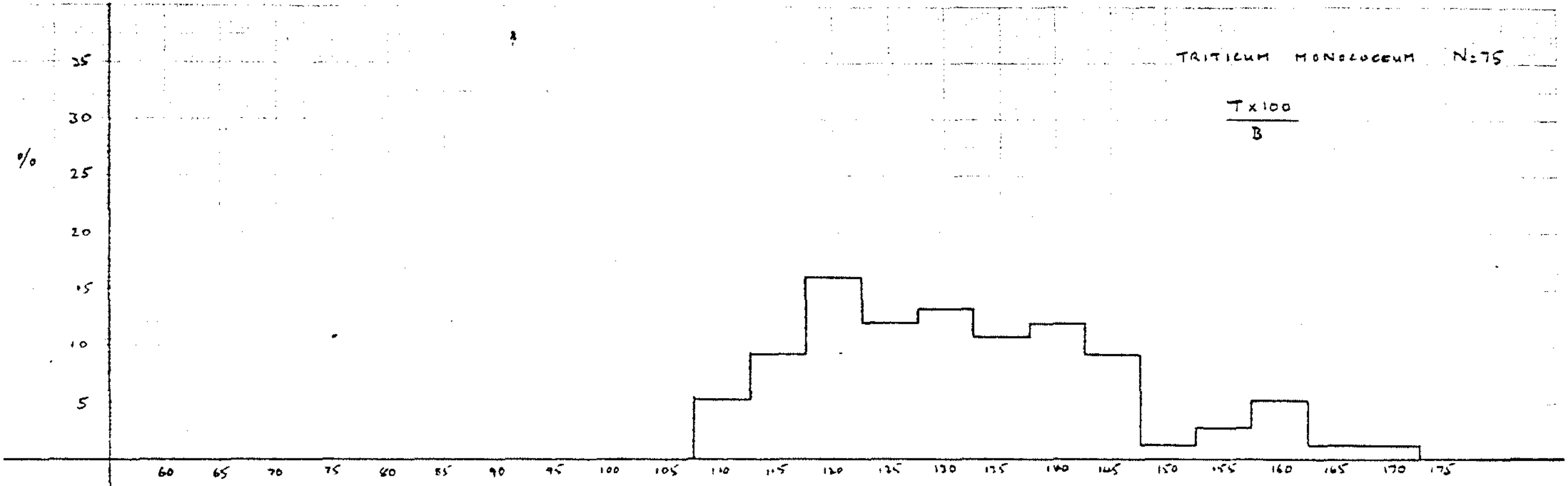
metres
GRAVEL
AREA OF BURNING



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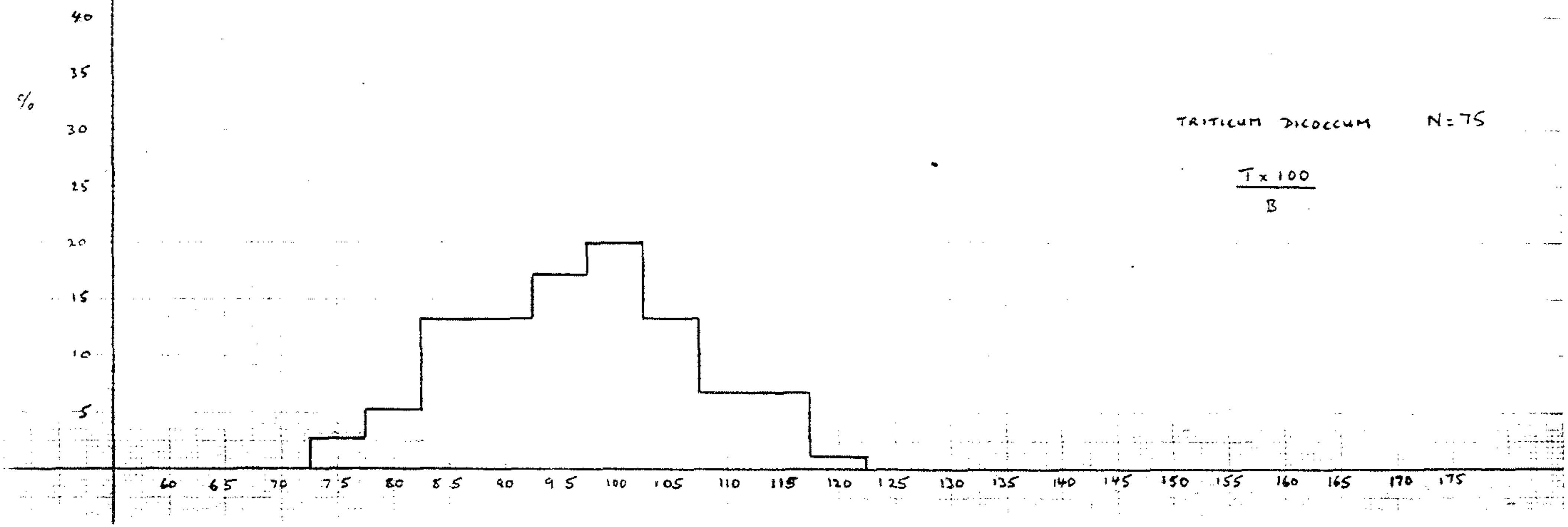

TRITICUM DICOCCUM N:75
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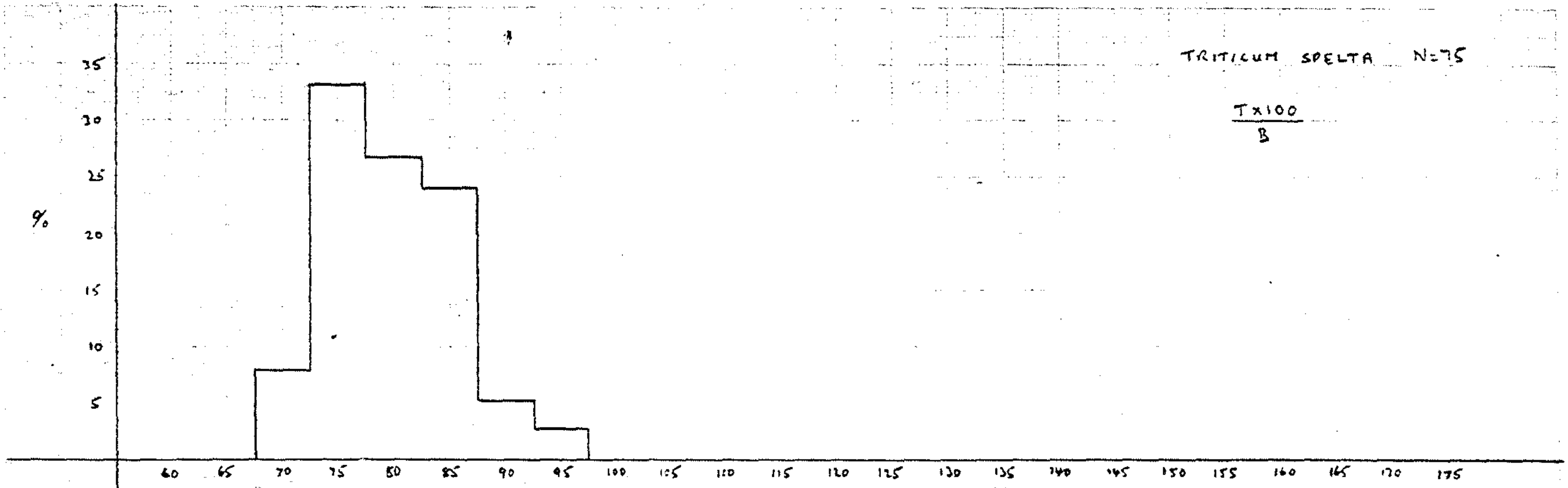
TRITICUM SPELTA N=75
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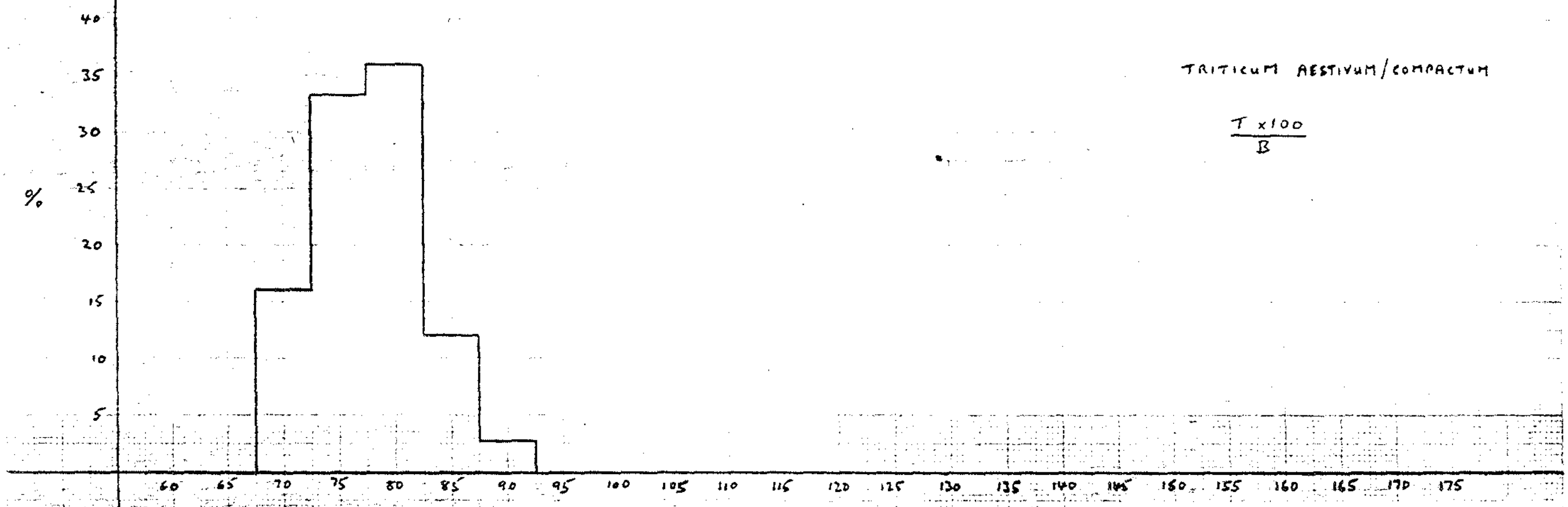
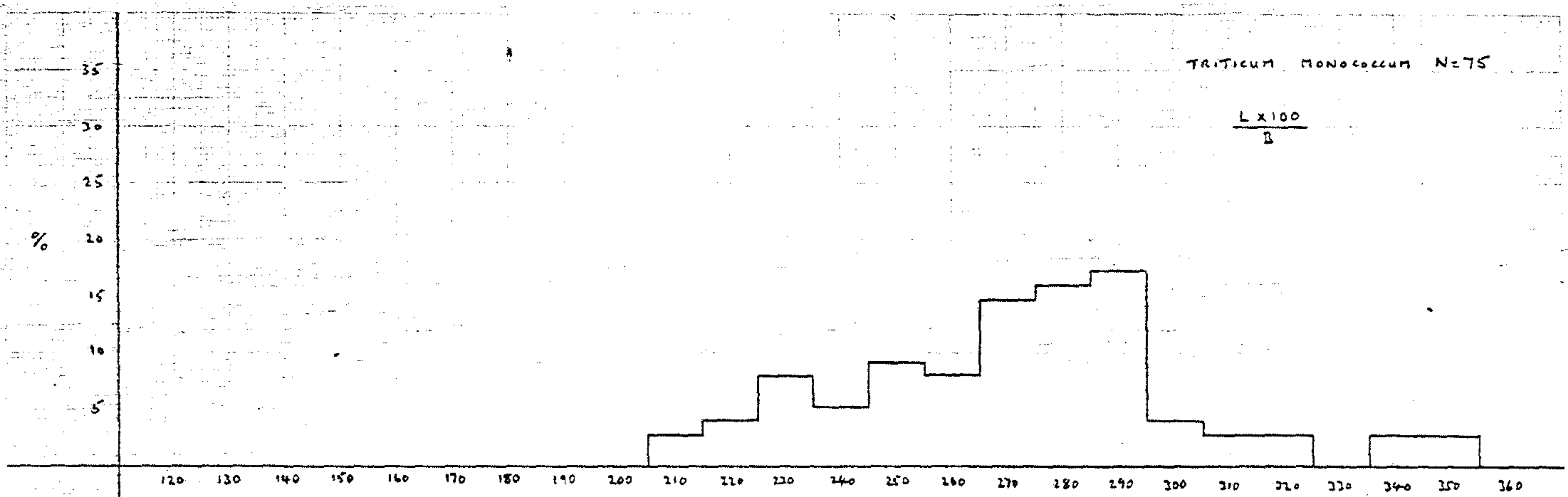
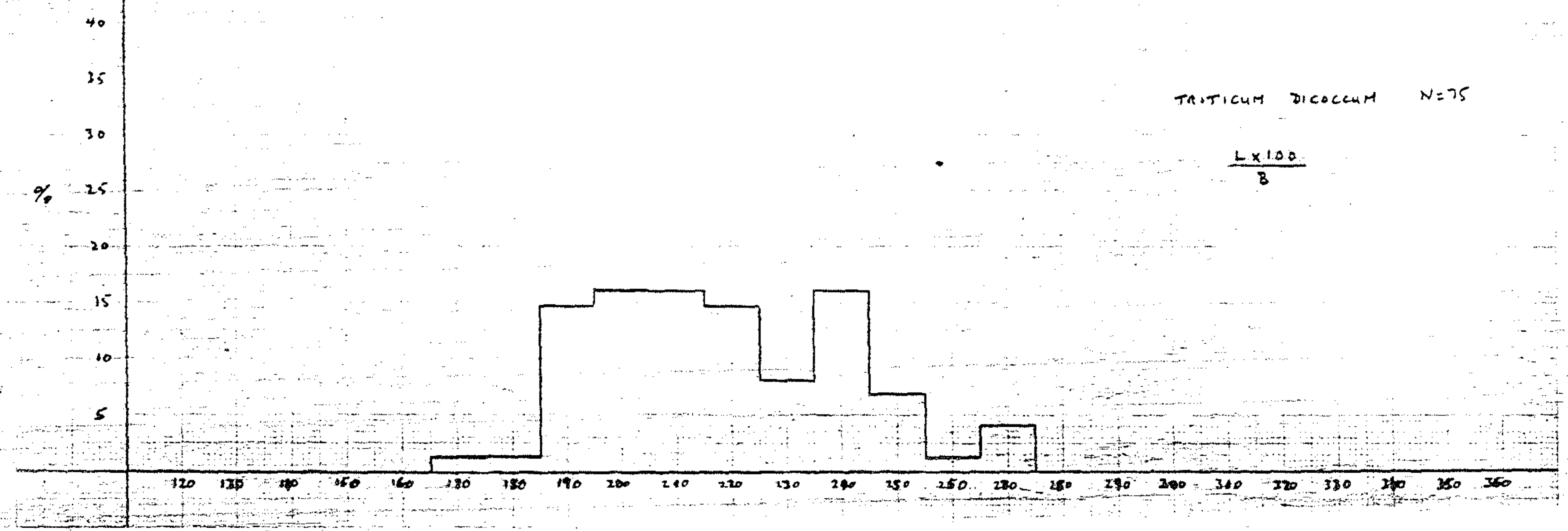
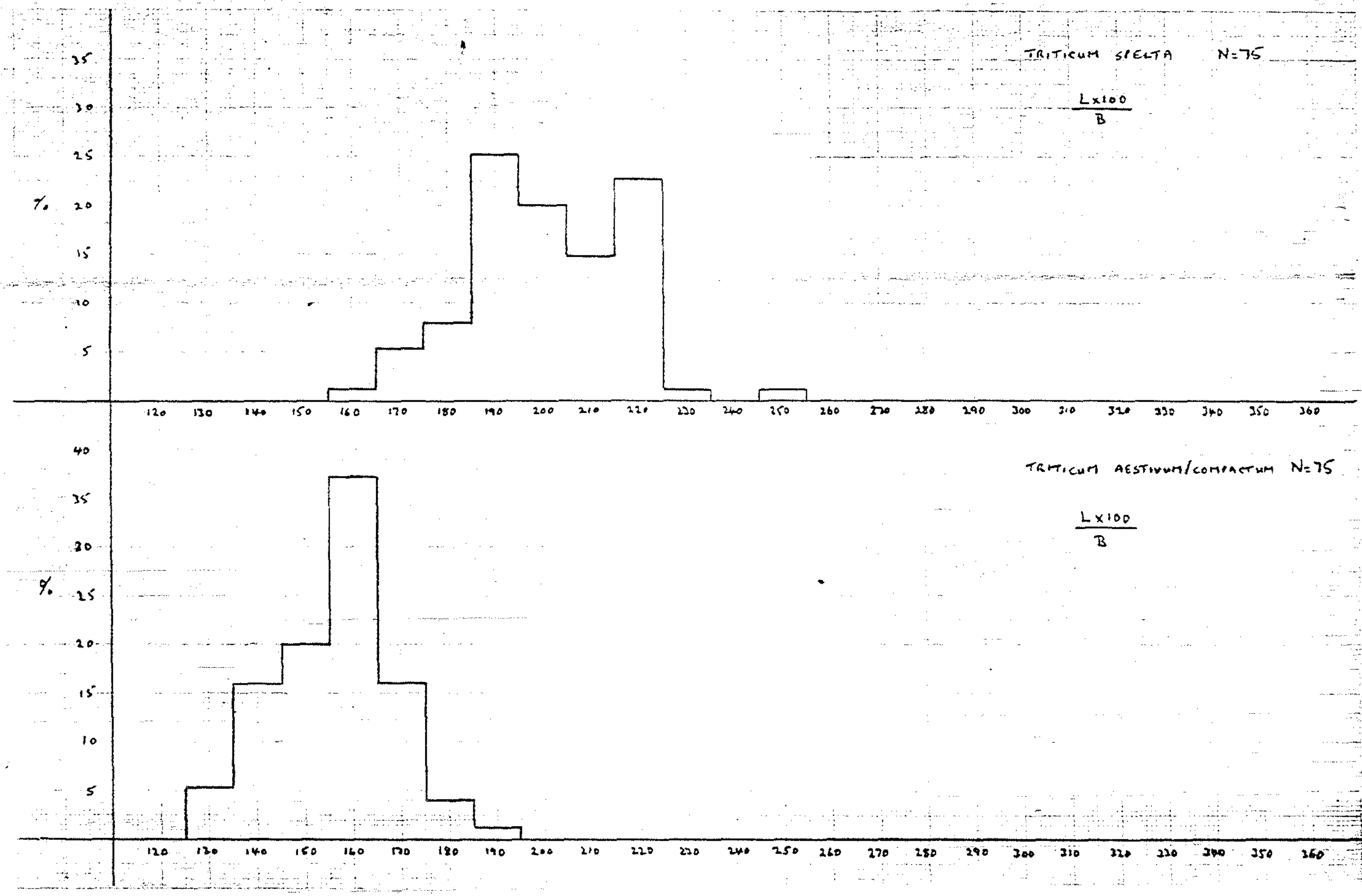
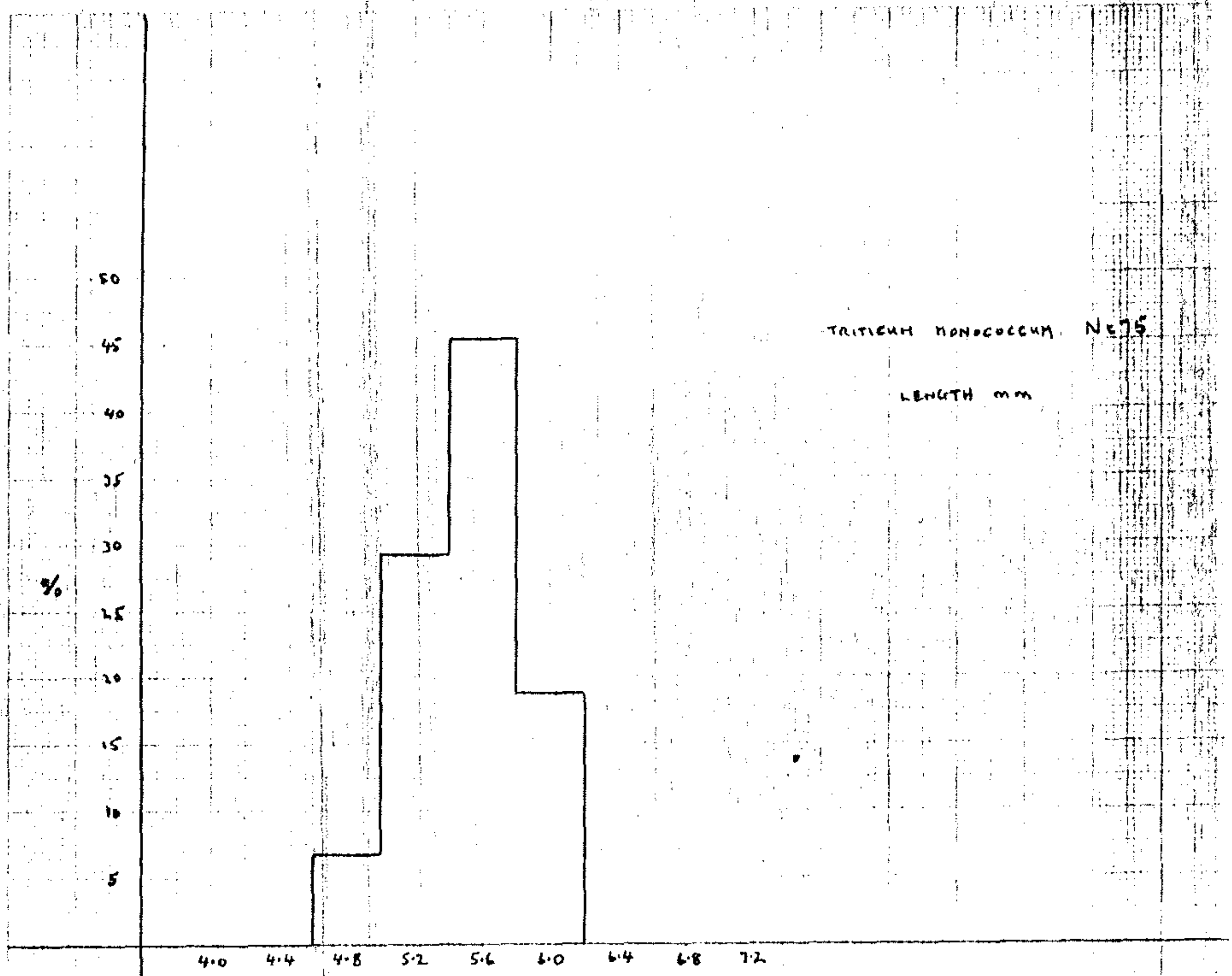
5
60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175

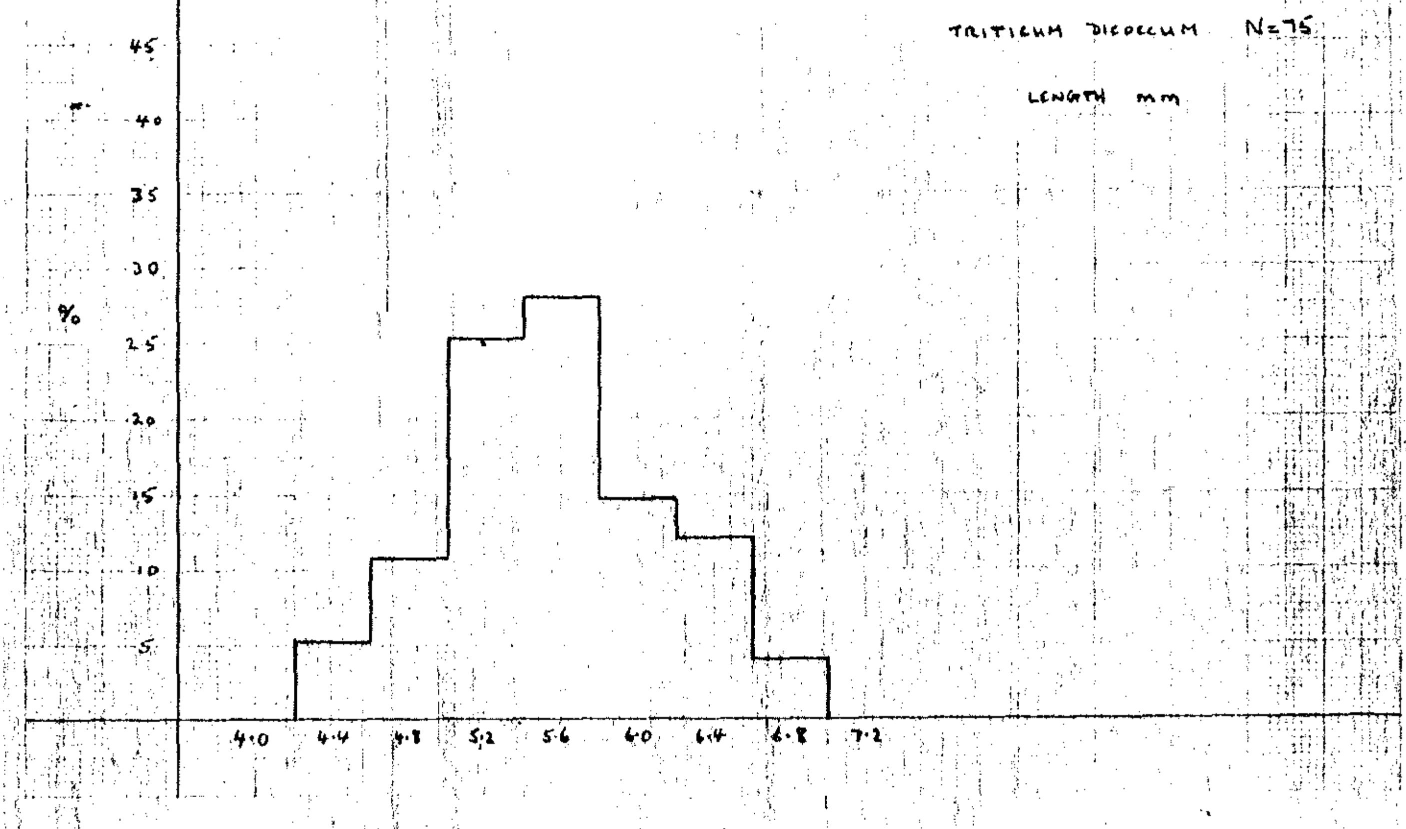

TRITICUM AESTIVUM/COMPACTUM
T x100 / B
%
40
35
30
25
20
15
10
5
60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175

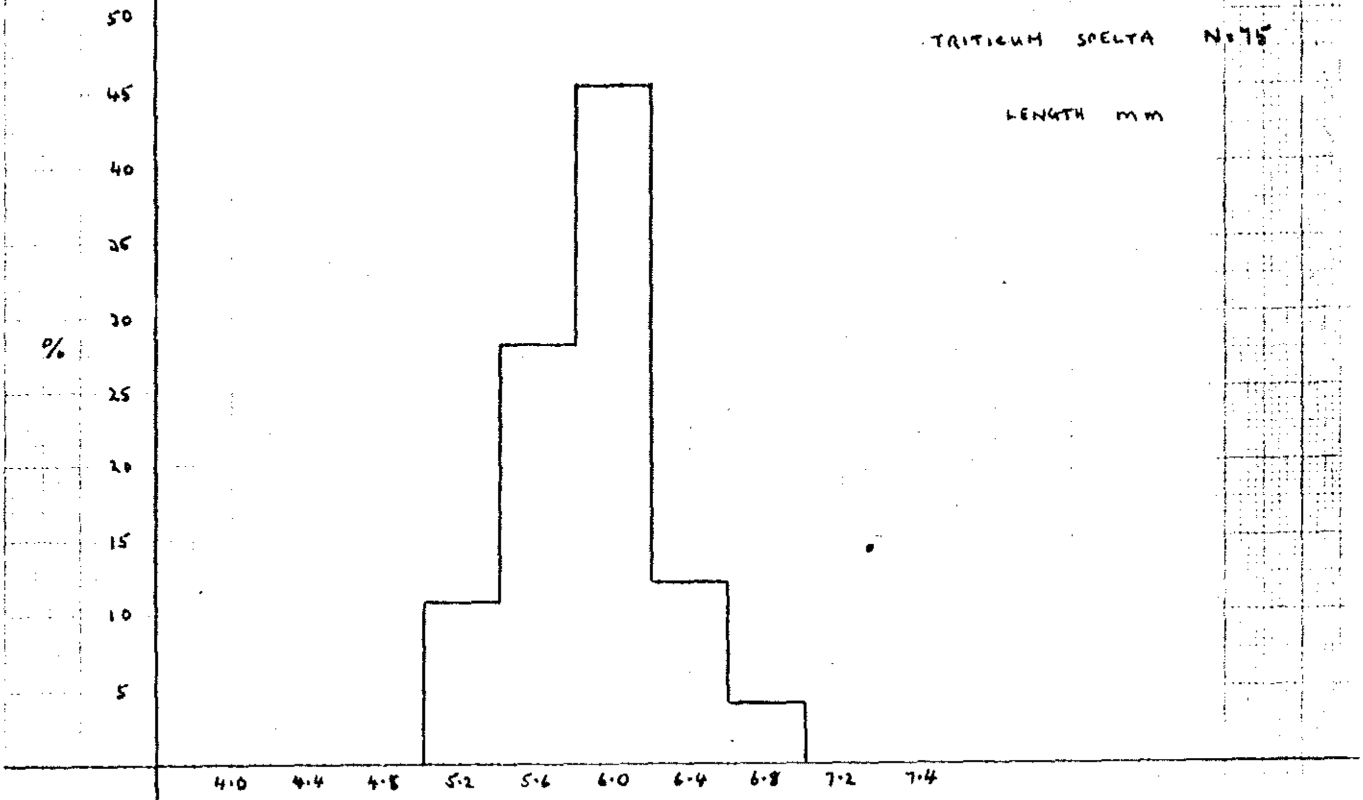

TRITICUM MONOCOCCUM N=75
L x 100
B
%
35
30
25
20
15
10
5
120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360

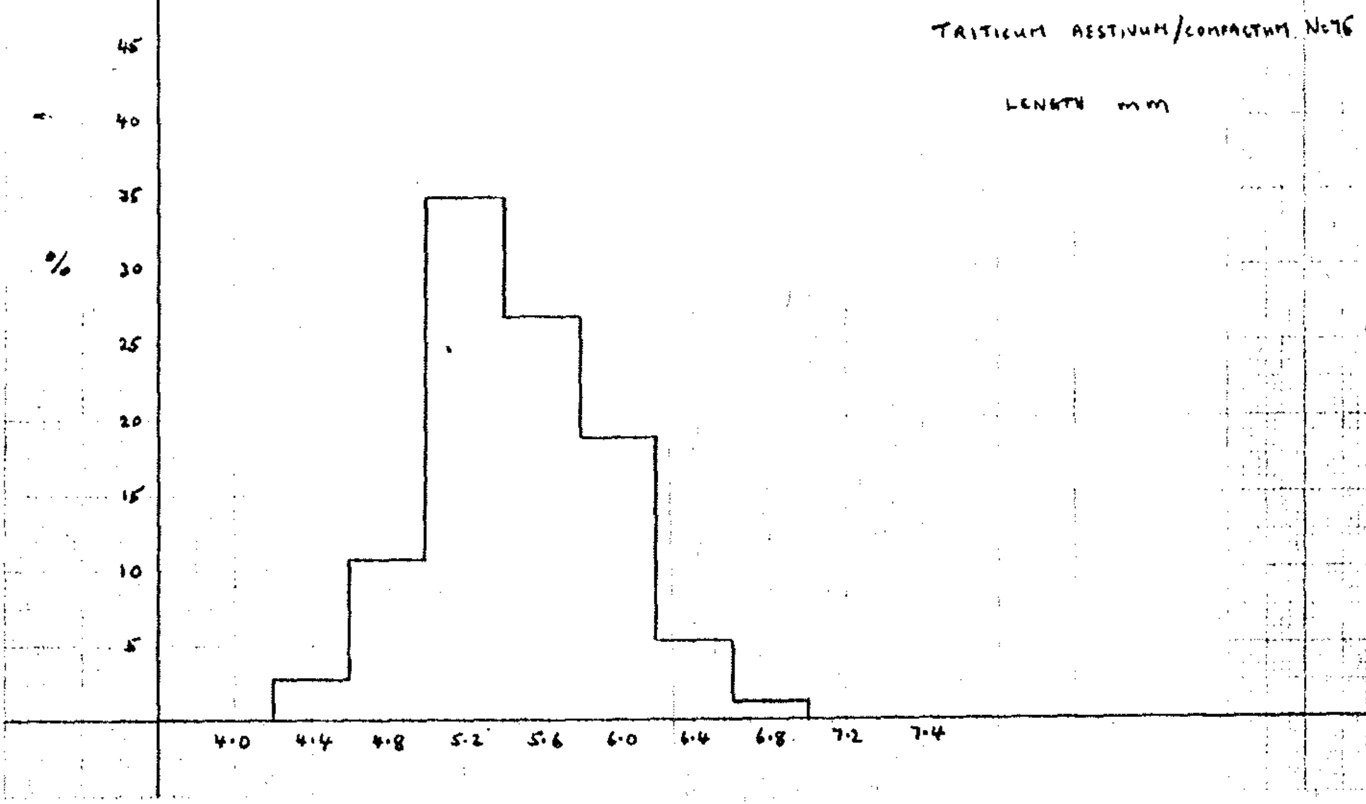

TRITICUM DICOCCUM N=75
L x 100
B
%
40
35
30
25
20
15
10
5


TRITICUM SPELTA N=75
L x 100 / B
%
TRITICUM AESTIVUM/COMPACTUM N=75
L x 100 / B
%


TRITICUM MONOCOCCUM N=75
LENGTH mm
%
50
45
40
35
30
25
20
15
10
5
4·0
4·4
4·8
5·2
5·6
6·0
6·4
6·8
7·2


TRITICUM DICOCCUM N=75
LENGTH mm
%
45
40
35
30
25
20
15
10
5
4·0
4·4
4·8
5·2
5·6
6·0
6·4
6·8
7·2


TRITICUM SPELTA N=75
LENGTH mm
%
50
45
40
35
30
25
20
15
10
5
4.0
4.4
4.8
5.2
5.6
6.0
6.4
6.8
7.2
7.4


TRITICUM AESTIVUM/COMPACTUM N=76
LENGTH mm
%
45
40
35
30
25
20
15
10
5
4.0
4.4
4.8
5.2
5.6
6.0
6.4
6.8
7.2
7.4

TRITICUM SPELTA

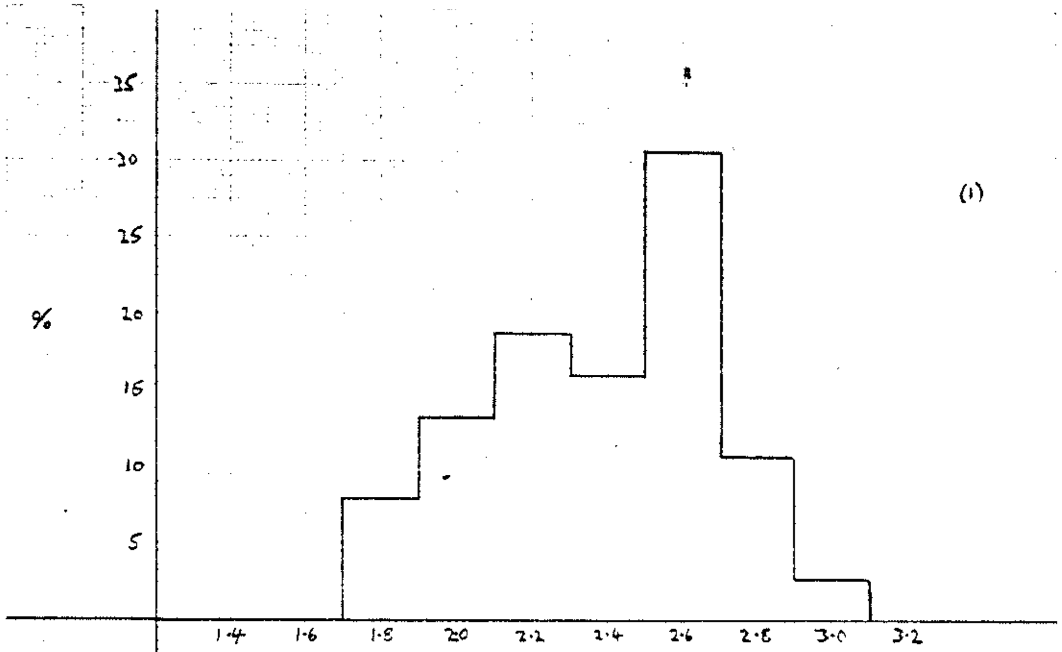
SPIKELETS AND SPIKELET FORKS

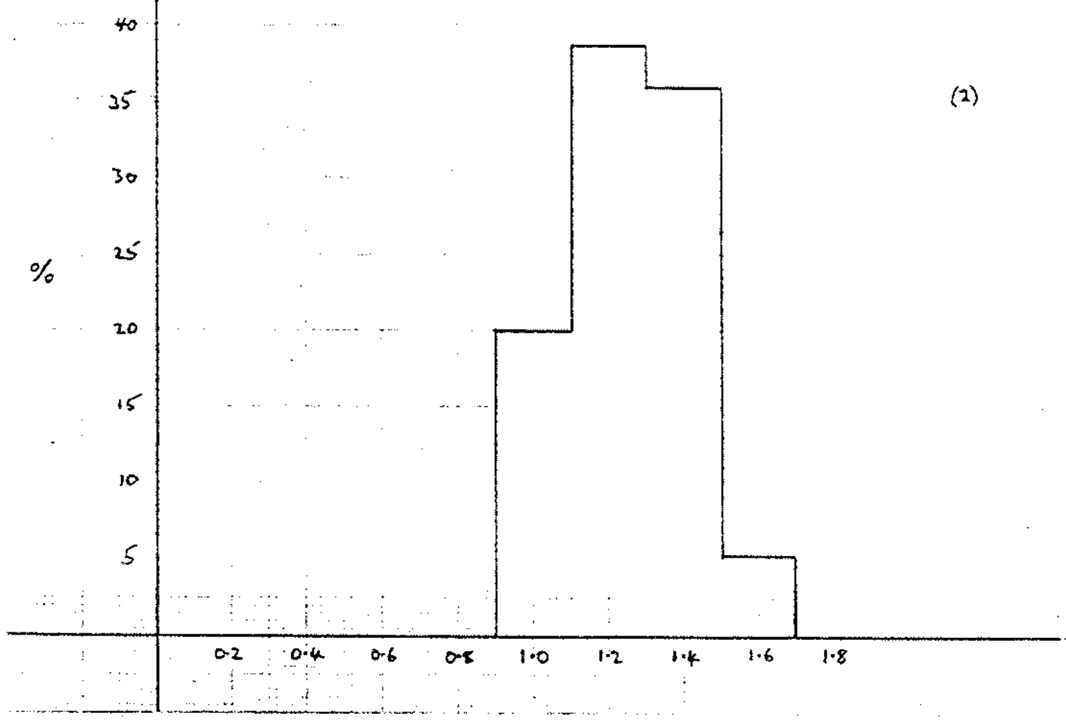
N = 75

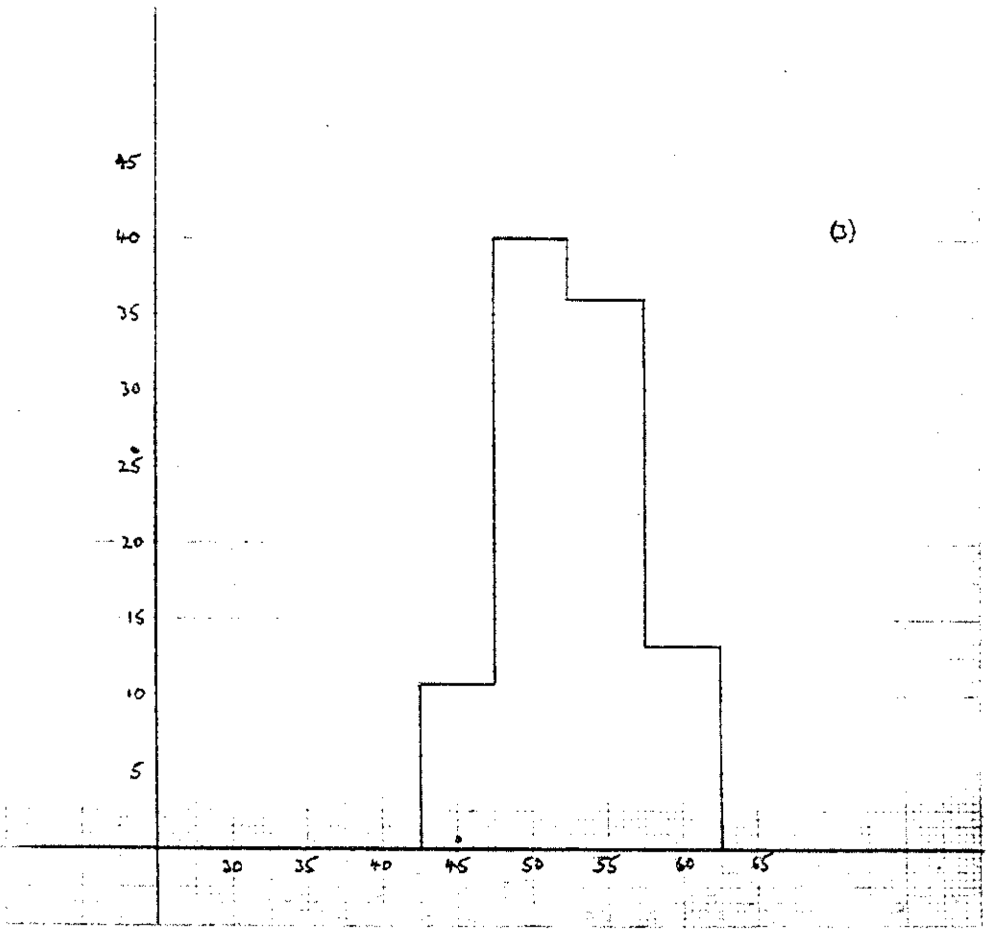
(1) ARTICULATION WIDTH (DIMENSION A)

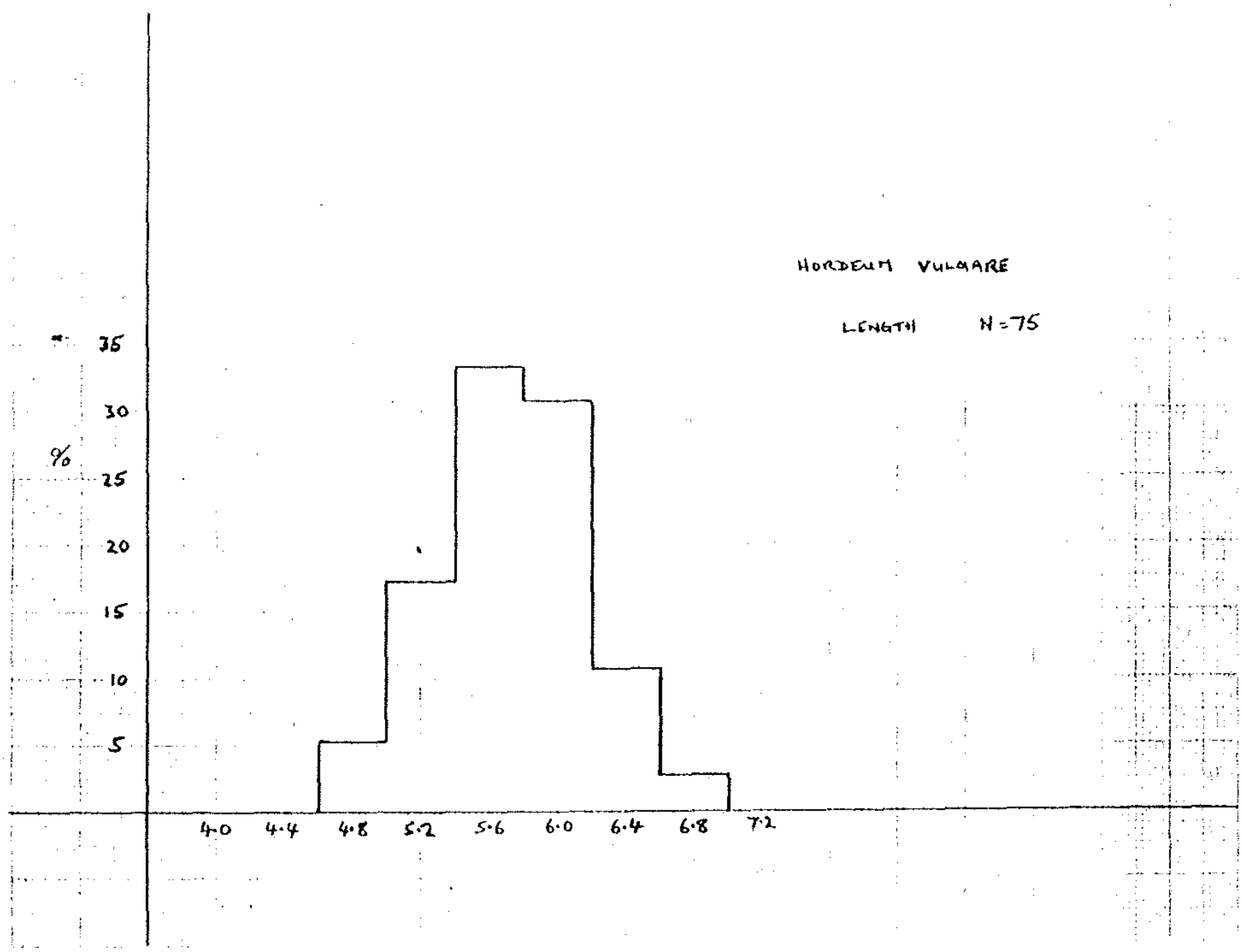
(2) GLUME WIDTH (DIMENSION B)

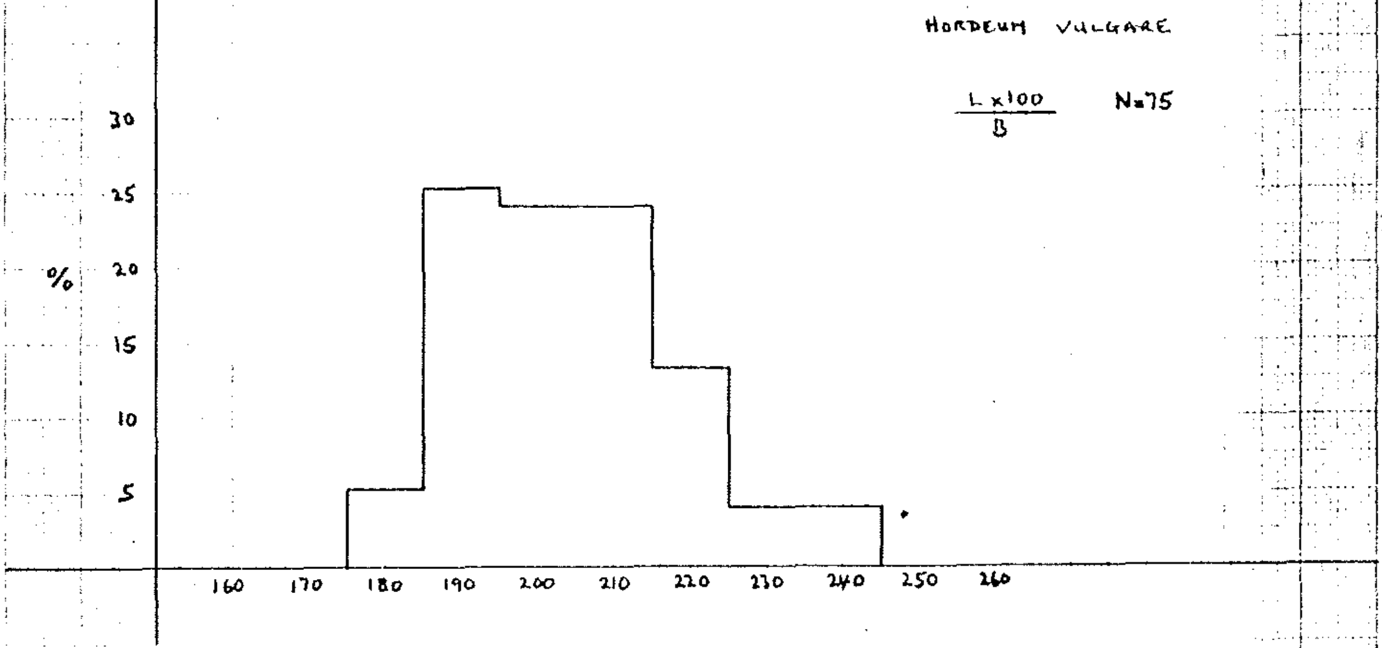
(3) RATIO $\frac{\text{DIMENSION B}}{\text{DIMENSION A}} \times 100$

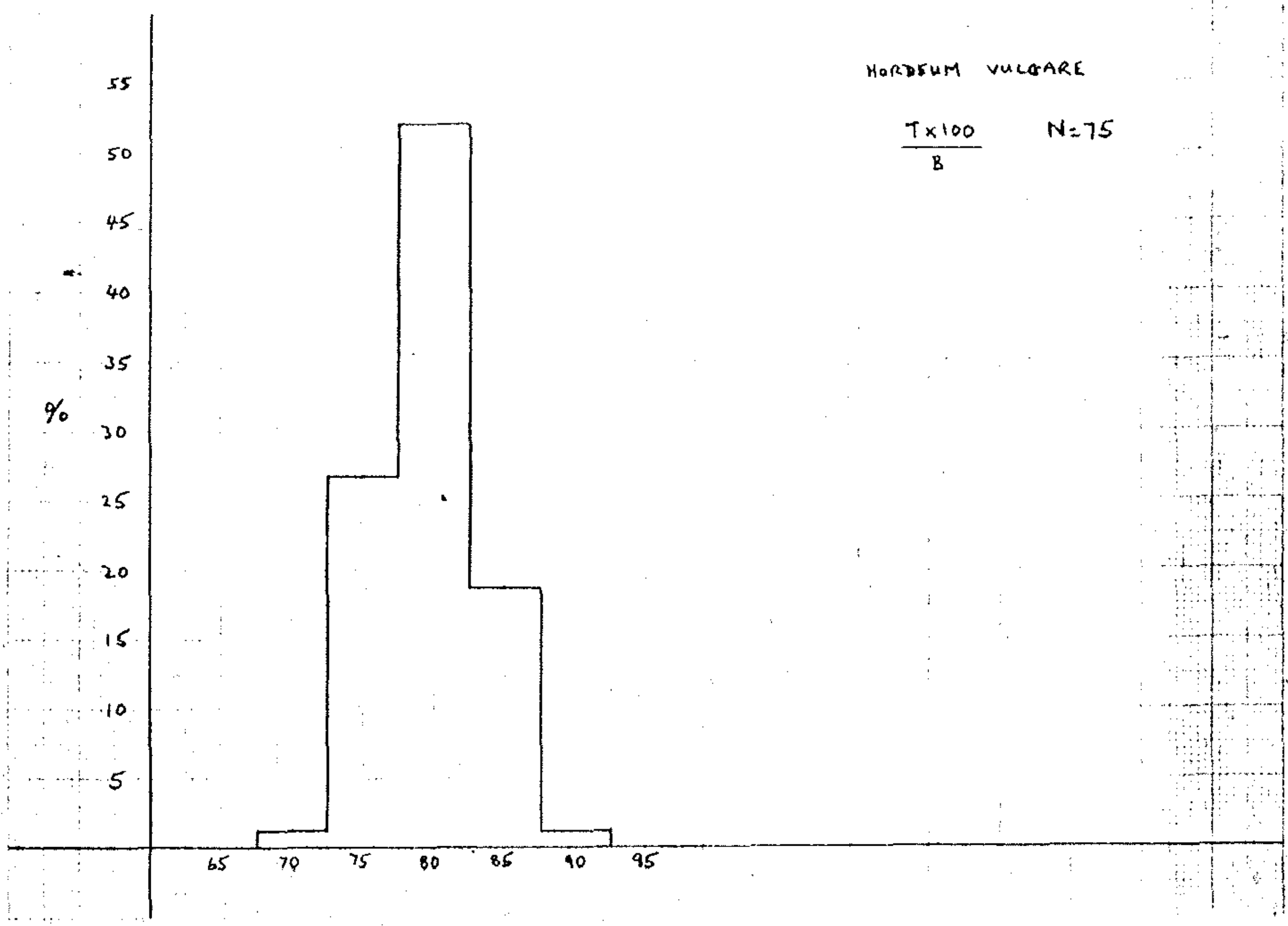







HORDEUM VULGARE
LENGTH N = 75
%
35
30
25
20
15
10
5
4·0
4·4
4·8
5·2
5·6
6·0
6·4
6·8
7·2


HORDEUM VULGARE
L x 100 / B
N=75
%
30
25
20
15
10
5
160
170
180
190
200
210
220
230
240
250
260


HORDEUM VULGARE
T x 100 / B
N=75
%
55
50
45
40
35
30
25
20
15
10
5
65
70
75
80
85
90
95

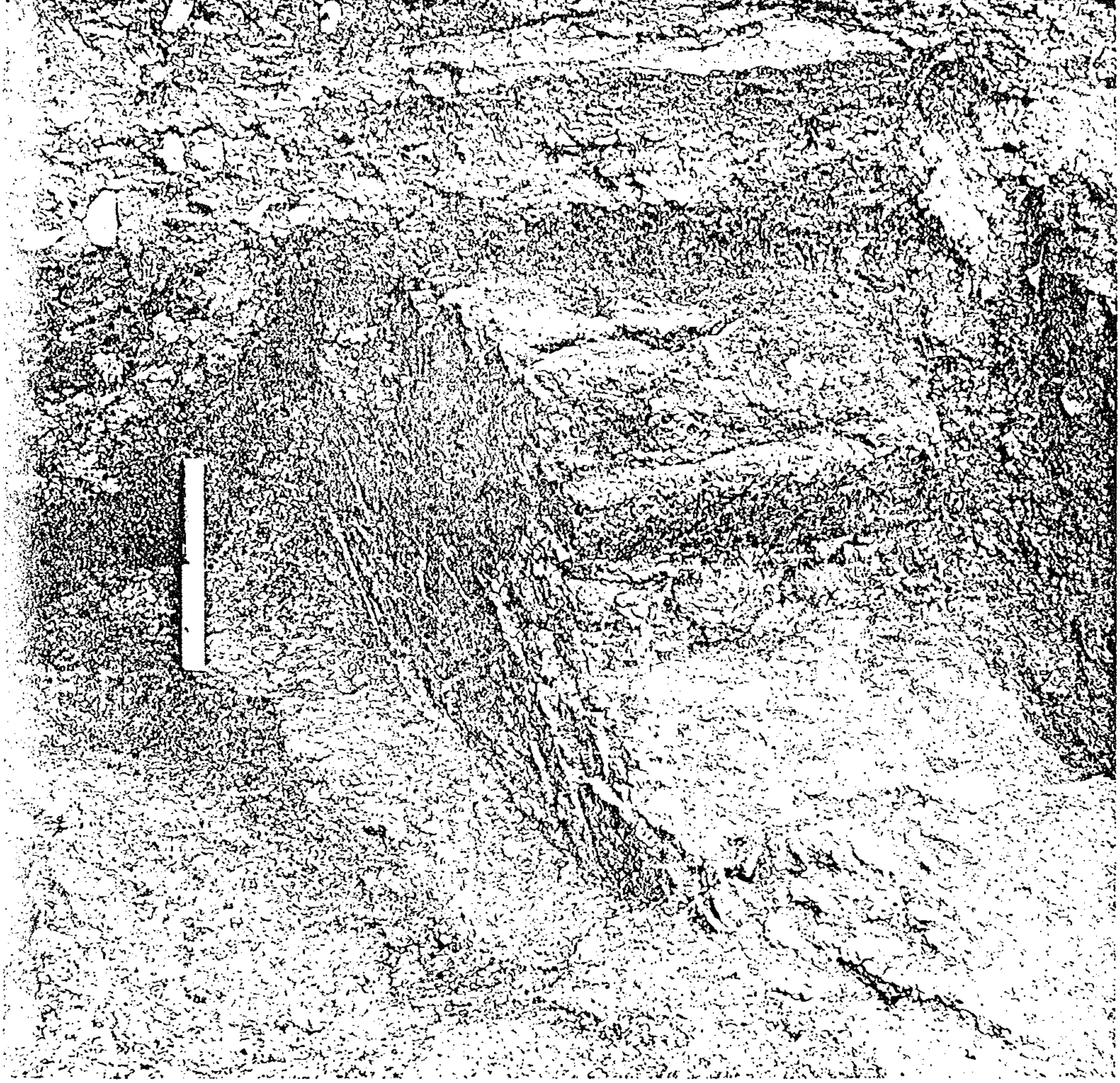


PLATE I

Photograph showing the position of the grain deposit (context 253) on the left in relation to the mudbrick wall (context 254) viewed from the north-east. FSE 76.

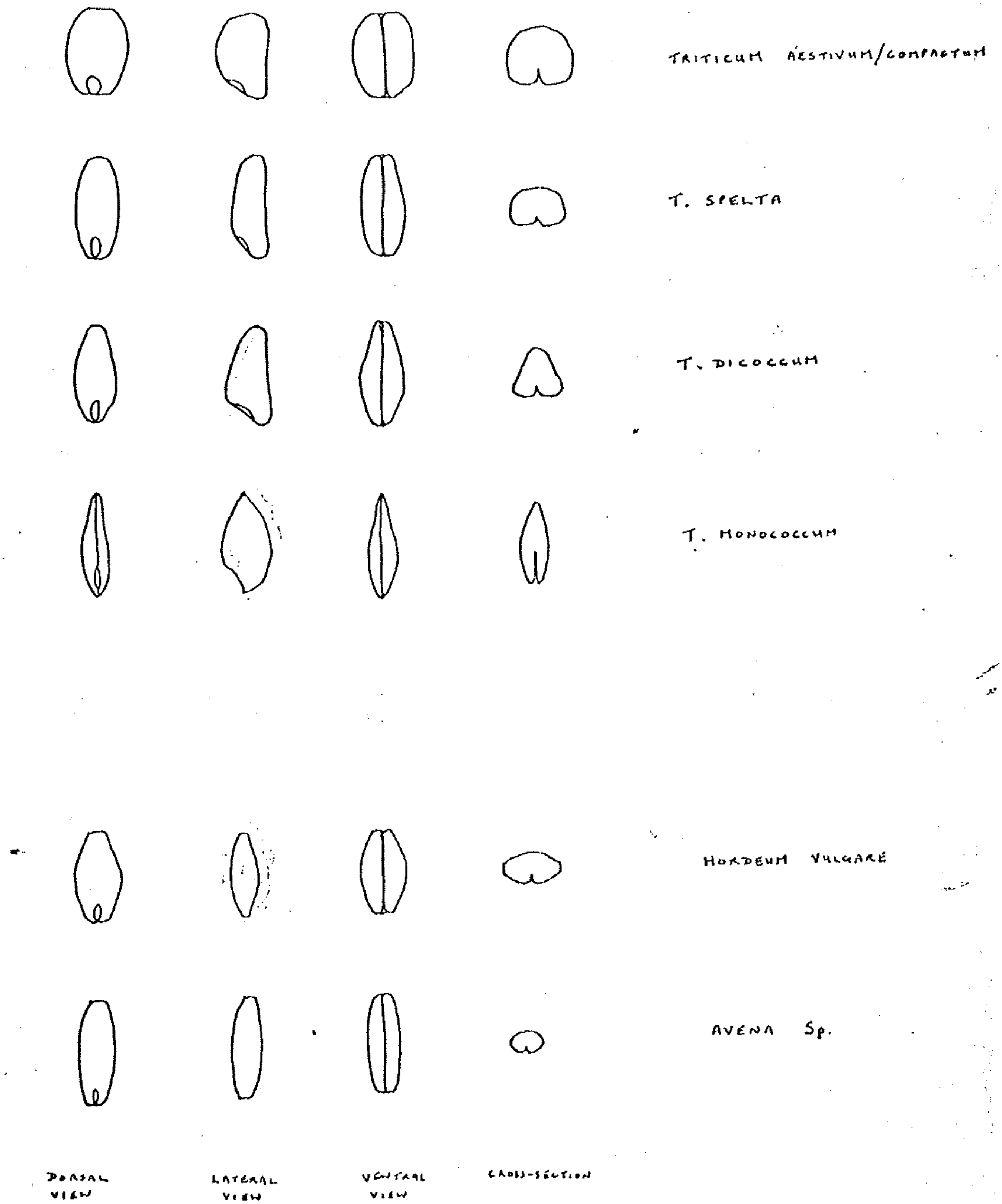

TRITICUM AESTIVUM/COMPACTUM
T. SPELTA
T. DICOCCUM
T. MONOCOCCUM
HORDEUM VULGARE
AVENA Sp.
DORSAL VIEW
LATERAL VIEW
VENTRAL VIEW
CROSS-SECTION

FIG. 3

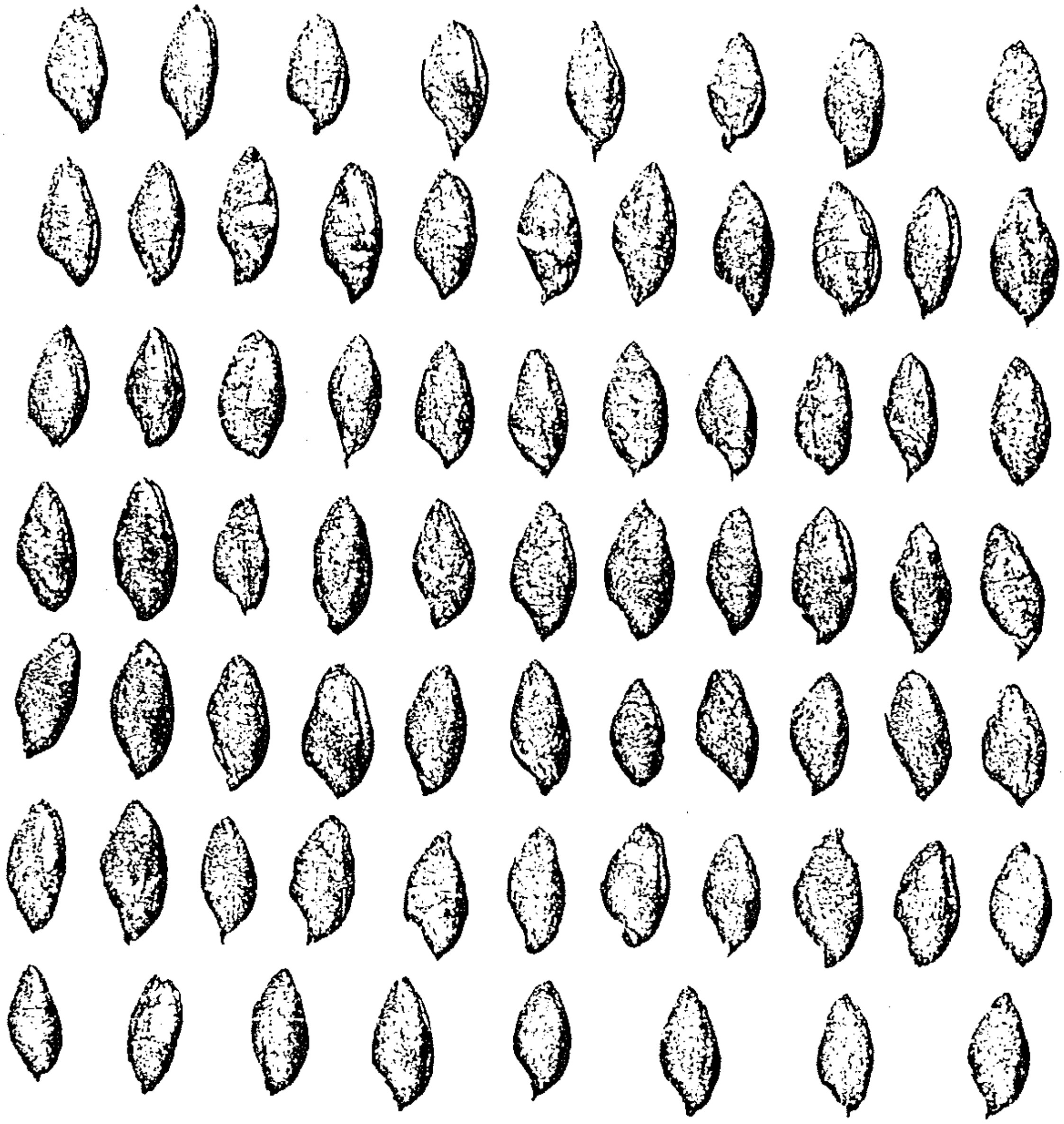


PLATE II

Grains of Triticum monococcum shown in lateral view (with dorsal side pointing to the left).

Note the sprouted grains in row 1, 3, 5, 6 and 7. Also note the lop-sided lens shape of these grains in this view and the considerable lateral compression in this species necessitating illustration in this view.

Magnification x 4

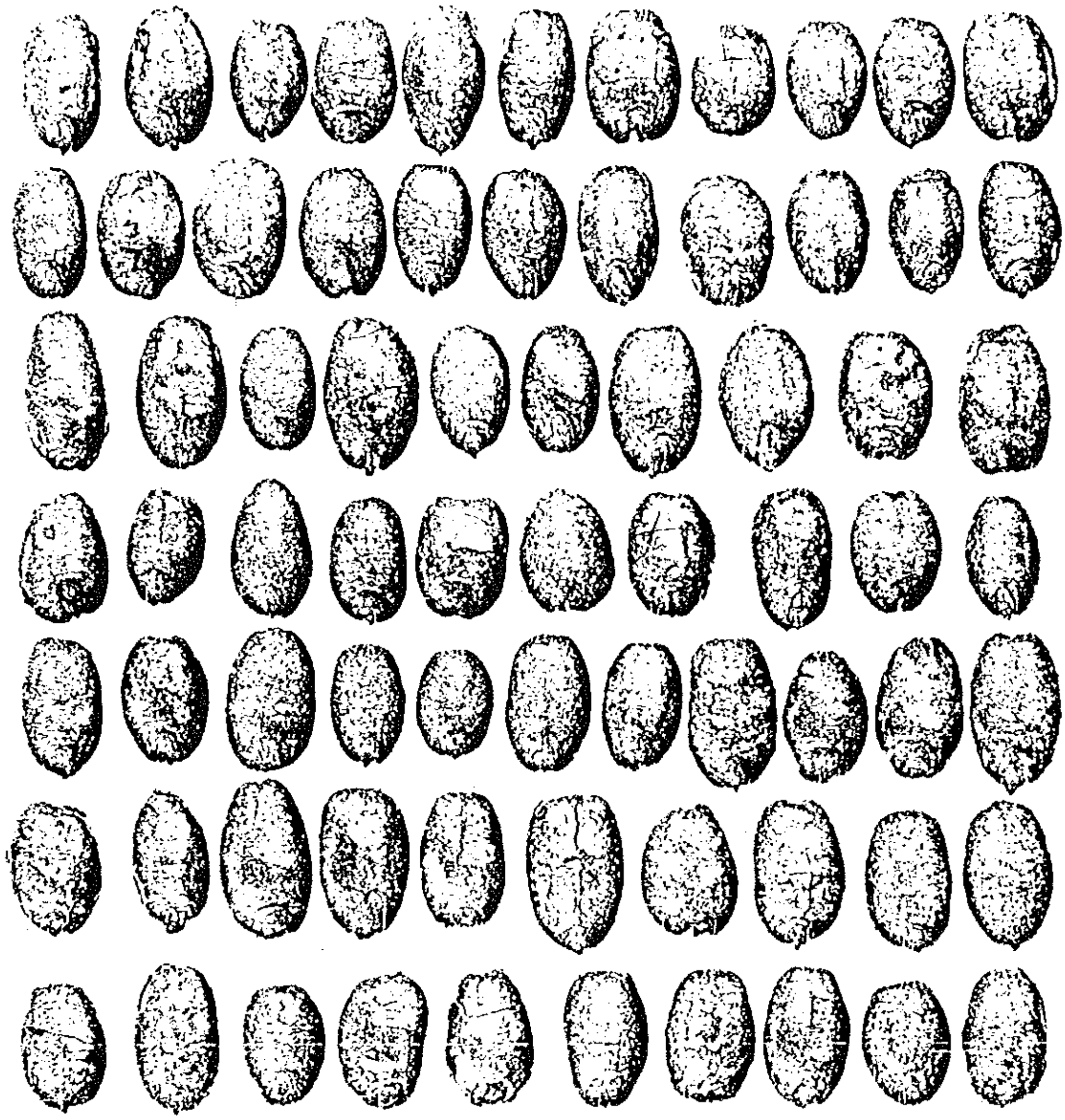


PLATE III

Grains of *Triticum aestivum/compactum* shown in dorsal view.

Magnification x 4.

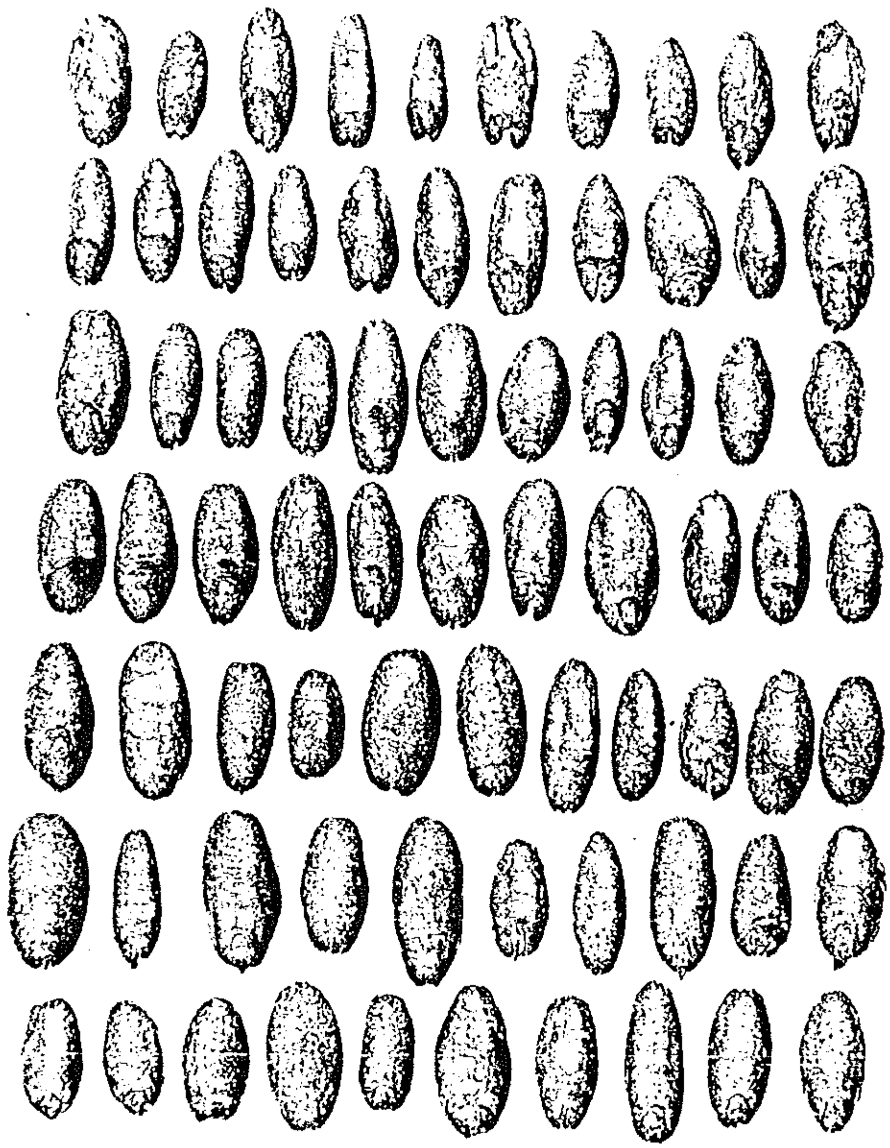


PLATE IV

Grains of Triticum dicoccum shown in dorsal view. Note the apparent lateral compression shown in grains of this species Magnification x 4

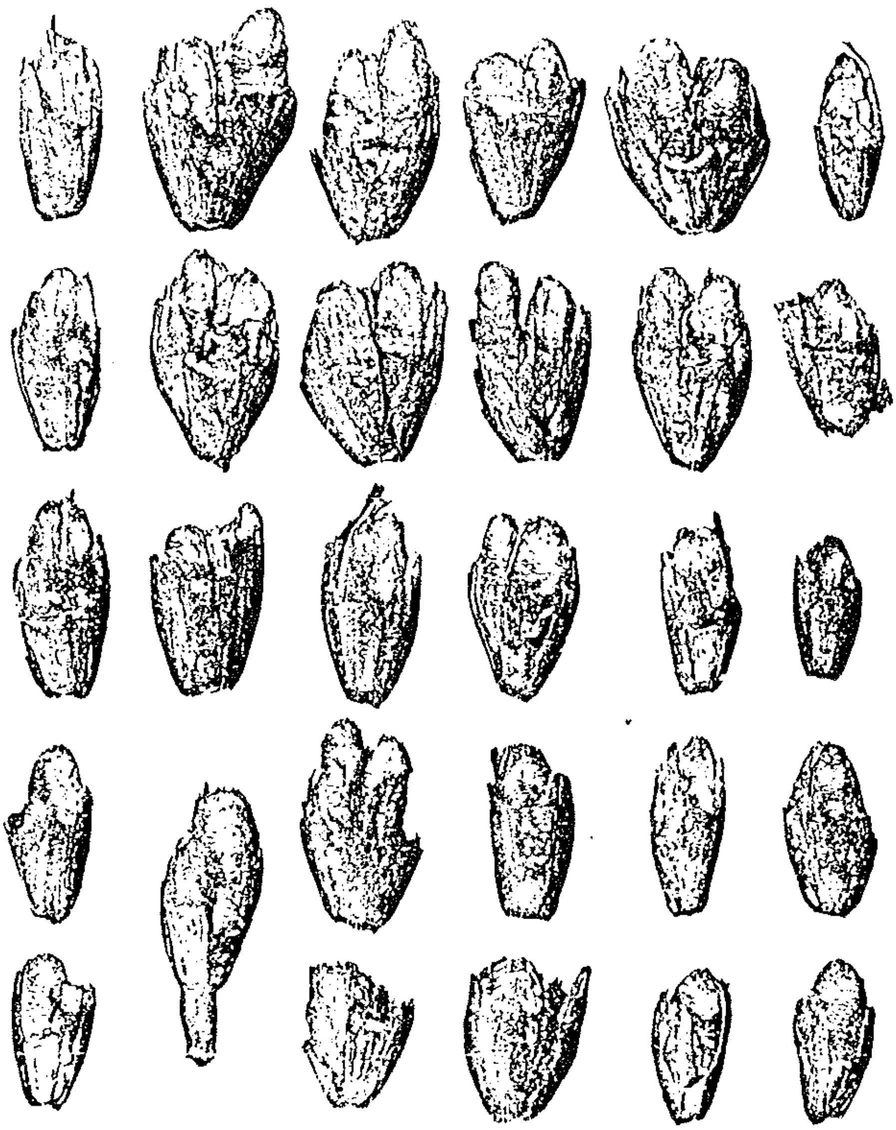


PLATE V

More or less complete spikelets of Triticum spelta, some of which are two grained, some single grained.

Note that all the spikelets exhibit a rachis fragment attached to each in the typical spelt fashion except one in the bottom left corner which has an additional rachis fragment attached to its base (more in the fashion of T. dicoccum spikelets)

Magnification x 4

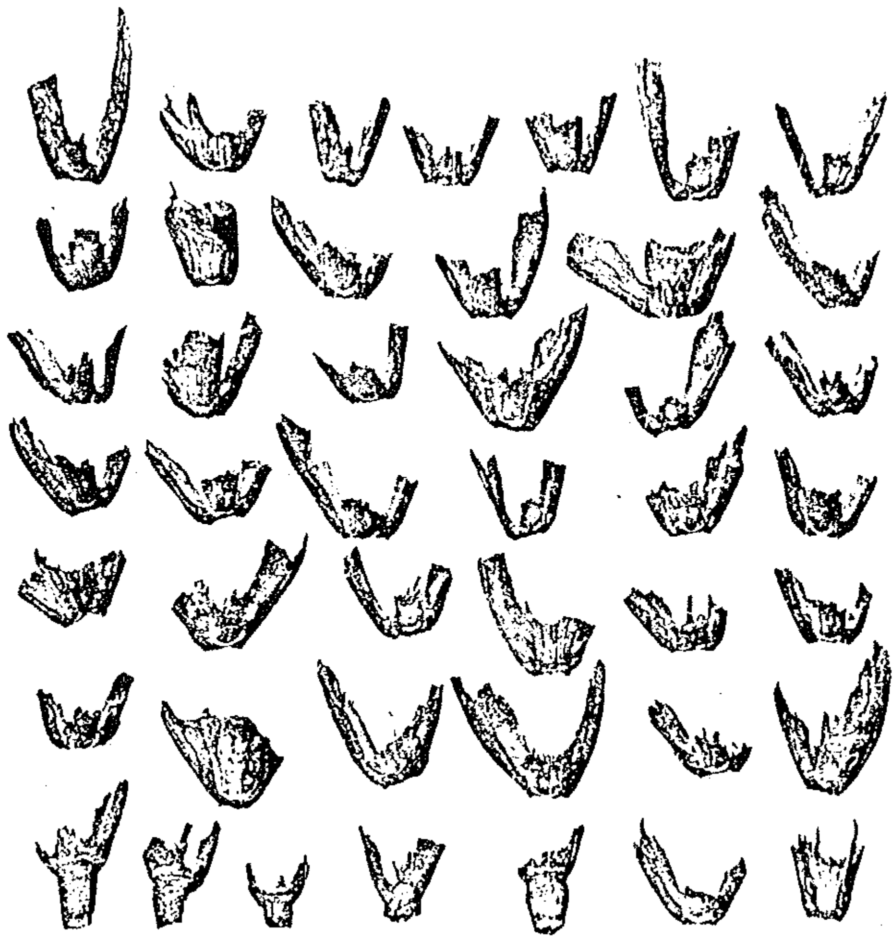


PLATE VI

Spikelet forks of Triticum spelta showing the typical for with attached rachis fragment.

The five spikelet forks to the left in the bottom line resemble T. dicoccum.

Note that some of the spikelets contained two grains, others were single grained.

Magnification x 4

PLATE VII

Grains of *Triticum spelta*. Note that they are more compressed dorso-ventrally and have a blunter apex than *T. dicoccum*. All in dorsal view.

Magnification x 4

PLATE VIII

Sprouted grains of *T. spelta*. All in dorsal view. Note the shrivelled distorted appearance of many of the grains.

Magnification x 4

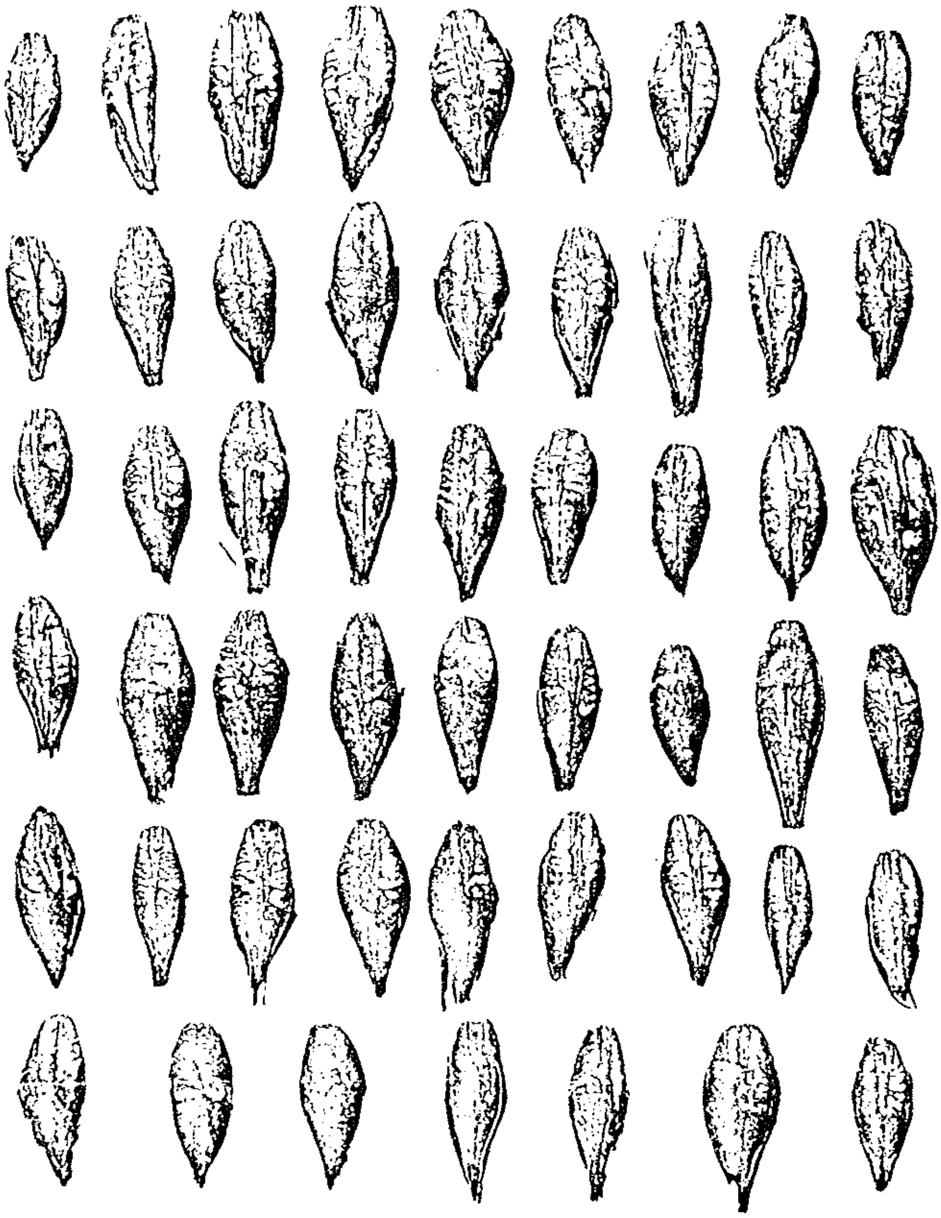


PLATE IX

Grains of Hordeum vulgare with lemma and palea still preserved (more or less). Most of the grains are shown in ventral view.

Note the presence of lop-sided twisted grains typical of six-row barley and the sprouted grains shown in dorsal view in rows 3 and 6.

Magnification x 4

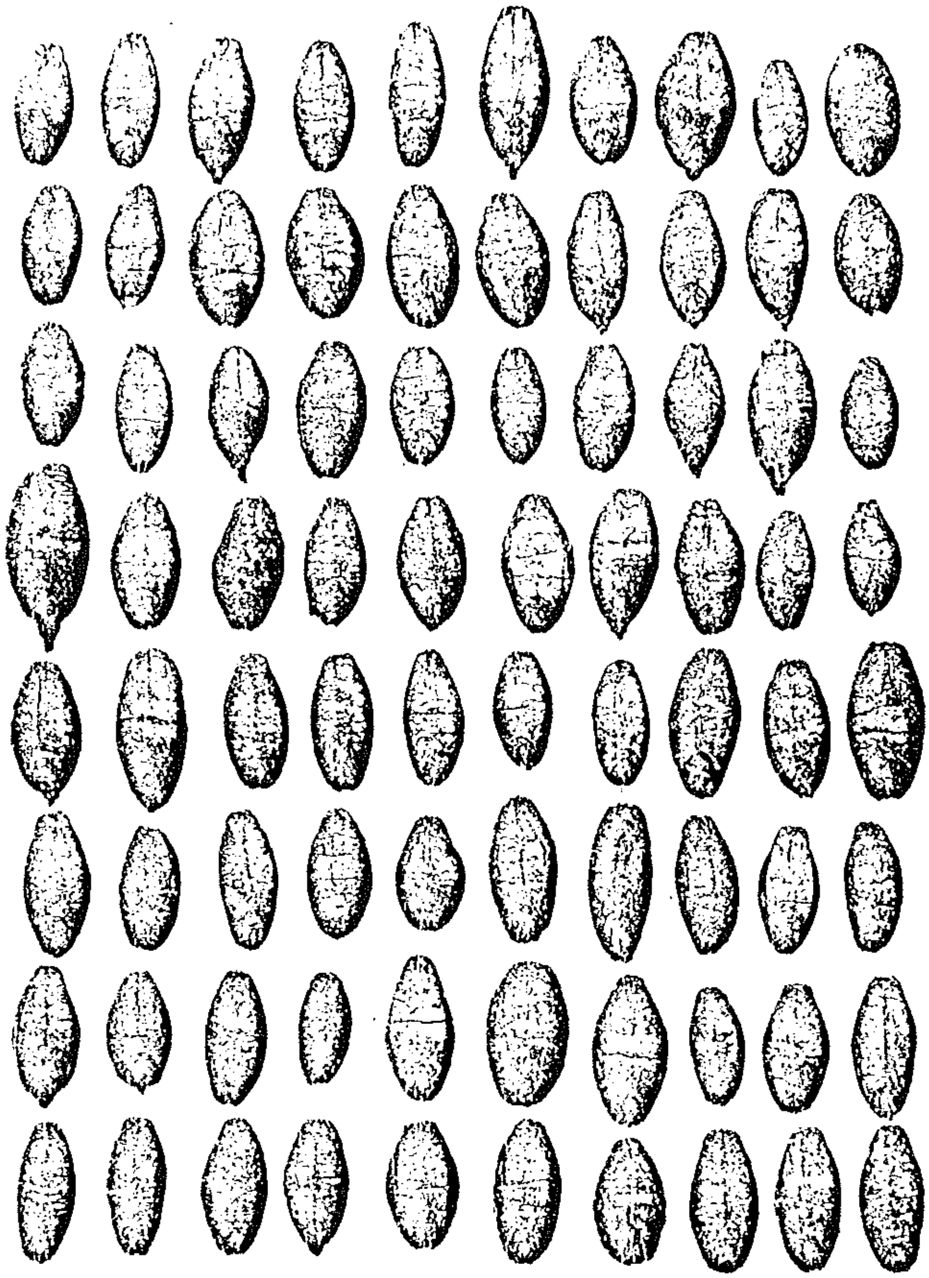


PLATE X

Grains of Hordeum vulgare without lemma and palea. Note the lop-sided grains typical of six-row barley. All the grains are shown in dorsal view.

Magnification x 4

PLATE XI

More or less whole florets of Avena fatua and spikelet for of the same species. Note the oval scar at the base of some of the florets and forks typical of this species. Magnification x 4

PLATE XIV

Seeds of Agrostemma githago which was the major broadleaved weed in the sample.

Magnification x 11.2