STUDIES OF *KIRKIDIUM KNIGHTII* (J. SOWERBY) FROM THE UPPER BRINGEWOOD BEDS NEAR LUDLOW, SHROPSHIRE.

by

Helen E. Boynton

Summary

Studies of disarticulation, orientation and size were made of the species of the pentamerid brachiopod *Kirkidium knightii* (J. Sowerby) from twelve localities near Ludlow, Shropshire. Using tracings made directly from the rock face at two localities and tabulated field data collected from ten localities, percentages of disarticulated and split valves, positions of orientation and variations in size were calculated. It was concluded that *K. knightii* disarticulated fairly easily first along the hinge line and then was broken along a line between the internal septa, the spondylium being the stoutest part of the shell which often remained after other parts of the shell were abraded away. Orientation appeared to be fairly random, whereas size showed relation to the sediment in that the larger shells were found in the carbonate-rich rocks and the smaller shells in the more silty limestones often on the margin of the shelf region.

Introduction

After a study of the shells of the *Cyrtina* [*Davidsonina*] *septosa* band in the Lower Carboniferous of Derbyshire (Sadler, 1964) the opportunity has now been taken to extend the technique to the Upper Silurian (Ludlovian) shell beds containing the pentamerid brachiopod *Kirkidium knightii* (J. Sowerby). Holland, *et al.* (1963) recorded the species as being common in the Upper Bringewood Beds near Ludlow, and Newall (1966) noted it was confined to particular beds or units. Accordingly this area and stratigraphical division were chosen for the study and a record made of the orientation, distribution and size of over 1,400 shells and shell fragments from an area comprising some 15 sq. km in order to try to determine the conditions of their deposition.

Geography and Stratigraphy

The main exposure of limestones and silty limestones containing *Kirkidium knightii* are to be found in an area north-west, west and south-west of Ludlow (text-fig. 1). Occasional specimens have been recorded from other outcrops of the Upper Bringewood Beds and from other stratigraphical horizons in the Ludlovian and Wenlockian but these are not considered here.

The Upper Bringewood Beds vary in thickness from 0 to 50 m, (Alexander, 1936). They are well developed at Leinthall Earls Quarry (locality 8) where there is a shallow anticline exposing a thickness of 40 m. The beds are massive and nodular limestones, with varying amounts of silty and muddy material, and the fossils generally occur in bands. Newall (1966) divided the beds into three main types of faunal units: *Conchidium* (*Kirkidium*) *knightii*, coral, and *Atrypa-Strophonella* units, all named after the dominant characteristic fossils. In this paper particular attention is paid to the *Conchidium* (*Kirkidium*) units.

Mercian Geol. Vol.7, No.3, 1979,
pp.181-190, 3 text-figs.

Palaeogeography (Upper Silurian)

As the massive and nodular limestones of the shallow shelf sea area are traced westwards to the margin of the deeper basinal region they pass into more silty limestones and finally into siltstones (Earp & Hains, 1971, fig. 35); Lawson, (1973b) showed this facies change in the Aymestrey area. Boulder beds are present in places in the basin facies and these have been interpreted as deposits transported down submarine canyons, the heads of which are located at the shelf margin (Whitaker, 1962), in the area immediately north and east of Leintwardine to the west of Ludlow (text-fig. 1). *Kirkidium knightii* has been recorded from siltstones of the basin facies at Bank Wood (264909) near Bishop's Castle by Allender (1960), but as the horizon at this locality is within the Middle Elton Beds, below the Upper Bringewood Beds, it is not detailed in this survey.

I have found a small specimen of *K. knightii* in the silty matrix between boulders in the boulder beds at Newton Lane, Lingen (377686) and suggest that it had probably been transported down a submarine canyon from the shelf region to the east.

Morphology of *Kirkidium knightii*
(text-fig. 2)

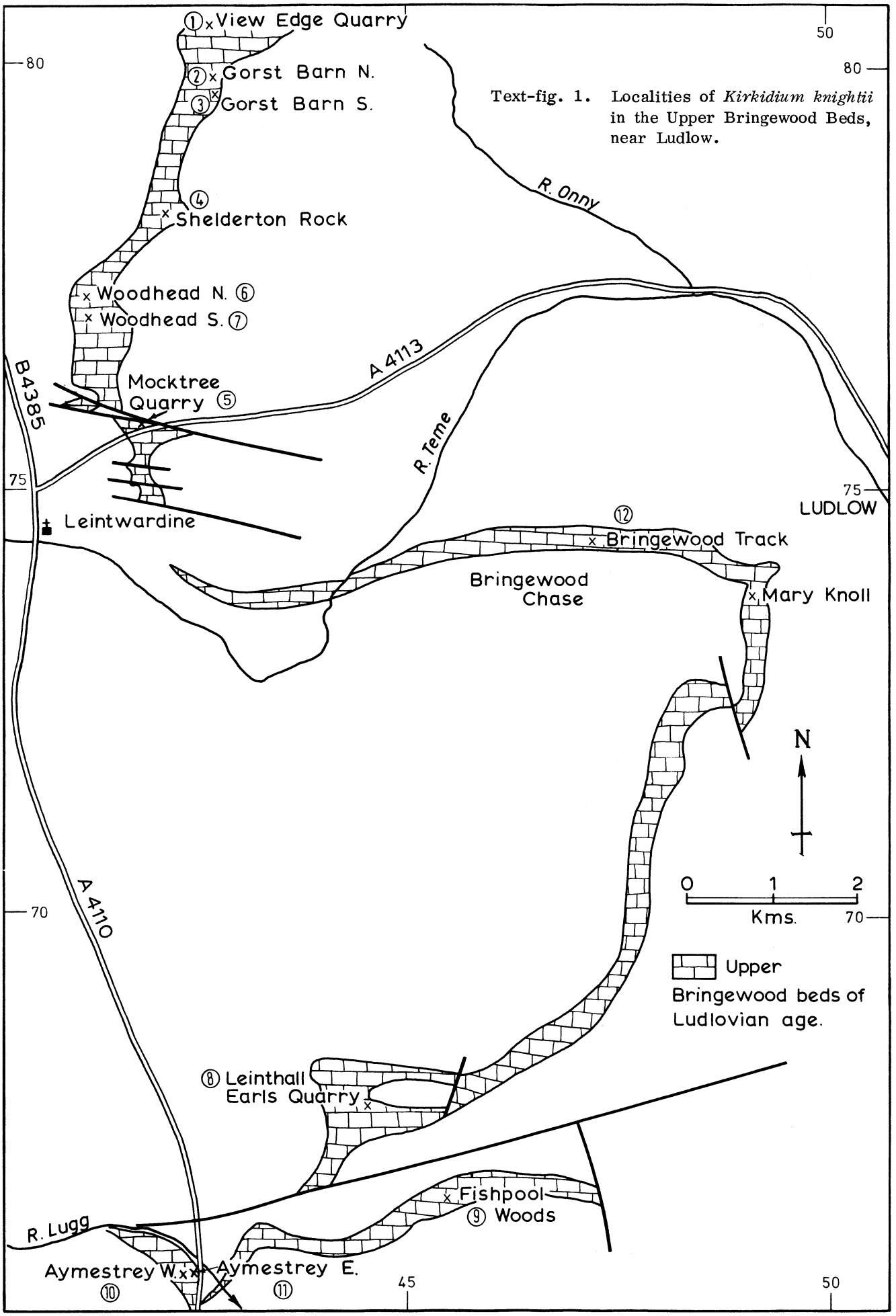
K. knightii is a large, thick-shelled brachiopod which is ovate or longitudinally oval in shape and often as wide as long (average size 5 cm by 5 cm). The shell is impunctate. The pedicle valve is more convex than the brachial valve and has a large incurved umbo. The brachial valve is oval in shape with a slight central depression running longitudinally. Surfaces of the valves are ornamented by numerous simple angular ribs, one or two bifurcating. Internally the dental plates of the pedicle valve converge in a trough-like shape for half the depth of the valve and this continues as a strong median plate made up of two septa which extends for two-thirds of the distance of the valve, towards the anterior margin. This internal structure is called the spondylium. In the brachial valve two much smaller, separate longitudinal septa extend from the hinge plate anteriorly to about half the length of the valve (text-fig. 2, no.4).

There is some variety in the shape of the shell and in the ribbing. This was illustrated by Lamont (1965) who suggested that the variation might have a palaeoecological significance. He said that coarse ribs appeared to indicate development in well-lit, shallow and wave-disturbed waters while more transverse forms with fine ribs predominated in muddy or silty waters where there was less water movement. He did not give reasons for these deductions.

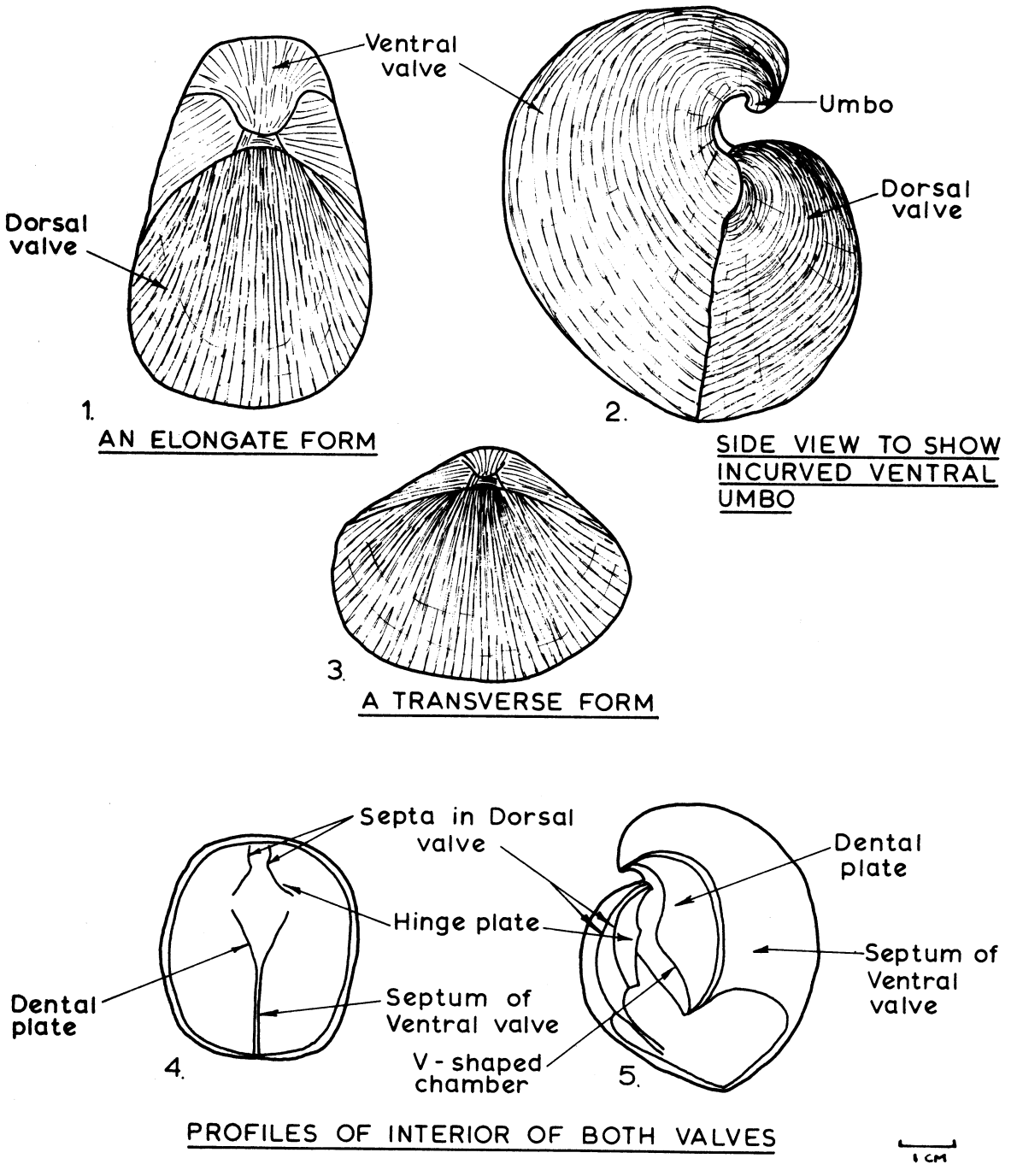
Method of study

Because of the difficulty of extracting individual specimens tracings of outlines of shells, shell fragments and corals were made onto paper directly from rock faces exposed at right angles to the bedding. By this means the exact position of each shell, its correct orientation, the state of disarticulation and size (as measured along the longest dimension visible) were recorded. This method of study, the same as that used for studying the *Cyrtina septosa* band in Derbyshire (Sadler, 1964) was used at two localities, View Edge Quarry (425806) and near Gorst Barn, north of Springhead Gutter (425789) which is referred to as Gorst Barn N.

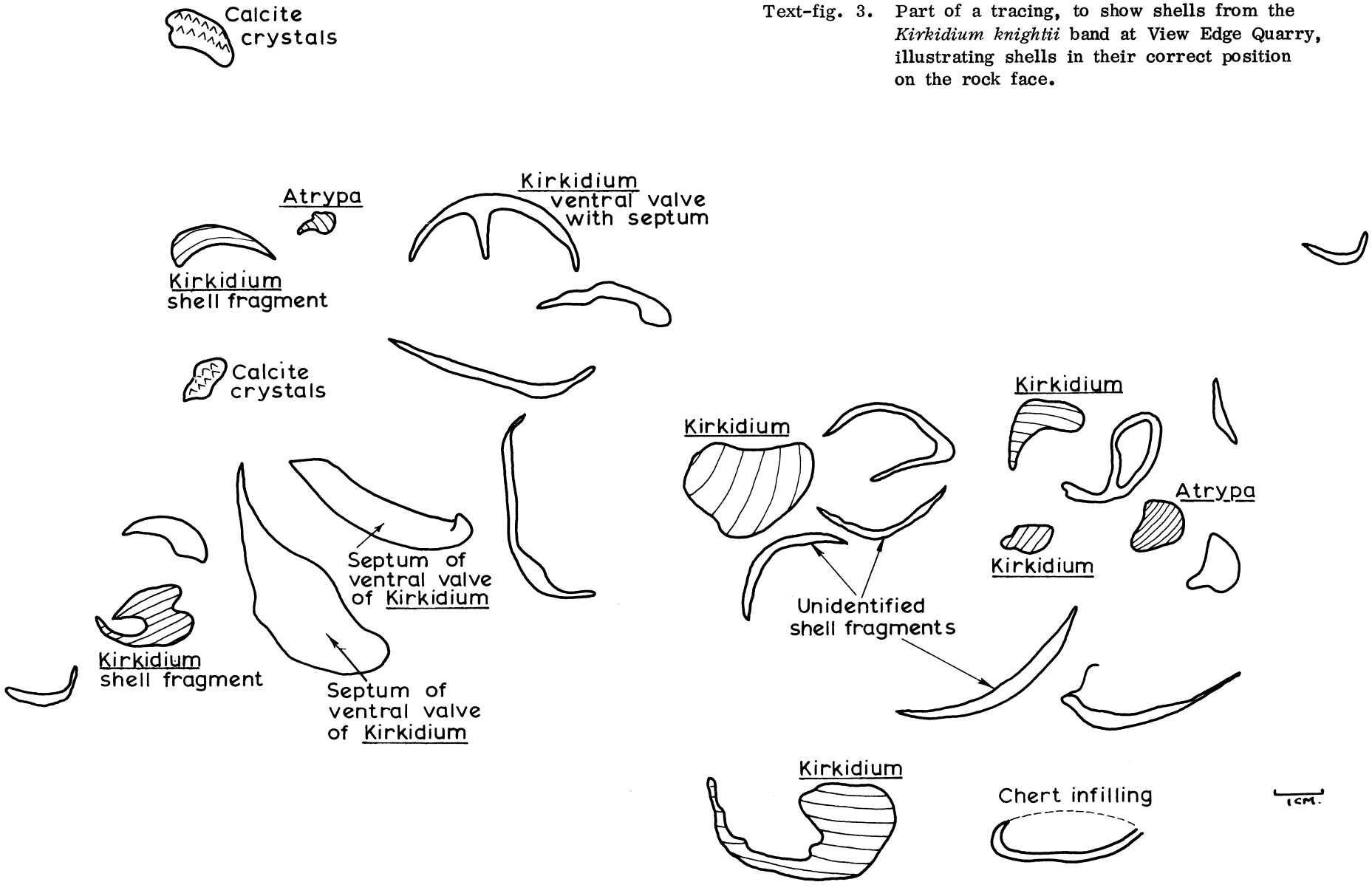
At View Edge Quarry where the band attains its maximum thickness of 4 m a tracing was made which measured 6 m in length and 0.6 m in height. It illustrated 614 shells and shell fragments. Text-fig. 3 shows a small part of the tracing. A smaller tracing was made at Gorst Barn N. where 532 shells and shell fragments were recorded.



Text-fig. 1. Localities of *Kirkidium knightii* in the Upper Bringewood Beds, near Ludlow.



Text-fig. 2. Morphology of *Kirkidium knightii*, all figs. x 1.



Text-fig. 3. Part of a tracing, to show shells from the *Kirkidium knightii* band at View Edge Quarry, illustrating shells in their correct position on the rock face.

Locality	Total no. of shells counted	Total % of *K. knightii* in fauna	% of *K. knightii* showing *Orientation* ⌣	⌢	Others	% of *K. knightii* showing *Disarticulation* Art.	Disart.	unknown	% of *K. knightii* showing *Size* "Small"	"Medium"	"Large"	Grid Reference
1. View Edge Quarry	641	32%	30%	19%	51%	2%	67%	31%	43%	54%	3%	425806
2. Gorst Barn N.	532	41%	68%	9%	23%	¾%	97%	2¼%	34%	62%	4%	425789
3. Gorst Barn S.	44	90%	55%	10%	35%	2%	85%	13%	32%	54%	14%	425788
4. Shelderton Rock	42	95%	22½%	37½%	40%	2½%	75%	22½%	30%	45%	25%	419779
5. Mocktree Quarry	16	100%	37½%	44%	18½%	6%	75%	19%	31%	69%	0%	416754
6. Woodhead N.	5	80%	25%	50%	25%	0%	75%	25%	100%	0%	0%	409768
7. Woodhead S.	10	80%	62½%	12½%	25%	0%	75%	25%	75%	25%	0%	409767
8. Leinthall Earls Quarry	74	91%	51%	22%	27%	1½%	91%	7½%	34%	8½%	17½%	442682
9. Fishpool Woods	28	100%	39%	18%	43%	0%	72%	28%	14%	61%	25%	451664
10. Aymestrey W.	16	50%	25%	50%	25%	0%	87½%	12½%	25%	62½%	12½%	421654
11. Aymestrey E.	12	100%	25%	58%	17%	0%	83%	17%	25%	75%	0%	422654
12. Bringewood Track	15	100%	33%	7%	60%	0%	80%	20%	90%	10%	0%	456736

Table 1. To show percentages of *Kirkidium knightii* in positions of orientation, the state of articulation and the size.

Key: Art. = Articulated

Disart. = Disarticulated

⌣ = Concave side uppermost

⌢ = Convex side uppermost

At the remaining ten localities correct disarticulation, orientation and size were tabulated in a field note book. From the field data, collected either on tracings or in tables, from the twelve localities it was possible to calculate the percentages of shells of *Kirkidium knightii* which were disarticulated, the percentages of shells in the following positions ⌣ (concave uppermost), ⌢ (convex uppermost), and others, and the percentages of shells in various size groups. Size groups as follows were used: (1) "small" shells, less than 3 cm, (2) "medium" shells, between 3 and 6 cm and (3) "large" shells, over 6 cm. Sizes were measured along the greatest dimension visible. The actual size of the fossil could not always be measured because only a small portion of the shell might be visible on the rock face. Therefore only a general idea of the size of shells in each fauna could be obtained because of this discrepancy.

At least one thin section of limestone from each locality was studied and at View Edge Quarry seven thin sections spaced at 15 cm intervals vertically were also taken, in order to note the approximate amount of silty material and the orientation of the intraclasts. At View Edge Quarry two thin sections showed microscopic detail below the band.

Results of View Edge Quarry and Gorst Barn N.

At View Edge Quarry and Gorst Barn N. tracings were taken from just below and from the *Kirkidium knightii* band. *K. knightii* was found together with *Strophonella euglypha* (Hisinger). *Gypidula lata* Alexander, *Sphaerirhynchia wilsoni* (J. de Sowerby), *Leptaena depressa* (J. Sowerby), *Favosites gothlandicus* Edwards & Haime, and *Heliolites interstinctus* (Linnaeus).

Percentages of disarticulated valves, different orientations and size according to the three groups described, were calculated from the tracings and the results recorded on table 1.

The percentages of *Kirkidium knightii* in these two faunas were lower than at the other ten localities because data were obtained below the band as well as from the band itself. At View Edge Quarry *K. knightii* made up 32% of the fauna and at Gorst Barn N. the percentage was 41%. 67% of the shells at View Edge Quarry were disarticulated and at Gorst Barn N. the percentage was 97%. Shells of the "medium" group of size made up 54% at View Edge Quarry and 62% at Gorst Barn N. "Large" shells gave small percentages at both localities, 3% at View Edge Quarry and 4% at Gorst Barn N. Orientation at both localities was random.

At View Edge Quarry it was noted that the base of the *K. knightii* band was distinctive with shells of *K. knightii* coming in abruptly with more calcium carbonate-rich rocks and a notable decrease in argillaceous material.

A small collection of specimens was made from Gorst Barn N. where the band is 1.3 m in thickness. It was noted that *K. knightii* var. *elongatum* was particularly common at this locality. The variety was described by Lamont (1965) as a narrow, elongate form with low convexity and fewer ribs.

Results from the other ten localities

At ten localities where the *K. knightii* band was less well developed and numbers of the species considerably fewer than at View Edge Quarry and Gorst Barn N., notes on orientation, disarticulation and size were tabulated in a field note book. From these notes and numbers, percentages of *K. knightii* in the total faunas were calculated and found to be high, ranging from 50% at Aymestrey W., to 100% at Mocktree Quarry. Percentages of disarticulated valves were also high ranging from 72% at Fishpool Woods to 91% at Leinthall Earls Quarry. Orientation was variable showing no distinct pattern. Figures for size showed largest percentages in the "medium" group at most localities, while "large" shells were present at three localities - 17½% at Leinthall Earls Quarry, 25% at Fishpool Woods and 12½% at Aymestrey W.

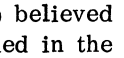
Interpretation of the results of the *Kirkidium knightii* survey

Disarticulation

After death a brachiopod will tend to disarticulate the two valves which become separated if subjected to water turbulence. Therefore a high rate of disarticulation indicates a death assemblange of fossils.

There are high percentages of disarticulation of *K. knightii* at all twelve localities indicating they are all death assemblages. Disarticulation appears to have taken place first along the hinge line, separating pedicle from brachial valve and then the valves are broken or split along the line between the internal septa particularly in the pedicle valve. This line (text-fig. 2, no.4) was probably a line of weakness which became exposed to water action after the two valves had separated. Numerous sections of pedicle valve spondylia are seen at most localities (text-fig. 3). *K. knightii* appeared to be a species which disarticulated and split fairly easily after death when subjected to water action.

Orientation

There appears to be no pattern in the orientation of brachial or pedicle valves of *K. knightii.* Valves are found in many positions including, concave side uppermost, ◡ convex side uppermost, ◠ , the hinge line uppermost) , and the anterior margin uppermost (. Newall (1966) believed that *K. knightii* lived with the pedicle valve lowermost and probably embedded in the sediment,  . It is thought that individual valves arranged in random pattern in the *K. knightii* bands studied, may represent accumulations of shell debris by fairly turbulent water action not too far from the original life positions. There is no pattern of orientation as shown by the intraclasts as seen in thin sections, although there is perhaps a slight preferred orientation parallel with the bedding.

Size

The shells were divided into groups consisting of "small", "medium" and "large" shells as described in *Method of Study*, p.182.

Most shells fell into the "medium" group with numbers ranging from 10% at Bringewood Track to 75% at Aymestrey E. As many complete specimens of *K. knightii* would fall naturally into the "medium" group, this indicates that many of the shells have not been greatly comminuted into smaller fragments. "Small" shells and fragments make up the next most important group with numbers ranging from 14% at Fishpool Woods to 90% at Bringewood Track. Woodhead N. recorded 100% "small" specimens. In contrast, the highest numbers of "large" shells, 25% at Shelderton Rock, 17½% at Leinthall Earls Quarry, 25% at Fishpool Woods and 12½% at Aymestrey W. were all found to be localities where the limestones were rich in calcium carbonate and where small subhedral quartz grains and argillaceous material were less important. At Woodhead N. and Woodhead S., Aymestrey W. and Bringewood Track where the limestones were more silty and less rich in calcium carbonate the shells were definitely smaller in size. This indicates that *K. knightii* preferred conditions where calcium carbonate was more abundant in the sea water for the manufacture of its thick large shell. Woodhead N. and S. and Aymestrey W. are all on the margin of the shelf and basin facies where shelly limestones pass into siltstones of deeper water sedimentation. It appears that at this margin conditions were far less suitable for *K. knightii* which preferred the more carbonate-rich waters of the shelf region.

Conclusions

This study of *Kirkidium knightii* from the Upper Bringewood Beds near Ludlow has revealed interesting results which are summarized below:

(1) The base of the *K. knightii* band is, particularly at View Edge Quarry, distinctive with this species coming in abruptly with the onset of the more carbonate-rich rocks. *K. knightii* generally occurs with other brachiopods and some corals, although it forms the dominant element in the fauna of the bands.

(2) Nearly all the shells are disarticulated showing that the bands are composed of death assemblages. Many pedicle valves are then broken along the line between the two internal septa to show parts of the spondylia. The anterior margin of the shell is often worn away.

(3) Orientation appears to be random with shells in many different positions of fossilization.

(4) Size of shells shows some relationship to the sediments in which the shells are found. "Small" shells are found in more silty limestones often at the shelf margin and "large" shells are present in the shelf area where the limestones are more carbonate-rich. "Medium" shells form substantial percentages at most localities indicating that many shells had not undergone great comminution by water action.

(5) Shells of *K. knightii* probably accumulated in shell banks, similar to the mussel beds of today and they were fossilized not too far from their life positions. This is shown by the high rate of disarticulation but low rate of dispersal of the shells after disarticulation.

(6) In comparison, shells of the *Cyrtina septosa* band (Sadler, 1964) in the Lower Carboniferous of Derbyshire showed a high disarticulation rate, indicating that these were also death assemblages. In Derbyshire the survey also showed a random pattern of orientation but no relation of size of shells with sediment. After processing the data of 1964 by computer (Sadler & Merriam, 1967) it was deduced that water movement over the shelf region was more turbulent than over the shelf margin. It is hoped to process the data of *K. knightii* by similar methods in order to discover further evidence for sedimentation in the Upper Bringewood Beds of the Ludlow region.

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Mrs. H.E. Boynton,
7, The Fairway,
Oadby,
Leicestershire
LE2 2HH.

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