

## KNAPPERS' ROT

### SILICOSIS IN EAST ANGLIAN FLINT-KNAPPERS

by

A. BATTY SHAW\*

ALONG THE line of the prehistoric trackway Icknield Way, a ridge of chalk, five miles wide, extends through west Norfolk to north-west Suffolk.<sup>1</sup> Beneath it lies a seam of floorstone flint that Neolithic men exploited when they dug a series of large and elaborate mines to extract the flint at a site in south-west Norfolk now known as Grime's Graves. Over the succeeding four thousand years when this same flint lay near the surface it no doubt continued to be used for flint implements and later for building houses, churches, and for other purposes. Then at the end of the eighteenth century a second series of mines was dug into the chalk ridge at Brandon, a Suffolk market town three miles south-west of Grime's Graves, when Brandon became the main source of supply of gunflints for the British army.

In his Milroy lectures for 1915, Collis<sup>2</sup> suggested that the Neolithic miners at Grime's Graves may have suffered from silicosis and conjectured that this might be the oldest occupational disease.<sup>3</sup> He also reported on a study of the second period of East Anglian flint mining and showed that the exposure of the Brandon gunflint-knappers to silica dust caused an excess mortality from pulmonary tuberculosis, known locally at the time as "knappers' rot".<sup>4</sup> Collis's observations have often been

\*A. Batty Shaw, M.A., D.M., F.R.C.P., Norfolk and Norwich Hospital, Norwich, Norfolk NR1 3SR.

<sup>1</sup> Icknield Way ran along the chalk downs from north-west Norfolk to Salisbury Plain. P. W. Blake, J. Bull, A. R. Cartwright, and A. Fitch, *The Norfolk we live in*, Norwich, George Nobbs Publishing, 1975, pp. 25–27.

<sup>2</sup> Edgar Leigh Collis (1870–1957). In 1915 he was one of H.M. Medical Inspectors of Factories, Home Office; from 1917–19 he was Director of Welfare and Health, Ministry of Munitions, and from 1919–33 was the first holder of the Mansel Talbot chair of Preventive Medicine, Welsh National School of Medicine. During his tenure of the chair he lived at Lossiemouth, Scotland, where he died in 1957. Obituary notices, *Lancet*, 1957, ii: 750; *Br. med. J.*, 1957, ii: 886.

<sup>3</sup> E. L. Collis, 'Milroy lectures 1915. Industrial pneumoconiosis with special reference to dust-phthisis', *Publ. Hlth, Lond.*, 1914–15, 28: 252–264, 292–305; and 1915–16, 29: 37–44. The lectures were also published as a monograph of the same title, London, H.M.S.O., 1919.

<sup>4</sup> Collis did not quote the synonym "knappers' rot" in his Milroy lectures but did so in his original report on phthisis among Brandon gunflint-knappers, E. L. Collis in *Minutes of Evidence, Royal Commission on Metalliferous Mines and Quarries*, London, H.M.S.O. (Cd. 7477), 1914, vol. 2, appendix J. p. 262. Though Collis states the condition was known locally as "knappers' rot", Herbert Franklin Field (born 1896) of Brandon, who became the fifth generation of his family to work as a gunflint-knapper when he was so employed from 1911–14 and for a further period in the Second World War, told the author in 1979 that he had never heard the term, nor has any other knowledge of it been obtained in Brandon. In France the

quoted in the literature on palaeopathology and occupational lung disease, but in spite of the increased interest in both these branches of medicine since Collis's time and the further knowledge that has since been acquired of flint mining at Grime's Graves and of the gunflint industry at Brandon, no further study of silicosis in East Anglian flint workers has been undertaken. This paper reports the findings of such a study.

#### NEOLITHIC FLINT MINING AT GRIME'S GRAVES

##### *General description*

Grime's Graves, a name probably given to the site by the Anglo-Saxons, were for many centuries just a series of shallow circular depressions on the slopes of a dry valley in the Breckland of south-west Norfolk (Fig. 1) and many explanations were proposed to account for them. It was only just over a hundred years ago, in 1869, that the hollows were shown to be infilled circular shafts of flint mines dug in the Neolithic period, and other contemporary but smaller mines have since been found at other sites in Norfolk.<sup>5</sup> Since 1869 a number of studies has been made of Grime's Graves<sup>6,7</sup> and they are the largest and best known group of Neolithic flint mines and associated flint working sites in Britain.<sup>8</sup> The mining area extends over ninety-three acres; there are thought to be between 350 and 500 galleried mines, and radio-carbon dating places activity on the site to a period around 2000 B.C. Each mine varies from six to fourteen metres in depth, and at the base, where floorstone flint is encountered, narrow galleries radiate like the spokes of a wheel (Fig. 3). Similar mines of the same period have been found on the Continent<sup>9</sup> dating from Neolithic man's discovery that he could work the freshly extracted flint before it lost its quarry water much more easily than the dead flint found on the surface.<sup>10</sup> The main stimulus to the mining activity at Grime's Graves, and other contemporary underground mines, was the provision of flint axes needed in large numbers by late Neolithic man to fell trees and thereby bring more land under cultivation. The quantity of flint produced at Grime's Graves for this purpose was far in excess of local domestic needs<sup>11</sup> and some must have been sent to

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condition was known as "la cailloute" or "la caillotte". J. Emy, *Histoire de la pierre à fusil*, Blois, Jean Emy et Société d'Exploitation de l'Imprimerie Alleaume, 1978, p. 97.

<sup>5</sup> At Massingham and Lyndford in West Norfolk and at Whitlingham near Norwich. Blake *et al.*, *op. cit.*, note 1 above, p. 25.

<sup>6</sup> R. R. Clarke, *Department of the Environment. Grime's Graves, Norfolk*, London, H.M.S.O., 1963, reprinted 1975. (A detailed and illustrated guide-book without references.) B. Green, *Young people's guide to Grime's Graves*, London, H.M.S.O., 1964, reprinted 1977. (A shorter illustrated guide-book; its author Miss B. Green, Keeper of Archaeology, Castle Museum Norwich, kindly read and corrected the present manuscript.)

<sup>7</sup> G. de G. Sieveking, 'Grime's Graves and prehistoric flint-mining', in H. Crawford (editor), *Subterranean Britain. Aspects of underground archaeology*, London, J. Baker, 1979, pp. 1-43. This account gives references to earlier studies and to the findings from the most recent survey undertaken by the British Museum during the 1970s.

<sup>8</sup> Most of Britain's other Neolithic flint mines were clustered around the Downs of West Sussex at Cissbury Ring, Harrow Hill, Findon, Blackpatch, and Stoke Down; there were others at Easton Down in Wiltshire and Peppard in Oxfordshire. W. Shepherd, *Flint, its origins, properties and uses*, London, Faber & Faber, 1972, pp. 231-233.

<sup>9</sup> In France, Portugal, Sweden, Belgium, Poland, and other regions outside Europe. *Ibid.*, p. 169.

<sup>10</sup> G. Rosen, *The history of miners' diseases*, New York, Schuman, 1943, p. 3.

<sup>11</sup> Sieveking, *op. cit.*, note 7 above, pp. 35 and 39, has estimated that forty-five tonnes of flint were obtained from each mine.



Figure 1. Grime's Graves, Weeting, Norfolk, a contemporary air view from the south. (Reproduced by courtesy of J. K. S. St. Joseph, Professor of Aerial Photographic Studies and the Committee for Aerial Photography, University of Cambridge. Cambridge University Collection: copyright reserved.)



Figure 2. The mining of flint nodules by a Neolithic man at Grime's Graves, using the antler of a red deer as a pick, depicted in a diorama at the Castle Museum Norwich. In the upper part of the photograph flint nodules are depicted on a wooden platform ready to be raised to the surface by a rope. (Reproduced by courtesy of F. W. Cheetham, Director of Norfolk Museums Service: photograph by Hallam Ashley.)



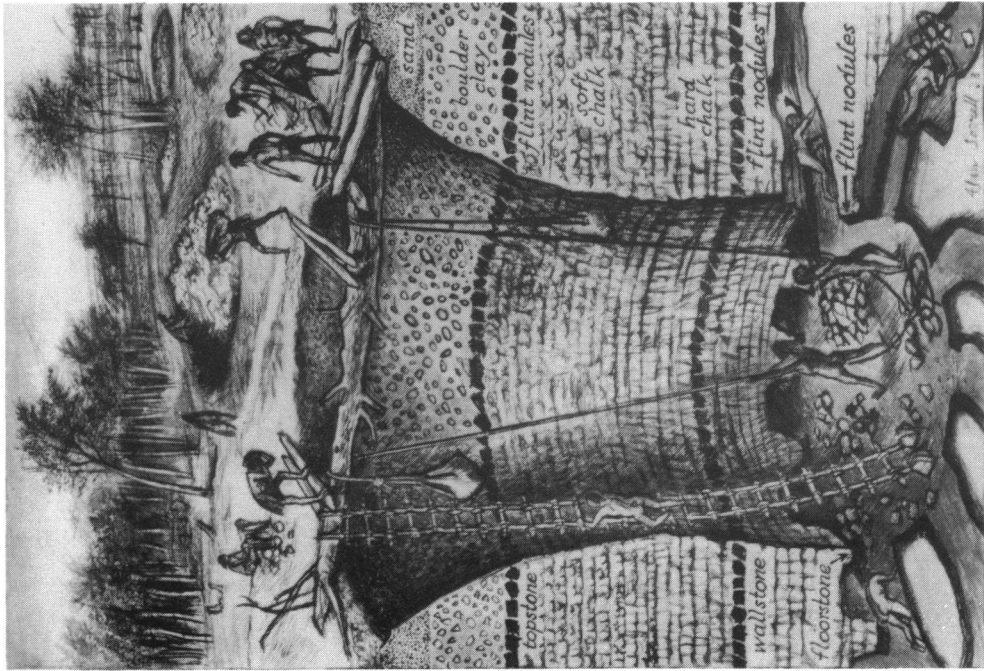


Figure 3. Drawing of how a Neolithic flint mine at Grime's Graves, Norfolk, was probably worked.<sup>17</sup> (Reproduced by courtesy of the Department of the Environment. Crown copyright; reproduced with permission of the Controller of Her Majesty's Stationery Office.)

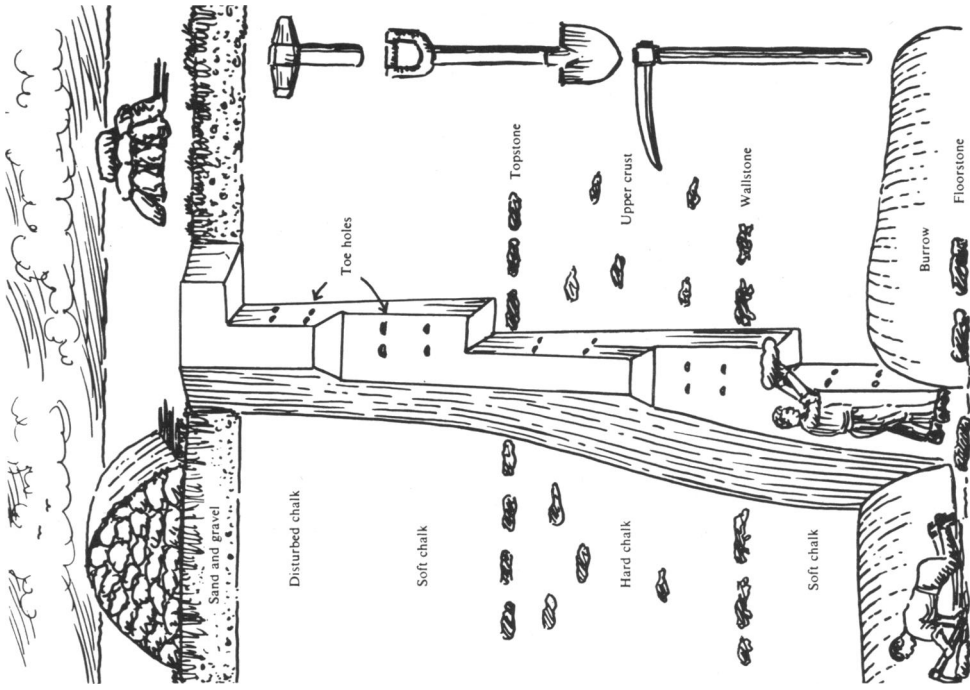


Figure 4. Diagram showing method of mining flints at Lingheath, Brandon, Suffolk, 1790–1930s. (Reproduced by courtesy of H. J. Mason and the Providence Press, Ely.)





Figure 5. Brandon gunflint-knappers' workshop with slabs of floorstone flint by the near window and barrels in which the gunflints were packaged, 1876. (A photograph reproduced by Skertchley, 1879.)



Figure 6. French “caillouteurs”, flint-workers, at Meusnes, Loir-et-Cher, c. 1925. The husband is flaking and the wife is knapping with a circular hammer, “*la roulette*”. At Brandon rectangular hammers are used for knapping as illustrated by the boy’s hammer shown in Figure 5. (From the Meusnes Museum; reproduced by courtesy of the Mayor of Meusnes.)



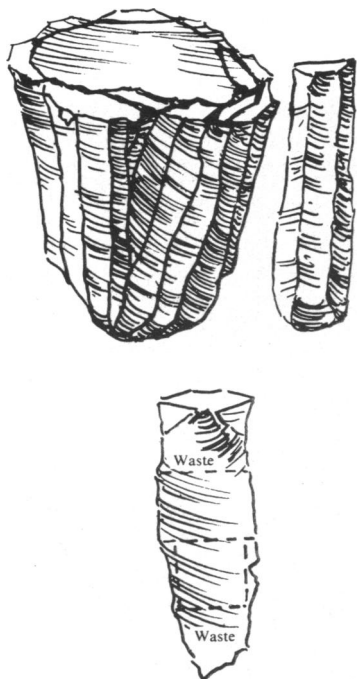


Figure 7. Flint flaking and knapping. Top left a flint nodule showing system of flaking, top right a flake, below showing how two flints can be knapped from a flake. (Reproduced by courtesy of H. J. Mason and Providence Press, Ely.)

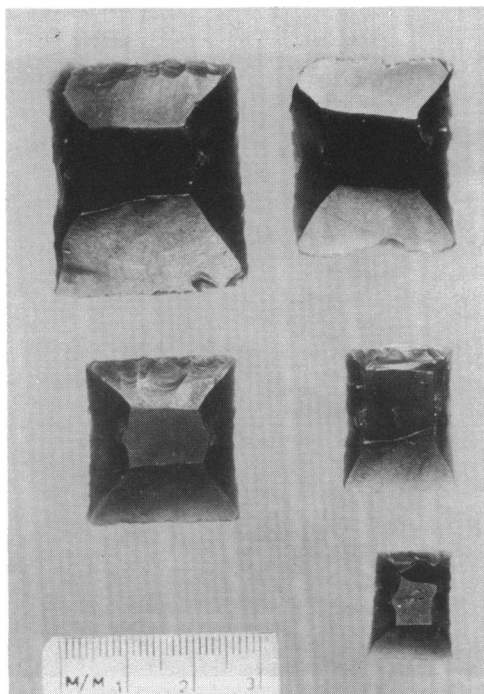


Figure 8. Brandon gunflints. (Reproduced by courtesy of S. de Lotbinière.)



Figure 9. Ashley, the last flint-miner at Lingheath, Brandon, Suffolk, with his pick similar in shape to Neolithic picks made from the antlers of red deer, a pile of flint nodules in the foreground, and behind it a pile of blocks of chalk, known locally as "clunch" and used as a building material, c. 1935. (Reproduced by courtesy of B. R. Clarke for the late R. Rainbird Clarke and the courtesy of the editor of *Antiquity*.)



Figure 10. The mouth of one of the Lingheath flint mines, Brandon, Suffolk. Ashley has brought up a nodule of flint. No ladder or tackle was used, c. 1935. (Reproduced by courtesy of B. R. Clarke for the late R. Rainbird Clarke and the courtesy of the editor of *Antiquity*.)

## *Knappers' rot*

other parts of Britain, earning for Grime's Graves the sobriquet of the Sheffield of Neolithic Britain.

An account of the technique of flint mining and knapping<sup>12</sup> at Grime's Graves is necessary for a consideration of the health hazards of these occupations. The first stage in digging a galleried mine was to excavate the sand and boulder clay from a circular area; when the hard chalk was reached it was cut and removed by picks made from the antlers of red deer, mounting sharpened oxen tibiae on the brow tine of antler picks to transform them into an axe or adze,<sup>13</sup> and by flint or stone axes. Then, when the floorstone was reached, tunnelling was commenced. In some flint mines, but not identified at Grime's Graves, oxen scapulae were used as shovels to aid the clearing of debris,<sup>14</sup> and no doubt hammerstones,<sup>15</sup> or some other form of hammer, were used to break the large slabs of floorstone flint that could not be manhandled and had not been broken up by subsoil pressure.<sup>16</sup> Then the flint nodules were manhandled or raised by ropes to the surface.<sup>17</sup> While the first gallery of a mine was being made, all the chalk was taken to the surface and thereafter chalk from further galleries was deposited in used galleries to save the labour of bringing it to the surface. Further to minimize the work, galleries were made only just big enough for a man to crawl along (Fig. 2). After the flint nodules were brought to the surface they were first broken by hammerstones into blanks for axes and other tools at "workshops" close to the edges of the mines; this work was carried out in the open air, for there is no evidence of the construction of huts at Grime's Graves.<sup>18</sup> Tools and implements were knapped into their final shape at Grime's Graves for local use, but other blanks were transported elsewhere for the specialist job of final knapping; in many regions of England, sometimes a long way from chalk-hills, patches of land have been found littered with thousands of discarded flakes and flint cores.<sup>19</sup>

### *Health hazards*

Since the human chipping of flints to make implements and weapons goes back over

<sup>12</sup> The use of knap, knapping, and knapper derives from the Low German "knap", to crack or crush. The *Shorter Oxford English dictionary* records knap for the description of breaking stones for the road in 1535, in 1787 a knapper as one who breaks stones or flints, and from 1870 one who shapes flints with a hammer. The definition of knap is also discussed by Shepherd, *op. cit.*, note 8 above, p. 187. Throughout this paper, and in its title, knapping is used in its relatively modern (nineteenth-century) senses to describe the shaping of flint with a hammer and the fourth phase of making gunflints.

<sup>13</sup> As recently described by Sieveking, *op. cit.*, note 7 above, pp. 17–18.

<sup>14</sup> Probably wooden shovels were used at Grime's Graves. Clarke, *op. cit.*, note 6 above, p. 15.

<sup>15</sup> Hammerstones were liver-coloured quartzites of the type usually referred to as Bunter pebbles in the German terminology. G. de G. Sieveking, personal communication.

<sup>16</sup> Shepherd, *op. cit.*, note 8 above, p. 148.

<sup>17</sup> The evidence suggesting the flints may have been manhandled up a series of ladders resting on wooden stages only came to light during excavations in 1972–73. Sieveking, *op. cit.*, note 7 above, pp. 29, 31. Such ladders are depicted in a model of a flint mine in an exhibition at Grime's Graves opened by the Department of the Environment in 1979. As there was no evidence for staged ladders prior to 1972 they are not illustrated in Fig. 3, a drawing made for Clarke's *Grime's Graves, Norfolk*, first published in 1963, *op. cit.*, note 6 above. "The miners must have required ladders to reach the foot of the shaft but we have no means of knowing which method (rope or ladder) was preferred for carrying rock", Sieveking, *op. cit.*, note 7 above, p. 30.

<sup>18</sup> No satisfactory post-hole structures have so far been discovered at Grime's Graves. G. de G. Sieveking, personal communication.

<sup>19</sup> Shepherd, *op. cit.*, note 8 above, p. 172

a million years,<sup>20</sup> there is justification for the oft-made claim that this is man's oldest industry. However Collis's<sup>3</sup> claim that Neolithic flint workers may have suffered from silicosis and that this might therefore be the oldest occupational disease, as often quoted in medical literature,<sup>21</sup> rests on less secure grounds. No lung tissue survives from Neolithic flint workers, but it is of interest that among the human skeletal remains from flint mines of this period two skeletons of miners killed by accident at work,<sup>22</sup> one with his deerhorn pick still clasped in his hand,<sup>23</sup> have been found, representing the earliest known evidence of occupational fatalities among miners or any industrial workers. The only human remains discovered at Grime's Graves have been a male calva and the fragments of the skeleton of an adolescent girl; neither of them showed evidence of an industrial accident.<sup>24</sup>

Fragments of lung tissue do survive from Egyptian mummies that have been claimed to show evidence of silicosis. Since their period is c. 4000 B.C., contemporary with the Neolithic period in Europe, the circumstantial evidence has been advanced that as silicosis was known to occur in this period it could have affected Neolithic flint workers. The presence of silica in the lung tissue from Egyptian mummies is undoubted,<sup>25</sup> but hitherto it has been difficult to understand how members of the Egyptian class whose bodies were mummified might have contracted silicosis.<sup>26</sup> This problem has been resolved by the recent description of a benign sand pneumoconiosis affecting those exposed to dry, desert dust<sup>27</sup> and this, and not classical silicosis, would appear to be the explanation for the silica found in the lung remnants of the Egyptian mummies.<sup>28</sup>

<sup>20</sup>Ibid., p. 146.

<sup>21</sup>Four recent papers quoting Collis's claim are F. Bonora, 'Considerazioni sulla eventuale esistenza della silicosi nella preistoria', *Pagine Stor.*, 1964, 8: 62–70; V. Busacchi, 'Evoluzione della conoscenza sulla patologia dei minatori in genere con particolare riguardo alla pneumoconiosi da polveri minerali', *Minerva med.*, Roma, 1966, 57: iii, 3223–3228; H. Schadewaldt, 'Zur Geschichte der Drescherkrankheit und anderer Pneumokoniosen', *Dt. med. Wschr.*, 1967, 92: 1581–1586; and E. Posner, 'Zur Geschichte der Staublunge', *Gesnerus*, 1976, 33: 48–64.

<sup>22</sup>Rosen, op. cit., note 10 above, p. 4.

<sup>23</sup>"The man from Obourg (Belgium)", referred to by a number of authors and well described, with references and an illustration, by P. A. Janssens, *Palaeopathology. Disease and injuries of prehistoric man*, London, J. Baker, 1970, pp. 19 and 31.

<sup>24</sup>These remains are in the British Museum (Natural History). See C. Wells 'Physical anthropology', in *British Association for the Advancement of Science. Norwich and its region*, Norwich, Norwich Local Executive Committee of the British Association, 1961, pp. 84, 86–87. The skeleton of a young woman was also found in the Neolithic flint mines at Cissbury Ring, Sussex. G. Rolleston, 'Note on the human and animal remains found at Cissbury', *J. anthrop. Inst. Gt. Br.*, 1877, 6: 20–36.

<sup>25</sup>A. R. Long, 'Cardiovascular renal disease. Report of a case of three thousand years ago', *Archs Path.*, 1931, 12: 92–94; A. Cockburn, R. A. Baracco, T. A. Reyman, and W. H. Peck, 'Autopsy of an Egyptian mummy', *Science*, N. Y., 1975, 187: 1155–1160.

<sup>26</sup>It would have been easy to comprehend among the Egyptian slaves of the same period who mined for gold and other metals but from whom no lung tissue survives. Rosen, op. cit., note 10 above, pp. 8–38.

<sup>27</sup>This was first described by A. Pollicard and A. Collett, 'Deposition of siliceous dust in the lungs of the inhabitants of the Scharen regions', *Archs ind. Hyg.*, 1952, 5: 527–534. These authors attributed the harmlessness of the silica dust of desert sand to its age. An account of fifty-four Bedouins suffering from the same condition whose lungs contained silica dust particles but no classical silicotic nodules at autopsy, thus giving the condition a benign prognosis, has been published by J. Bar-Ziv and G. M. Goldberg, 'Simple siliceous pneumoconiosis in Negev Bedouins', *Archs envir. Hlth*, 1974, 29: 121–126.

<sup>28</sup>E. Tapp, 'Diseases in Egyptian mummies', in A. R. David (editor), *Manchester mummy project. Multidisciplinary research on ancient Egyptian mummified remains*, Manchester Museum, 1979, pp. 95–103.



## *Knappers' rot*

The only proof that Neolithic flint workers suffered from silicosis would be the demonstration that their lungs contained silicotic nodules, but such evidence does not exist. It remains to consider whether the circumstantial evidence of the mode of work of those who extracted flint<sup>29</sup> from the mines, or knapped it into weapons and implements, suggests that these workers would have contracted silicosis. The more favoured alternative is that the flint workers might have contracted silicosis during the process of mining. Thus Janssens has written that "we can easily imagine that the Neolithic miners from Spiennes and Obourg, hacking flints out of the limestone day after day with their staghorn pick axes, suffered from silicosis".<sup>30</sup> The evidence from studying the technique of flint mining at Grime's Graves which resembled that used at Spiennes and Obourg in Belgium, together with the evidence from flint mining at Brandon in the eighteenth to twentieth centuries A.D., later to be considered, does not favour this supposition of Janssens and others. The flint was not broken in the flint mines, save when the nodules were too large to manhandle or to break up a thick tabular layer of flint, and the nodules were brought whole to the surface. There would have been much dust in the flint galleries, but it would be chalk dust, from the chalk in which the flint lay embedded, and not siliceous dust. The second alternative does not appear to have been suggested previously, namely that Neolithic flint workers might have contracted silicosis when knapping the flint nodules into tools and implements in the open air at ground level, but there is an interesting recent study from India that reveals that silicosis can be contracted in this way. Redstone, brought down from mines at Rajasthan in the form of big slabs or boulders, was cut into smaller blocks for use as decorative plates and pillars in buildings; the smaller stone-cutting was carried out by men working in groups of two to four in the open in winter and under improvised thatch roofs in summer. In the study 35.2 per cent of the stone-cutters was shown to have silicosis.<sup>31</sup> Because of the presence of free ventilation it is unusual to find silicosis among surface workers, but this Indian study shows that if sufficient dust is created silicosis may occur in such circumstances. It is, however, important to note that these stone-cutters worked with metal hammers and tools, for in another recent study of silicosis, among grindstone-cutters in the north of Nigeria, the local people had only noted the appearance of a chest disease causing premature death of the grindstone-cutters since the advent of steel-headed tools in the 1910s. These grindstone-cutters again worked in the open air, but in pits that encouraged an increased concentration of dust, and 39 per cent of a group of past and present workers was shown in the early 1970s to have radiological evidence of silicosis. Warrell and his co-workers who undertook this study attributed the advent of respiratory illness (silicosis) after the introduction of metal-headed tools to the occupation becoming very much more dusty, as many more grindstones were thereby produced each year.<sup>32</sup> Thus, although it

<sup>29</sup> Flint comprises silica and water with some sodium and potassium.

<sup>30</sup> Janssens, *op. cit.*, note 23 above, p. 4.

<sup>31</sup> S. P. Gupta, A. K. Garg, and O. P. Gupta, 'Silicosis among stone-cutters', *J. Ass. Physns India*, 1969, 17: 163–172; S. P. Gupta, A. Baja, A. L. Jain, and Y. L. Vasudera, 'Clinical and radiological studies in silicosis; based on a study of the disease among stone-cutters', *Ind. J. med. Res.*, 1972, 60: 1309–1315.

<sup>32</sup> D. A. Warrell, B. D. W. Harrison, I. W. Fawcett, Y. Mohammed, W. S. Mohammed, H. M. Pope, and B. J. Watkins, 'Silicosis among grindstone cutters in the north of Nigeria', *Thorax*, 1975, 30: 389–398;

remains a possibility, it seems unlikely that the flint-knappers at Grime's Graves, without metal-headed tools, breaking the flint with hammerstones and working in the open air of Breckland, where fresh East Anglian winds are seldom absent, would have been exposed to a sufficient concentration of dust, even if they had lived long enough, to develop silicosis.

It is concluded that there is little support for Collis's<sup>3</sup> speculation that the Neolithic flint workers at Grime's Graves may have suffered from silicosis or at least, as Rosen has written, that "nothing positive . . . can be said on this matter".<sup>33</sup>

#### THE FLINT-KNAPPING INDUSTRY AT BRANDON

##### *General description*

From 1790 Brandon became the main source of supply of gunflints for the British army.<sup>34</sup> Mines were sunk on heath-land to the south-east of the town to raise the floorstone of flint, in Brandon itself outhouses were converted to workshops for shaping the flint nodules into gunflints and the industry became so flourishing that within a few years large dumps of waste flint surrounded the town, provoking exclamations of wonder from contemporary topographers.<sup>35</sup> Brandon supplied the gunflints for the British army at Waterloo,<sup>36</sup> but with the defeat of Napoleon in 1815 and the end of the war with France, the demand for Brandon gunflints slumped. The recently established local industry suffered a further setback following the introduction of the percussion cap in 1806 and its adoption by the British army in the late 1830s. By 1838 it was recorded that the gunflint trade in Brandon "had become nearly obsolete".<sup>37</sup> By this time, however, the Brandon gunflints had achieved not only a national but an international reputation for their high quality, markets other than the British army were established, and in 1838 the Brandon flint-masters banded together forming the

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and *idem*, 'A microfocus of silicosis among sandstone quarriers near Dambatta, Kano State, Nigeria', *Savanna*, 1975, 4: 1-11. B. D. W. Harrison, one of the authors of these papers, is now a consultant physician in general and thoracic medicine to the Norfolk and Norwich and West Norwich Hospitals and I am grateful to him for reading and amending the present manuscript.

<sup>33</sup> Rosen, *op. cit.*, note 10 above, p. 7.

<sup>34</sup> This claim, made by de Lotbinière in 1977, has not been challenged. From a painstaking search of the Board of Ordnance records at the Public Record Office, de Lotbinière revealed many previously unknown facts about gunflint-knapping at Brandon, and elsewhere in England. Among them was an order in 1790 from the then Master General of Ordnance, the 3rd Duke of Richmond, to his Board that it should receive a supply of gunflints from Philip Hayward of Bury St. Edmunds, described in 1793 as a gunflint manufacturer of Brandon. De Lotbinière suspected that the 3rd Duke of Richmond learnt of the high quality of Brandon flint from a cousin, later Earl Cadogan, who in 1778 had bought the Santon Downham estate which lies alongside Brandon. From then on Brandon became the main source of supply of gunflints for the British army. S. de Lotbinière, 'The story of the English gunflint. Some theories and queries', *J. Arms Armour Soc.*, 1977, 9: 18, 32-53. I am deeply indebted to S. de Lotbinière for all his advice and help in this study, for allowing me access to his unique *collectanea* on the Brandon gunflint industry, and for his helpful corrections to the manuscript.

<sup>35</sup> "[At Brandon] is also a manufactory of gunflints, the refuse of which, thrown together at the end of the town, forms such heaps as would astonish a stranger on account of their magnitude." T. K. Cromwell, *Excursions in the county of Suffolk*, 2 vols., London, Longman, Hurst, Rees, Orme & Brown, 1818, vol. 1, p. 88.

<sup>36</sup> "The battle of Waterloo was won in the flint knapperies of Brandon rather than on the playing fields of Eton." J. Seymour, *The companion guide to East Anglia*, London, Collins, 1970, p. 287.

<sup>37</sup> W. White, *History, gazeteer, and directory of Suffolk*, Sheffield, R. Leader, 1844, p. 583.



## *Knappers' rot*

Brandon Gunflint Joint Stock Company to promote the sale of their gunflints.<sup>38</sup> These were provided for such clients as the East India Company, and just before the Crimean War the last large-scale order was executed: eleven million carbine flints for the army of our ally Turkey. Other outlets developed for Brandon gunflints, and in 1870 the chief of these were South and North America, the Cape of Good Hope and the African coast generally, New Zealand, and Spain. During the South African war a brisk trade was revived in tinder-boxes, and in 1907 Austria, China, and Tibet appeared on the list of importers of Brandon gunflints.<sup>39</sup> The industry suffered a further decline in the First World War but survived, and in 1935 Brandon gunflints were used in the Abyssinian muskets against Mussolini's invading army. The declining industry suffered a further recession in the Second World War, but in the years immediately following, large orders came from the Gold Coast and other parts of West Africa, for the people of these territories were not permitted to carry any firearms other than flint-locks before they gained Independence. In 1950 Brandon was producing 700,000 gunflints a year and since the Second World War has been the only surviving gunflint industry in Europe.<sup>40</sup> Today the gunflint trade is kept alive by the needs of muzzle-loading clubs in America, Europe, and elsewhere, and by the flint-lock collectors who want to fit flints to their weapons;<sup>41</sup> in 1980 two part-time Brandon flint-knappers were sufficient to meet this need.<sup>42</sup>

### *The manufacture of gunflints*

In 1837 Mitchell gave the first eye-witness account of the manufacture of gunflints at Brandon,<sup>43</sup> and in 1876 Skertchley undertook a more detailed report on the industry for H.M. Geological Survey that was published in 1879.<sup>44</sup> Skertchley's classic

<sup>38</sup> The deed of settlement dated 27 January 1838 establishing this company "for the purpose of manufacturing and selling gunflints and generally of transacting all business whatsoever which may relate to or be in any way connected with that trade" was, 1980, in private ownership in Brandon. The Suffolk Record Office, Bury St. Edmunds (refs. HC 506 and Tem. 686) contains the following records of the Brandon Gunflint Joint Stock Company: Manufacturers Ledger 1838–1846 (W 33/1/6.1); Minutes of Directors' Meetings 1838–1843 (W 33/1/7.1); and Minutes of General Annual Meetings and Special General Meetings 1839–1845 (W 33/1/7.2).

<sup>39</sup> R. Clarke, 'The flint-knapping industry at Brandon', *Antiq.*, 1935, 9: 38–56, a detailed account with illustrations and references.

<sup>40</sup> Shepherd, *op. cit.*, note 8 above, p. 188. Flint-knapping centres survive (1972) outside Europe "among the aborigines of Australia, in New Guinea, parts of Africa and Turkey", p. 192.

<sup>41</sup> In 1952, Herbert Edwards (1892–1973) then the best-known Brandon flint-knapper, gave two display cases of Brandon gunflints to Queen Elizabeth II on the occasion of the presentation to the then Prince Charles, Duke of Cornwall, now Prince of Wales, of a flintlock pistol that it is understood was once owned by Flora MacDonald and given to her by Prince Charles Edward Stuart, the Young Pretender. This presentation was made by Mrs. Galbraith of New Zealand.

<sup>42</sup> James Henry English, who traded, 1980, in the name of his father-in-law H. Edwards, see note 41 above, and who is assisted in his work of gunflint-knapping, knapping flints for church restoration work, etc., by a part-time assistant. It is incorrect to say that "the last practitioner of the art [of flint-knapping at Brandon] retired in the mid-1970's", D. Alderton and J. Booker, *The Batsford guide to the industrial archaeology of East Anglia*, London, B. T. Batsford, 1980, p. 149.

<sup>43</sup> J. Mitchell, 'On the manufacture of gunflints', *Edinb. new phil. J.*, 1837, 22: 36–40.

<sup>44</sup> S. B. J. Skertchley, *Memoirs of the geological survey, England and Wales. On the manufacture of gunflints, the method of excavating for flint, the age of Palaeolithic man and the connexion between Neolithic art and the gunflint trade*, London, H.M.S.O., 1879. De Lotbiniere, *op. cit.*, note 34 above, states

account, from which all subsequent articles derive, has described the technique of the industry in greater detail than any other publication and the ensuing account is also based on it.

Five operations are involved in the manufacture of gunflints. First, the flint is raised or collected; then it is quartered, flaked, knapped,<sup>42</sup> and finally packaged. Flints for the Brandon industry came from chalk and stone pits within a forty-mile radius, but the predominant and most interesting source of supply for the industry when at its zenith was a series of mines sunk on Lingheath, an area defined in 1807 as comprising 116 acres on the south-east outskirts of Brandon. The construction of these mines is of interest, for although the first of them were dug at least eighty years before the Neolithic flint mines were discovered at nearby Grime's Graves in 1869, the structure of the mines with their radiating galleries at about ten metres, where the floorstone flint occurs, was very similar to the Neolithic mines (Figs. 3 and 4). Furthermore, the picks used by the Lingheath miners were similar in shape to the antler horns used by their Neolithic forbears for the same purpose. For these and other reasons Skertchley first propounded the myth, reflected in the title of his monograph,<sup>44</sup> of a direct link between the Neolithic and Brandon flint industries. But as Sieveking,<sup>7</sup> among others, has argued, there is no cause to postulate such a connexion. The Brandon flint-miners differed from their Neolithic forbears in having available to them metal spades, hammers, crowbars, and metal-headed picks, but they seem not to have made use of the ropes, as Neolithic man may have done, to raise the flint, and only manhandled the flint nodules to the surface. In the nineteenth, and at the beginning of the twentieth, centuries Lingheath was covered with hundreds of crescent-shaped mounds of grey and disintegrated chalk that marked the sites of the flint mines,<sup>45</sup> but the number of new mines inevitably dropped during this period with the decline of the industry. The last miner on Lingheath stopped work in the late 1930s when he was over eighty years of age (Figs. 9 and 10),<sup>46</sup> since when flints have been obtained from other East Anglian sources,<sup>47</sup> though at the present time true Brandon flints from a local lime-pit are used for making gunflints.

From Lingheath the flints were carted to the knappers' workshops in Brandon, small one-storey buildings either adjacent to or forming part of their own flint-faced houses, with windows that were kept closed and doors into whose surrounding cracks sacks were inserted to keep out the winds in winter (Fig. 5). In these workshops, a number of which, in alternative use, can still be seen, gunflint-knappers quartered, flaked, and knapped the flint nodules and the two Brandon flint-knappers of the present day follow the same procedures in a modern workshop behind a contemporary bungalow. First, the flint-knapper rests the nodule on a thick leather kneepad and

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that the collection of flints illustrated in Skertchley's monograph is now in the Geological Museum, London.

<sup>45</sup> Today the main area of the flint mines at Lingheath is flattened for agricultural cultivation but in the woodlands around its perimeter the sites of many former flint mines can still be identified.

<sup>46</sup> "Pony" Ashley, described by one who knew him as "walking home from Lingheath with a sack on his back and white from top to toe with chalk from the flint pits". H. J. Mason, *Flint – the versatile stone*, Ely, Providence Press, 1978, p. 19.

<sup>47</sup> "Brandon flints then became Brandon knapped flints", Shepherd, *op. cit.*, note 8 above, p. 188.



## *Knappers' rot*

roughly dresses, or quarters, it with a hammer. The quarters are then marked up into suitable cores, and from these a different hammer, whose use requires great skill, breaks the core into flakes until only a small core remains. Then with a knapping-hammer the flakes are knapped into gunflints (Figs. 7 and 8) and according to size and quality these are thrown into containers that were wooden barrels at the height of the industry's activity (Fig. 5). In barrels the flints were despatched by carts, or by barge along the Little Ouse to Kings Lynn, until the railway came to Brandon in 1845. Rail then became the main means of transport until lorries also became available.

The almost complete lack of documentary records of the Brandon flint industry has succeeded in obscuring details of all but the more recent stages in the course of the industry.<sup>48</sup> Thus there are no records of the number of men engaged in flint mining during successive years, nor are figures known for the number of flint-knappers during the peak of the industry's activity between 1790–1815. It is of importance, however, to note that at Brandon the occupations of flint-mining and flint-knapping have been distinct, perhaps because the mines at Lingheath were some distance from the workshops in Brandon itself, for this differed from the practice in the contemporary French gunflint industry where the same individual carried out both tasks – the importance of this point of difference will be discussed in the next section. The only occupational figures known are those for the number of gunflint-knappers at Brandon in different years after 1837, shown in Table 1, though they require some qualifications.<sup>49</sup>

### THE HEALTH PROBLEMS OF THE GUNFLINT INDUSTRY

#### *Previous studies*

The flintlock ignition system for firearms developed in the early sixteenth century, and 1686, the year of Monmouth's rebellion, is customarily cited as the year in which the British army adopted it for general use. Prior to 1790, gunflints for the army, and other civilian users in England, were mainly provided from gunflint factories in Kent and Wiltshire,<sup>34</sup> though there were other subsidiary centres.<sup>50</sup> No published reference to the health of those engaged in these early gunflint factories in England has been traced, but in France where there were numerous gunflint factories, there are such records from the seventeenth century onwards. The records of a local *curé* at Couffy in Loir-et-Cher describe the burial by him of a boy and two men killed by accidents between 1684 and 1696 when searching underground for *les pierres à fusil*. The risks

<sup>48</sup> The only surviving documentary records are those cited in note 38 above. In 1801 the population of Brandon was 1,148; that increased to 2,002 by 1841 (White, *op. cit.*, note 37 above); in 1891 it was 2,334 (W. White, *History, gazeteer and directory of Suffolk*, 5th ed., Sheffield, W. White, 1891–1892, p. 583); by 1937 it had changed little and was 2,427 (*Kelly's directory of the counties of Norfolk and Suffolk*, (Norfolk), London, Kelly's Directories, 1937, p. 63). Since 1945 the population of Brandon has increased considerably and is now over 6,000.

<sup>49</sup> Qualifications to the figures not shown in parentheses, especially census figures, include "double" occupations. In times of economic depression it is known that Brandon agricultural workers supplemented their incomes by part-time flint-knapping after their normal day's work, and inn-keepers were often owners of gunflint workshops: the census returns may have shown only their main occupations. The extent of "part-time" work was very variable. On the basis of known Brandon gunflint production, S. de Lotbinière, personal communication, considers the quoted figures for 1800 and 1846 too high.

<sup>50</sup> Shepherd, *op. cit.*, note 8 above, p. 187.

TABLE 1. Number of Gunflint-knappers at Brandon

Year	Number	Source
1800	(200)	Clarke, <sup>39</sup> Hunter <sup>56</sup>
1837	70–80	Mitchell <sup>43</sup>
1841	50	Census figures <sup>51</sup>
1846	(100)	Clarke, <sup>39</sup> Hunter <sup>56</sup>
1851	31	Census figures <sup>51</sup>
1861	36	Census figures <sup>51</sup>
1868	36	Skertchley <sup>44</sup>
1871	35	Census figures <sup>51</sup>
1876	26	Skertchley <sup>44</sup>
1879	21	<i>Encyclopaedia Britannica</i> <sup>52</sup>
1890	35	<i>Notes and Queries</i> <sup>53</sup>
1896	18	Hunter <sup>56</sup>
1907	17	Clarke <sup>39</sup>
1911	12	Collis <sup>3, 4</sup>
1924	7	Clarke <sup>39</sup>
1929	5 (some P/T)	Middleton <sup>54</sup>
1934	3 (2 P/T)	Clarke <sup>39</sup>
1948	6 (some P/T)	English <sup>55</sup>
1980	2 P/T	Author's observations

(Numbers in parentheses are those considered unreliable.<sup>49</sup>)

(P/T = part-time)

to gunflint-workers of accidents and also of flint dust that led to “most of the workmen dying between twenty and forty years after spitting and wasting for six months” were the subject of a report to the Committee of Public Safety of the first French Republic in 1799.<sup>57</sup> In 1820 a French artillery colonel who was Director General of *Manufactures Royales* offered a prize for finding some way of protecting the gunflint-workers from flint dust, but the resulting mask was unacceptable to them. Reference to these three accounts was made by Emy in 1978,<sup>58</sup> who also had access, as had de Chateauneuf in 1831,<sup>59</sup> to the unpublished *mémoires*, written between

<sup>51</sup> Census figures made available by S. de Lotbinière, personal communication.

<sup>52</sup> ‘Flint’, in *Encyclopaedia Britannica*, 9th ed., Edinburgh, A. & C. Black, 1879, vol. 9, pp. 325–326.

<sup>53</sup> ‘Flint-flakes’, in *Notes and Queries*, 7th series, 1890, 10: 172.

<sup>54</sup> E. L. Middleton, *International Labour office (League of Nations) Geneva. Silicosis. Records of the international conference held at Johannesburg 13–27 August 1930*, London, P. S. King, 1930, pp. 478–489.

<sup>55</sup> J. H. English, see note 42 above, personal communication.

<sup>56</sup> D. Hunter, *The diseases of occupations*, 6th ed., London, Hodder & Stoughton, 1978, pp. 950–954.

<sup>57</sup> “Le 16 messidor de l’an 7”.

<sup>58</sup> Emy, op. cit., note 4 above, pp. 95–107.

<sup>59</sup> B. de Chateauneuf, ‘De l’influence de certaines professions sur le développement de la phthisie pulmonaire’, *Annls Hyg. pub. Méd. lég.*, 1831, 6: 5–49. In his comments on Bourgoïn’s figures from the gunflint industry at Meusnes, de Chateauneuf wrote in this paper “by a fate which seems connected with all



## *Knappers' rot*

1820–1824, of Bourgoin, a doctor at Selles-sur-Cher in the early nineteenth century, that provide the most definitive study yet made of the health risks of the gunflint industry. These Bourgoin listed in his detailed report as accidents, injuries to the eyes and eyelids, rheumatism, and pulmonary tuberculosis (phthisis). In an account of his autopsy studies of the lungs of those dying from tuberculosis he described not only “*les cavernes*” from tuberculosis but that in some cases “*la substance entière du poumon est dure, sèche, criante sous le scalpel*”, suggesting that he was describing silicosis. These observations were made at Meusnes in Loir-et-Cher where Bourgoin also reported a great increase in the mortality rates between the two periods of 1680–1709 and 1760–1790; during the intervening years, 1709–1760, there had been established at Meusnes what was to become one of the main centres of the French gunflint industry. This increased mortality Bourgoin attributed to “*les ravages de la phthisie*”.

Bourgoin's unpublished *mémoire* was first made known publicly when de Chateauneuf published extracts from it in 1831.<sup>59</sup> It may have been a consequence of de Chateauneuf's paper, though it seems more probable that the observation was made independently of it, that in 1839 the first record of a health hazard from the gunflint industry at Brandon was published. This appeared in *Pigot's Directory* for Suffolk where it was claimed that at Brandon “the breaking and preparing the gunflint is detrimental to health and but few employed in the process attain a greater age than fifty”.<sup>60</sup> Mitchell had made no reference to the health of the Brandon gunflint-workers in his report of 1837,<sup>43</sup> but reference to it was made by Skertchley in 1879, though he thought little of it in that he wrote “gunflint manufacturing used to be thought unhealthy and that every knapper died of consumption at forty years. This may have been true but if so the consumption was of drink, not of the lungs, it being the practice to work from Wednesday to Saturday and drink the rest of the time”. Skertchley went on to say that this latter habit was coming to an end and also noted that several of the twenty-six knappers alive at the time of his report were “quite old”.<sup>61</sup> Nevertheless the local belief that gunflint-knappers died young persisted,<sup>62</sup> and was vindicated by the first medical study of the health of Brandon gunflint-knappers, that of Collis<sup>3,4</sup> already referred to. Collis's main findings (Table 2) were that out of a total of twenty-seven deaths among gunflint-knappers during 1886–1910, the average age of death was forty-six years, and their mortality rate from pulmonary tuberculosis 77.8 per cent, compared with sixty-three deaths among the Brandon rural district population, presumably of both sexes, between 1901–1910 where the mortality rate from pulmonary tuberculosis was 6.5 per cent. Surprisingly, there were no deaths from pulmonary tuberculosis among thirteen deaths in widows and wives of gunflint-

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that concerns the art of war, this industry slays those who follow it; it kills them before their time; for them there is no old age”.

<sup>59</sup> ‘Suffolk’, *Pigot and Co.'s royal national and commercial directory and topography of the counties of Bedford, Cambridge, Essex, etc.*, London, Pigot, 1839, p. 534.

<sup>61</sup> Skertchley, *op. cit.*, note 44 above, p. 5.

<sup>62</sup> The belief persists to the present day. On several occasions during the course of this study the author heard it said in Brandon that “12 widows of gunflint-knappers, who had died young, lived on the London Road before the Second World War”.

TABLE 2 Table Comparing the Mortality from Phthisis of Flint-knappers (at Brandon) with that of Certain Other Classes 1886-1910

Class	Cause of death, stated as percentages, from				Total number of deaths	Average age at death	Calculated death rate from phthisis from per annum among 1,000 living
	All causes	Phthisis	Respiratory diseases other than phthisis	All other causes			
Flint-knappers (average number employed for 25 years estimated at 16.5)	100.00	77.8	7.4	14.8	27	46.0	41.0
Wives (2) and widows (11) of flint knappers	100.00	0.0	15.4	84.6	13	78.0	0.0
Brandon rural district* (population about 5,150)	100.0	6.5	11.7	81.8	63	—	0.8
All males† (England and Wales, 1900-02)	100.0	11.2	17.6	71.2	509,567	Median age at death between 56 and 57	1.6

Source of table: Collis, op. cit., footnote 3 above.

\*The figures for this class, supplied by Dr. A. Harris, M.O.H., Thetford, Norfolk, are for all ages, 1901-10.

†The figures for this class, calculated from the Supplement to the Sixty-fifth Annual Report of the Registrar-General, are for all males aged 15 years and upwards, 1900-02.

## *Knappers' rot*

knappers.<sup>63</sup> Collis attributed what he termed this "terrible mortality" from pulmonary tuberculosis to the gunflint-knappers' exposure to silica during their work, and considered they were especially exposed to dust when gunflint-knapping rather than when quartering or flaking. A further medical study of one aspect of the Brandon gunflint industry was reported twenty-five years later by Middleton, another H.M. Inspector of Factories; Middleton took air samples at "breathing level" when two Brandon workers were engaged in gunflint-knapping and these two samples gave counts of 1,313 and 1,192 particles per millilitre with 1.4 and two per cent of the particles over two microns in size and most of the particles under one micron in size.<sup>64</sup> His findings are of interest due to the recent attention focussed on the size of the inhaled particles of siliceous dust in relation to the subsequent development of silicosis.<sup>64</sup> Based on Collis's and Middleton's work, Hunter wrote a concise account of silicosis in the East Anglian gunflint industry<sup>65</sup> and used Collis's figures from Brandon, where the quartz (silica or silicon dioxide) content of the dust is 100 per cent, to illustrate how the death rate from pulmonary tuberculosis among workers in different industries at risk from inhaling quartz was directly related to the quartz content of the dust.<sup>65</sup>

### *A study of the Brandon death registers*

One of the main objects of the present study was to seek further evidence in confirmation, or refutation, of Collis's much-quoted finding that the mortality rate from pulmonary tuberculosis among gunflint-knappers at Brandon was 77.8 per cent, for this was based on only twenty-five such deaths over a twenty-five-year period. However, the almost complete lack of documentary records of the Brandon gunflint industry already referred to<sup>48</sup> made this a daunting task and all but one line of alternative investigation yielded negative results.<sup>66</sup> The only fruitful source of further infor-

<sup>63</sup> Collis described one family where ten male flint-workers had died from phthisis; thirteen females in the same family were alive, and of the three living males two were gunflint-knappers and one was not. Of six males in another family, two out of three flint-workers died from phthisis while the remaining three in other occupations were alive. He felt the wives and widows of the gunflint-knappers must have had some immunity to phthisis and found records of only one child of a flint-knapper dying from phthisis during the twenty-five-year period of his survey, Collis, *op. cit.*, note 4 above.

<sup>64</sup> This field has been discussed by T. Hatch and W. C. L. Hemeon 'Particle size and dust exposure', *J. ind. Hyg. Toxicol.*, 1948, 172-180; see also, E. J. King, G. P. Mohanty, C. V. Harrison, and G. Nagelschmidt, 'The action of flint of variable size injected at constant weight and constant surface into the lungs of rats', *Br. J. ind. Med.*, 1953, 10: 76-92.

<sup>65</sup> Hunter, *op. cit.*, note 56 above, p. 940.

<sup>66</sup> Among the sources of negative investigations were the following. The Brandon parish registers, burials 1653-1924, Suffolk Record Office, Bury St. Edmunds. This office had no records of reports by Medical Officers of Health from West Suffolk prior to the 1930s. A search of the Suffolk County Medical Officer's Annual Reports from 1912 onwards by Dr. M. F. H. Bush, Area Medical Officer to the Suffolk Area Health Authority, revealed no reference to gunflint-knappers' silicosis, and reports prior to 1912 were unavailable. The lapidary inscriptions, where legible, on the tombstones in the churchyard of St. Peter's, Brandon, proved no help, nor did enquiries of local general practitioners and of past and present consultants to hospitals serving Brandon. G. A. Gresham, Professor of Morbid Anatomy in the University of Cambridge, found no account of any autopsies on Brandon gunflint-knappers in his department's records, and R. Williamson, Emeritus Reader in Morbid Anatomy and Histology, University of Cambridge, recalled no specimen of a gunflint-knapper's lung in any past or present pathological museum at Cambridge since he went there in 1930; he also found no record of a paper by a member of the Department of Pathology on flint-knapping or silicosis in a list in his possession of papers written by members of the Department from 1884 to 1937. No relevant records have been traced at the Norfolk and Norwich Hospital, opened in 1771,



mation proved to be the death registers for Brandon from 1837, when such registration was nationally introduced; these registers are complete and have been meticulously kept from 1837 to the present day.<sup>67</sup>

All male deaths in the Brandon death registers have been studied from 1838 to 1937,<sup>68</sup> a period of a hundred years, by the end of which time the number of Brandon gunflint-knappers had been in single figures for some twenty years (see Table 1). Between 1838 and 1937 there were 1715 male deaths with a high infant mortality and a total of 800 deaths (46 per cent) below the age of ten years. Over the age of ten years, an age when boys are known to have worked in the gunflint industry,<sup>69</sup> there were 915 deaths among whom 91 (9.9 per cent) were recorded as gunflint-knappers. The average age of death of the 91 gunflint-knappers was 44 years and of the 824 men recorded in other occupations 66 years. Among the gunflint-knappers 74 (82.4 per cent) died from pulmonary tuberculosis<sup>70</sup> compared with 111 (13.4 per cent) in other occupations (Table 3); one gunflint-knapper's death was certified from "intemperance" and two from accidents.<sup>71</sup> During the hundred-year period of 1838–1937 the gunflint-knappers' mortality rate from pulmonary tuberculosis of 82.4 per cent correlates closely with Collis's figure of 77.8 per cent for a quarter, 1886–1910, of the same period, and the mortality rate of 13.4 per cent in those of other occupations is comparable to the 11.2 per cent national mortality rate from pulmonary tuberculosis in males above the age of fifteen years for 1900–1902, cited by Collis (Table 2).

In contrast with Collis's finding of no deaths from pulmonary tuberculosis among the wives and widows of gunflint-knappers,<sup>72</sup> the records for 1838–1937 disclose twenty-one such deaths. Among the deaths of fifty-one gunflint-knappers' children under the age of ten years, five were certified as from pulmonary tuberculosis and such diagnoses as "inflammation of the lungs" in the days before radiography may have

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that served Brandon patients, especially after the construction of the Norwich–Brandon railway in 1845, and until the West Suffolk Hospital, Bury St. Edmunds, opened in 1876, developed its services. The Newmarket Hospital, first opened as an Emergency Medical Service Hospital during the Second World War, and the West Suffolk Hospital, Bury St. Edmunds, now provide the local hospital service for Brandon, and again enquiries of both these hospitals met with negative results. W. R. Parkes, physician to the Pneumoconiosis Medical Panel, London, was unable to trace any claim for compensation by a Brandon gunflint-knapper to the London or Stoke-on-Trent Panels.

<sup>67</sup> At the inception of death registration in July 1837 Brandon was in Thetford Sub-district until January 1838 when it was transferred to Methwold Sub-district that came under Downham Market District. In 1938 Brandon was transferred to Mildenhall Sub-district under Newmarket District and there were further changes with the administrative reorganizations of 1948 and 1974. Hence the Brandon death registers from 1837–1937 are at Downham Market, Norfolk, and from 1938 to the present at Newmarket, Suffolk. I am indebted to Mrs. P. Golds, Superintendent Registrar to Downham Registration District, and J. Moore, Superintendent Registrar to Newmarket Registration District, for allowing me to study personally the death registers for Brandon in their care.

<sup>68</sup> There were no registered Brandon deaths from July to December 1837.

<sup>69</sup> In his personal papers Herbert Edwards (1892–1973), see notes 41 and 42 above, recorded that he started gunflint-knapping at the age of seven years.

<sup>70</sup> Also recorded in the registers as phthisis, phthisis pulmonalis, and consumption.

<sup>71</sup> One gunflint-knapper died following "a fall from a cart", and the second when "the wheel of a wagon passed over the head of the deceased".

<sup>72</sup> This suggests that their husbands may have died from silicosis rather than pulmonary tuberculosis.

## *Knappers' rot*

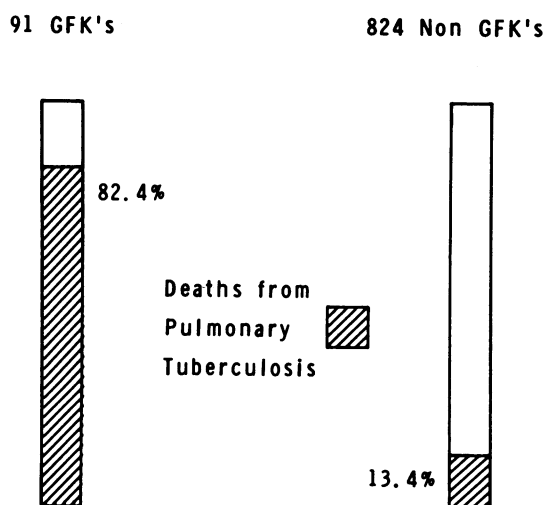
concealed others.<sup>73</sup>

Among the few recorded deaths of flint-miners there was no case of death from pulmonary tuberculosis, in keeping with the traditional view heard in Brandon that flint-miners did not die young like the gunflint-knappers. This finding is in accord with the conclusions reached earlier in this paper that flint mining, whether undertaken by Neolithic men or for the purpose of providing flint nodules for gunflints, did not cause silicosis and thence predispose to pulmonary tuberculosis. It is a conclusion that could not be reached from the French gunflint industry where the same workers were engaged both in flint mining and gunflint-knapping.

**TABLE 3**  
**BRANDON MALE DEATHS FROM PULMONARY TUBERCULOSIS 1838-1937**  
(over the age of 10 years)

GFK - Gunflint Knapper

	Total Deaths	Deaths from pulmonary tuberculosis	Average age of death (years)
GFK's	91	74	44
Non GFK's	824	111	66



<sup>73</sup> It perhaps reflects the reluctance of medical practitioners to complete certificates notifying cases of infectious disease that, though nine Brandon gunflint-knappers or their wives are recorded in the death

This study of death registers naturally brought no evidence to bear on which stage of gunflint-knapping was the most dangerous to health, but parallel discussions with those who have been, or who currently are, engaged in gunflint-knapping at Brandon<sup>74</sup> support Collis's view that it is the gunflint-knapping, as opposed to the quartering or flaking, that provides the greatest hazard. Furthermore, when this work was carried out in workshops where the windows were closed, the doors sealed from draughts, and usually in winter with a coal fire burning to keep the workers warm and the flints dry, the conditions were ideal for the development of dust disease of the lungs in the gunflint-knappers.

No post-mortem, radiological, or other clinical evidence has been traced<sup>66</sup> to confirm that the diagnoses of death from pulmonary tuberculosis among Brandon gunflint-knappers were correct or whether in addition the knappers suffered from silicosis, a diagnosis that does not appear in the death registers. It is thus only on epidemiological and statistical evidence that the pulmonary tuberculosis causing the death of gunflint-knappers can be attributed to a consequence of silicosis. The enhancing effect of free silica on the development of tuberculosis is well known, and during the century, 1838–1937, covered by this study most silicotics died from pulmonary tuberculous infection.<sup>75</sup> This further study provides strong evidence for concurring with Collis<sup>3,4</sup> in his conclusion that the Brandon gunflint-knappers suffered a very high occupational prevalence of silicosis.

### *Measures of prevention*

In the East Anglian flint mines minor accidental injuries were no doubt incurred by miners, but the absence of any records of fatal mining deaths at Brandon, or of a skeleton of a miner killed by accident at Grime's Graves, suggests for both periods skill in the construction of the mines and the observation of high safety standards. In France a different situation prevailed, for in the accounts quoted by Emy<sup>76</sup> many instances of fatal injuries were reported from falls of chalk or soil among those working in the mines. This is probably explained by a difference in the mining methods between the two countries, for the Report of the Committee of Public Safety, 1799, refers to the importance of adequate "pit props", *les piliers de soutien*, unknown in East Anglian flint mines, in preventing mining accidents.

All writers on the subject, however, have agreed that the most important preventive measure is reduction of the flint-knappers' exposure to dust. Bourgoin, writing in 1820–1824 when there were 800 workers in the French gunflint industry, recommended

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registers as having died from pulmonary tuberculosis between 1913–1938, none of them appears in the Brandon register of notified cases of pulmonary tuberculosis. *Pulmonary tuberculosis. Register of notification received. 1913–1941. Rural District of Mildenhall*, Suffolk Record Office, Bury St. Edmunds (Ref. EF 505/4/4, 186C.P11).

<sup>74</sup> Among them James Henry English, see note 42 above, and Herbert Franklin Field (born 1896), see note 4 above; between 1911 and 1914 Herbert Field recalls working in the flint workshops from 7 a.m. to 8 p.m. with short breaks for meals. "You did not see the dust except in the rays of the sun and when it settled. [The procedure of] knapping produced the most dust." He returned to gunflint-knapping for a further period in the Second World War when most of the gunflints were despatched to Africa.

<sup>75</sup> W. R. Parkes, *Occupational lung disorders*, London, Butterworths, 1974, p. 180.

<sup>76</sup> Emy, *op. cit.*, note 4 above, pp. 98–99.



## *Knappers' rot*

improved ventilation of the houses where the gunflint-knappers worked, and that they should wear masks covering the nose, mouth, and eyes to prevent injuries to the latter, and with an attached breathing tube. The French government of the day showed reluctance to provide these, and they proved unacceptable to the workers.<sup>76</sup> A similar reluctance to wear masks also prevailed among the Brandon gunflint-knappers, who seldom used them, but Field recalls the use of cotton-wool masks secured with an elastic band in 1911–1914 and the visits of factory inspectors to ensure that they were used.<sup>77</sup> Masks have seldom been used at Brandon, though one of today's flint-knappers wears a surgical mask over his nose and mouth.<sup>42</sup> Brandon workers do not appear to have experienced the ophthalmic injuries on which Bourgoïn laid emphasis, and there is no knowledge among past or present Brandon gunflint-knappers of the use of goggles to protect the eyes.<sup>78</sup> Middleton<sup>54</sup> referred to the potential value of localized exhaust draughts, but they were too costly for the industry though one was in use at Brandon from the early 1950s–1960s.<sup>79</sup> The 1910 Royal Commission on Metalliferous Mines and Quarries recommended that workers with certain stones should be prohibited from working in closed sheds, but the findings of the Commission were published in 1914 when, due to the outbreak of the First World War, no consolidating or amending legislation ensued.<sup>80</sup> An alternative preventive measure, proposed among others by Middleton,<sup>54</sup> was to knap out of doors, as illustrated at Meusnes in Fig. 6, but this was impractical in winter, and at Brandon the knapping blocks were heavy sections of tree trunk, which were not easy to move. The measure was, however, sometimes adopted at Brandon in the summer months.

### SUMMARY AND CONCLUSIONS

It is a paradox that one of England's industrial diseases should only be known in one of its predominantly agricultural regions, for East Anglia's diseases are those traditionally associated with a rural way of life.<sup>81</sup> This has come about through a feature of the region's geology whereby a deposit of flint, claimed to be the finest in England,<sup>82</sup> was deposited in certain areas of Norfolk and Suffolk. Neolithic men's

<sup>77</sup> Field, see notes 4 and 74 above, personal communication.

<sup>78</sup> However, R. G. Joice of Newton-by-Castle Acre, Kings Lynn, Norfolk, an authority on Norfolk "bygones", has claimed seeing goggles used at Brandon by gunflint-knappers. For this reason he has displayed a pair of goggles with a selection of gunflint-knapping tools in the "Dick Joice Collection of Bygones at Holkham", opened at Holkham Hall, Norfolk, in 1979. This pair of goggles is one of several given to him by his father and had been used by the "stone splitters" who worked on the roads breaking flints with a small iron hammer on a long whipshaft handle; similar goggles were used by those working at the dusty end of threshing machines. R. G. Joice, personal communication.

A pair of goggles identical to those at Holkham Hall is displayed, again with gunflint-knapping tools, at the Bridewell Museum of Norwich Crafts and Industries. D. Jones, Keeper of Social History, Castle Museum Norwich, has been unable to trace its provenance.

<sup>79</sup> Used by Herbert Edwards, see note 41 above. The author has a photograph of him with the extractor fan.

<sup>80</sup> A. Bryan, *The evolution of health and safety in mines*, London, Ashire Publishing, 1975, p. 77.

<sup>81</sup> D. F. van Zwanenberg, 'The geography of disease in East Anglia', *J. R. Coll. Physns Lond.*, 1974, 8: 145–153.

<sup>82</sup> C. P. Chatwin (editor), *Natural Environment Research Council. Institute of Geological Sciences. (Geological Survey and Museum) British Regional Geology. East Anglia and adjoining areas*, 4th ed., London, H.M.S.O., 1961, reprinted 1977, p. 37.

exploitation of this flint for weapons and tools has bequeathed to Norfolk the largest and best-known group of Neolithic flint mines in Britain. It appears to have been Collis in his Milroy lectures of 1915<sup>3</sup> who first suggested that the Neolithic flint-workers in Norfolk and elsewhere might have suffered from silicosis, thereby entitling them to the record of suffering from the first known occupational disease. Although this idea has been taken up by others since, from the evidence reviewed in this study there is not only no proof, but it appears improbable, that they suffered in this way. Among the reasons for disagreement with Collis's postulate is the evidence available from the second period of East Anglian flint mining some 4,000 years later when Brandon in Suffolk became the main source of supply of gunflints for the British Army and achieved an international reputation and trade, that it still retains, for the quality of its gunflints. The method of mining for flint in this second period was almost identical to that in the first and has provided a model to help answer the health hazard problems of the Neolithic mining period. However, while the technique of mining in the two periods was similar, that of knapping Neolithic spears and axes differed from the knapping of gunflints in that the latter is conducted with metal and not stone hammers thus provoking more dust, and it was undertaken not in the open air but, when the industry was at its height, in ill-ventilated workshops. Here the Brandon gunflint-knappers were exposed to a high concentration of pure silica dust for long periods, and, as Collis first showed and as this study has been the first to confirm, they suffered from a very high prevalence of silicosis leading to pulmonary tuberculosis and premature death. Though many gunflint-knappers have paid this penalty for their labours, they have the distinction, as have the twelve gunflint-knappers of Collis's day and the two Brandon gunflint-knappers of today, of being, as Collis wrote, "the lineal occupational representatives of the oldest of man's industries".<sup>3</sup>