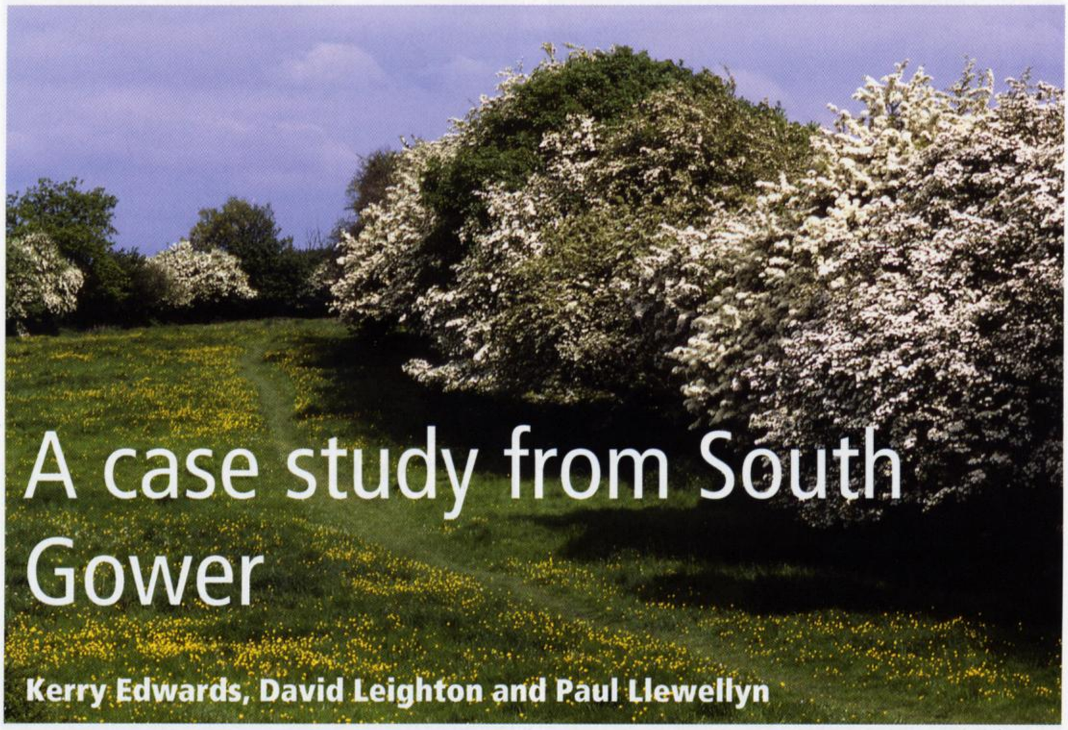
British Wildlife vol.17 (4), April 2006, 260-9

Hedgerows and the historic landscape



Hawthorn hedge in flower. Richard Revels

A case study from South Gower

Kerry Edwards, David Leighton and Paul Llewellyn

Hedgerows remain a familiar and highly-regarded feature of the British rural scene, constituting some of the oldest habitats still visible in the landscape. Sharing many of their species with ancient woodlands, hedges provide a final stronghold for wildlife threatened by changing agricultural practices. Since the ground-breaking work of Max Hooper and his associates, which commenced more than forty years ago, both the wildlife value and the history of hedgerows have attracted widespread interest. Although by the early 1990s the ecological significance of hedges had yet to receive the same degree of critical attention as their history and origins (Clements and Tofts 1992), the introduction of statutory controls and conservation measures for hedges has since added new impetus to the quantification of their wildlife value. Over the same period, a developing awareness of 'landscapes' has led to a fuller appreciation of the complex interaction between human and natural influences that is central to their character (Cadw/CCW 1998). Landscape features such as ancient woodlands and hedgerows are now regarded as cultural artefacts as much as living entities, of interest to ecologists and historians alike, encouraging a more integrated approach to their study (Beswick and Rotherham, 1993).

Hooper's research revealed that the species diversity of a hedge, in respect of its tree and shrub composition, could be related to its age and the manner in which it had been created (Pollard *et al.*1974). 'Hooper's Rule' is essentially a correlation between the number of woody species present in a 30-yard length of hedge and its age in centuries, assuming that new hedges were planted using just one or two species and that floral diversity increases uniformly over time. Hedges originating from woodland (through 'assarting') tend towards greater species diversity and a more complex relationship with age.

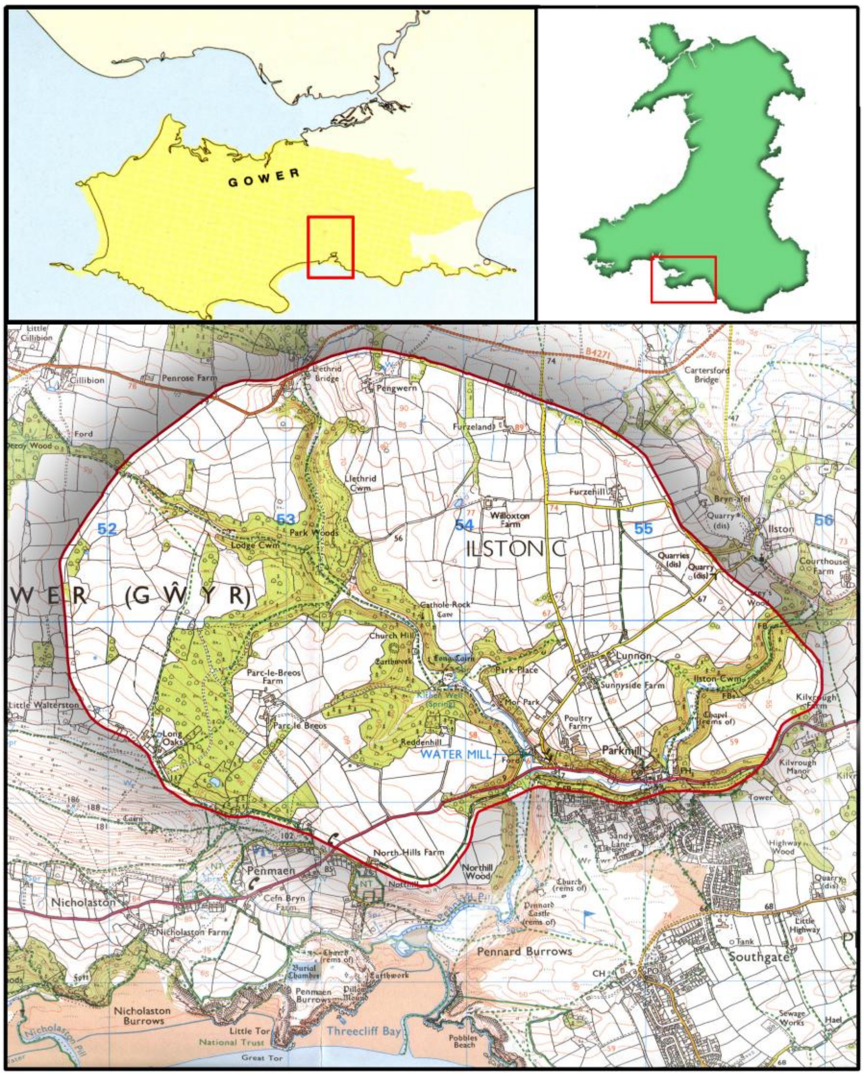
Numerous local studies have examined the relationship between the age and species content of hedges. Adverse results have led to doubts about the validity of the rule and the manner of its application (Muir and Muir, 1987). However, the species-age relationship was never promoted as a method of close dating nor claimed as universally applicable. Negative results arose as much from uncritical application and unrealistic expectations as from unrecognised anomalies caused by local environmental and management conditions. Expressed statistically, there is a 95% confidence that the age of a hedge determined by Hooper's Rule lies within 200 years of the calculated date (Dowdeswell 1987), an uncertainty which precludes the method as an absolute dating tool.

Regardless of its validity for dating, Hooper's Rule does reflect a genuine trend. As hedges become older they acquire more species. But if older hedges are richer in species, the converse does not always follow. Because hedgerows are intricate biological systems, their diversity is conditioned by numerous variables. A range of complex ecological effects arises from their linear continuity and from the connectedness between and within them. Any single hedgerow dataset, if examined in isolation, is capable of supporting several seemingly logical but very different interpretations. Identifying and evaluating variables which influence species diversity is therefore crucial when attempting to date hedges.

Hedgerow studies in Gower

Gower, an Area of Outstanding Natural Beauty, has a history of hedgerow studies dating from the mid-1970s when species counting exercises by parties of school students gave rise to a tentative dating for certain holdings in the Parkmill area in south Gower (Burn *pers. com.*). During the 1980s hedgerow-dating was applied at selected locations to obtain a framework for the chronology of land clearance and the establishment of farms in north-east Gower (Kissock 1991). The distinction between 'assart' and 'enclosure' areas, and the contrast in species content of hedges formed by these processes, were a theme of that study. In the late 1990s an ecological assessment of hedgerows in the peninsula was conducted in response to impending hedgerow regulations (HMSO 1997). This also aimed to differentiate between assart and enclosure areas, initially identified on the basis of field patterns (WEC 1998). Both studies made use of historical and ecological data, but each approached the question from one viewpoint using data externally acquired from the other. A further weakness was that the sampling strategies adopted entailed a limited selection of hedges over a wide area across a range of soil types, microclimates and other variables.

During the 1990s several studies initiated under the auspices of the School of Biological Sciences in the University of Wales, Swansea, examined the entire hedgerow complements of specified holdings. Large bodies of data were generated, suitable for statistical treatment and for evaluating species content as a function of conditioning factors (O'Shaunessy 1998; Sutherland 1999). In 1999, a programme of investigation examined *every* hedgerow across a historically defined area well served by the documentary record (Edwards 2000). The aims were to explore the dependability and accuracy of Hooper's Rule by comparing the physical and ecological attributes of the hedgerows, and to establish any correlations with the historical development of the area. It was intended to identify and minimise (or negate) variables perceived as distorting the dating of hedges by Hooper's Rule, against a chronological backcloth formed by the available historical and archaeological evidence. The outcome of that project forms the basis of this article.



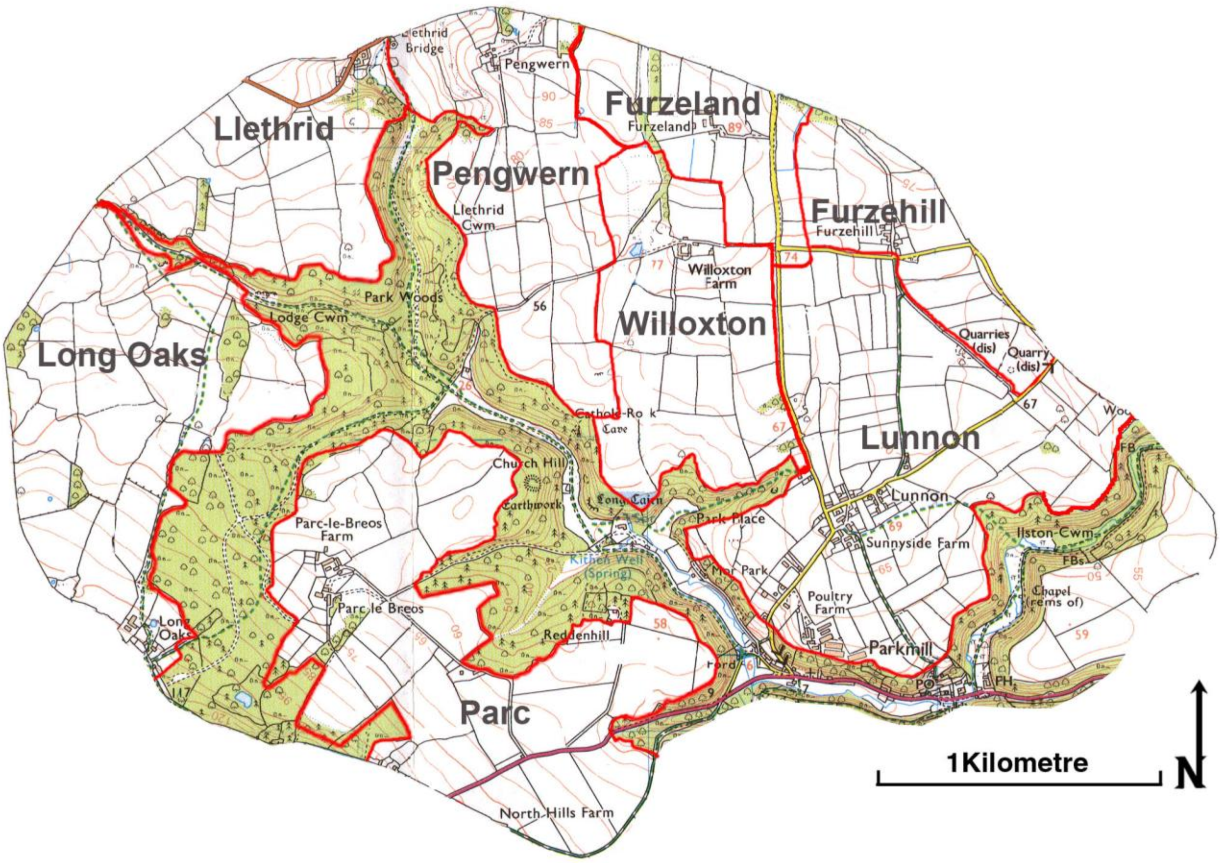
Location map showing study area in South Gower
Crown Copyright Ordnance Survey NC/03/07. All rights reserved.

The study area and its history

The study area is defined by the boundary of a medieval deer-park known as Parc le Breos, its oval outline preserved in the modern field pattern (map). The park, situated near Parkmill, now comprises roughly 800ha of farmland and woodland rising to an altitude of about 90m above OD. It is mostly undulating carboniferous limestone country with a uniform cover of largely well-drained loamy soils. Land use is mainly animal husbandry practised as part of mixed farming regimes. Woodland covers about 25% of the park and is concentrated in a large block in its western half.
The history of the park, its break-up and subsequent development have been described by Leighton (1999). The park was an asset of the Marcher lordship of Gower and originated in the period 1221-32. Medieval deer-parks were usually marked out by a continuous timber fence, or pale, set atop an earthen bank flanked by a ditch and were carved out of uncultivated land. The recorded presence of woodland in the 1220s is, however, the only direct reference to land use before

imparkment. After its foundation the park was reduced by about half when the eastern segment was converted into a manorial farm, or grange, some time before 1337. The reduced deer-park continued to function until at least 1400, but by 1551 it was being re-developed as new houses and boundaries were created to form the present pattern of holdings.

On the east, the grange was defunct by 1366 when the partitioning of land there had already begun. The dominant feature of the field pattern around Lunnon is a decayed system of open, or sub-divided, fields formed by the amalgamation of cultivated strips into ‘closes’. Modern Pengwern and Willoxton are present as place-names by 1366, and were well established holdings by 1650. Furzehill was well-developed before 1595 and Furzeland originated in the 1580s. The holdings as they were in the late 18th century are shown below, and these divisions define the farm holdings for the purpose of this study.



Map showing the farm holdings within the park in the late eighteenth century
Crown Copyright Ordnance Survey NC/03/07. All rights reserved.

Methodology

A strict application of the methodology of Pollard *et al*. (1974) was implemented. Every hedge within, and on the boundary of, the park was sampled in consecutive 30 yard lengths using the same standard distance measure. Field corners defined the limits of each hedge. Only one side of each hedge was examined, omitting junctions, gaps and gateways, with only established trees and shrubs being counted. Survey in the period May to September enabled the presence of spring-flowering plants to be noted. Details of all trees, and the structure and profiles of hedge banks, were also recorded. The dataset comprised 1,332 measured lengths, from 273 hedges. In

total, 36.53km (22.7 miles) of hedgerow were examined. Species averages were calculated for each hedge and Hooper's first regression equation was used to estimate their ages: *age of hedge = (110 x no. of species) + 30 years*.
A test sample of hedges dated through documentary sources was first assessed in order to gauge the method's validity at this location, the outcome conditioning the treatment of the dataset as a whole. Meanwhile, the historical research continued in order to create a time-line for the development of the modern landscape. Guide dates were obtained for the establishment of farms within tolerances dictated by the available sources. However, the two sides to the investigation - ecological and historical - were carried out separately to ensure that species assessment of the hedges was conducted without prejudice.

The test sample

Two groups were chosen: hedges planted during the last 200 years inside the park; and those of the park boundary which replaced the timber pale as the park went out of use, first on the east and then on the west. It is assumed that the pale was replaced by hedges when the containment of deer ceased.
The earliest available maps date from about two centuries ago and this allowed a number of new hedges to be identified and dated by their appearance between consecutive map editions. Some recent hedges were dated by oral testimony, others from local-authority sources. Hedges in the older group were dated from land-use change deduced from early surveys and financial accounts. Dates for hedge-planting were presented as falling in a range framed by the earliest and the latest possible dates for their creation, expressed statistically as the median point between the two dated sources accompanied by a standard deviation. In this way, historical dates of greater or lesser variance were obtained for 6.4km of counted hedgerow or 17.5% of the final hedge total.

Table 1 compares the historical dates for the hedge groups with dates calculated using Hooper's Rule. The most marked discrepancies arose in the case of the younger hedges. The average Hooper's date of 445 years represents a mean deviation of +316 years, in a range which varied from +195 to +624 years, a consistent overestimation of age.
In the case of the older hedges, those of the western pale also provided Hooper overestimates though of far smaller magnitude. The average deviation of +47 years spanned a range from -143 to +220 years. Hedges on the eastern pale - the oldest of all - furnished Hooper's dates which underestimated their historical ages by an average of 56 years. While this figure masked a wide variation from -540 to +673 years, the overall trend was clear. These results show that in the test sample Hooper's Rule underestimates the ages of older hedges while overestimating the age of younger hedges.

HEDGE GROUP	DATE WITHIN RANGE	AGE (years ago)	HOOPER AGE AVERAGE (y.a.)	MEAN DIFFERENCE
PARK PALE (E)	1221-1337	721+/-58	665	-56
PARK PALE (W)	1400-1551	524+/-75	571	+47
PARK INTERIOR	1800-1999 (var.)	129+/-23 (av.)	445	+316

Reference date = 1999 (year of sampling)

Table of historically-dated sample hedges with averaged Hooper dates

Analysing the sample results

Tracks and lanes

A feature of the recent hedges is a superabundance of Elder *Sambucus niger* and Dog-rose *Rosa canina*, much less frequent in the older hedges. Downweighting scores for these species, from 1.0 to 0.5, successfully addressed this problem but the same hedges were found to be affected by factors of a more far-reaching significance. Of the 20 younger hedges in the sample half were located at Parc, a nineteenth century hunting estate which, unlike its neighbours, was extensively landscaped. Furthermore, 40% lined tracks and lanes, and these displayed some of the largest date discrepancies in the entire sample.

Species richness in lane hedges has been noted in Gower, as elsewhere, and is usually explained by their origins in old woodland (Cameron and Pannett 1980; WEC 1998). The eastern park is criss-crossed by a network of lanes and tracks. Most are demonstrably recent or were superimposed on an already enclosed landscape. Origins in old woodland cannot therefore explain high species counts. Several interrelated factors may account for their distinctiveness. The value of a hedge as a wildlife corridor is magnified when two parallel boundaries in close proximity flank a narrow road, thus affording advantages similar to a strip of woodland. The way in which species interact and compete are affected. Species characteristic of mature hedges, for example, may be favoured through the provision of shelter or shade. The existence of routeways facilitates the passage of wild animals as seed carriers, the passage of human traffic and farm stock having a similar effect. Motorised vehicles also contribute to this and further impact on the local environment. Inter-species competition can be altered, and species diversity increased, through changes in nutrient levels and heightened toxicity caused by vehicle emissions, reinforced by increased salinity from winter gritting. Some slow colonisers, such as Dogwood *Cornus sanguinea*, occur rarely but when present are more prevalent along lanes, as if benefiting from the advantages of the lane environment. Whatever factors lie behind their species richness, roadside hedges clearly yield anomalous results when Hooper's Rule is applied to them.

Banks and ditches

Banks provide a range of ecological niches for species to take hold. They constitute areas of steep gradient affording conditions for colonisation by opportunistic species. This tendency is more noticeable where banks are associated with ditches which constitute 'woodland strip' environments similar to tracks and lanes. In the test sample the most pronounced overestimates of age were in the far north of the study area, in older hedges with banks accompanied by deep, overgrown ditches, where mean species counts rose to 12.4. However, across the study area bank-and-ditch systems are rarely found.

Banks have a separate historical significance. It is often believed that the oldest hedges are most likely those supported by banks (Pollard *et al.* 1974; Rackham 1976), and in certain circumstances bank morphology can be used as a dating tool (Hodges 1991). During this survey it was noted that regardless of whether banks are present, hedgelines become dumps for stones cleared from fields. Banks may therefore be created and gradually built up in this way. Here, banks show considerable variation, from irregular spreads of earth and stones to upright, stone-faced linear structures. Because of erosion by grazing animals, banks need regular maintenance. Local sources reported that hedging skills extend to maintaining banks, in particular re-stacking and stabilising them with facing stones. Bank profiles therefore can reflect recent management history rather than their origins. In the present study no special significance was accorded to bank structure.

Stones cleared from fields along a hedge at Long Oaks (Kerry Edwards)

Management

As hedgerows are man-made features, arguably the most important factor in their composition, condition and longevity is their history of maintenance and neglect. During the survey, observations and discussions with local farmers identified several management practices which influenced the presence or otherwise of a species. Management starts with planting, though no record for past planting regimes survives. Repairs will have made use of shrubs available from a variety of sources with some species favoured over others at different times in the life of the hedge. Some plants were better for laying, and others for trimming. Hazel *Corylus avellana* is often seen as characteristic of assart hedges but its widespread occurrence as coppice stools also points to its economic importance. Other species have been selectively removed from hedgerows, as in the case of Gorse *Ulex europaeus*, which is considered to have poor value as a hedgeing plant. Some species, such as Holly *Ilex aquifolium*, are treated differently from farm to farm (J.Williams pers. comm.). In one farm, Holly was removed from hedges during laying because its sharp leaves were a nuisance to farmworkers during hay-making, while on an adjacent farm the species was maintained for its winter feed value. In fact, the feeding of Holly near to field gateways has increased the incidence of the species in adjacent hedges. On the same holding where this was noted, a family preference for Gooseberry *Ribes uva-crispa* fruit favoured these plants as hedging shrubs (pers.obs.). Some well-established hedges which fell into disuse were later reinstated. Late colonisers from the old hedge became dominant in the boundary as gaps appeared, later infilling distorting the history of the ‘new’ boundary. Recorded examples arose from local testimony but many more instances must have gone unrecorded.

Statistical check
The significance of large datasets was underscored in the application of a one-way analysis of variance (ANOVA). A p-value of <0.5 showed that Hooper's Rule is poor at predicting dates from small datasets (and, by implication, single hedges), but when applied to a large dataset much of the variation is cancelled out and dependable results are obtained.

The progress of partition and enclosure: Hooper dates and historical chronology

The sample results were applied to the complete dataset. No separate allowance was made for hedges supported by ditched banks because of their rarity. However, because routeways are so prevalent across the area, their hedges were omitted. The single most important group of variables bearing on species composition falls under 'management history', but the difficulties of evaluation meant that no allowance could be made for this category. The entire dataset was subdivided according to historic tenanted holdings; mean species counts were calculated and their corresponding dates tabulated (see Table 2).

HEDGE GROUP	HISTORICAL DATE	AGE years ago	Mean no. of species	HOOPER AGE years ago	HOOPER DATE
PARK PALE (E)	1279+/-58	721+/-58	5.77	665	1334
PARK PALE (W)	1476+/-75	524+/-75	4.80	558	1441
LUNNON	after 1366	< 633	4.70	547	1452
FURZEHILL	before 1595	> 404	4.76	554	1445
FURZELAND	after 1585	< 414	4.45	519	1480
PENGWERN	1508+/-142	491+/-142	4.38	512	1487
WILLOXTON	1495+/-129	504+/-129	4.16	488	1511
LLETHRID	1591+/-40	408+/-40	3.95	463	1536
LONG OAKS	1591+/-40	408+/-40	4.02	472	1527
PARC	1591+/-40	408+/-40	3.41	406	1593

Reference date = 1999 (year of sampling)
Comparison of historical and Hooper dates for the park boundary and farm holdings

The eastern farms
There is no documentary evidence for the inception of these holdings. Median historical dates assigned to them are based on the earliest record of their place names and their first appearance in rentals and surveys. In reality, they evolved into their present state over centuries; the gain and loss of hedges, visible in the test sample, occurred in each holding. The enclosures around Lunnon never constituted a single farm. An agricultural landscape of narrow strip fields became enclosed at an

irregular rate over an indeterminate period. Early maps show that the rectilinear fields around Lunnon were far more numerous in the mid 19th century. Many narrow, closely spaced parcels were reduced as larger fields were created during the 20th century. For most of their existence these hedges had very close neighbours, perhaps interacting in a manner similar to those flanking lanes and tracks. However, the averaged date is consistent with the earlier historical dates for the eastern holdings.

The western farms

Farms on the west side form a coherent group, dating from the mid 16th century, but the same caveats regarding boundary gain and loss also apply. Hooper dates fall within 70 years of the mean historical dates.

Because these holdings are broadly contemporary with Furzeland on the east, similar Hooper dates were expected. However, Furzeland shows the largest discrepancy between predicted historical date (soon after 1585) and hedgerow date (1480), albeit within the accepted confidence limits for Hooper's dating (+/-200 years). Furzeland is the smallest farm and has the smallest dataset, half its hedges along tracks and lanes. Their exclusion left a small working sample which adversely affected the result. However, their inclusion increased the deviation, giving a date of 1343; the best historical date now lies outside the Hooper confidence range for this hedgerow date.

An ancient Ash stub left after the removal of a hedge (Kerry Edwards)

Although each data subset comprises a range of species counts (2.5-5.6 at Llethrid and 1.4-12.4 along the pale), Hooper dates broadly accord with the historical guide dates. The oldest hedges are on the east, which has the longest history of enclosure and partition, the youngest on the west which remained a deer-park (and therefore unfarmed) for a longer period. Hedges planted on the line of the pale give dates consistent with its replacement by hedgerows in two distinct phases. The Hooper dates thus support the historical sequence for the break-up of the deer-park and the creation of farms during the 15th and 16th centuries. Sediment studies in nearby Ilston Cwm recorded a period of valley alluviation tentatively dated to 1400-1600. This was interpreted as reflecting a renewed phase of valley side instability, attributed to enclosure and intensified agricultural activity in the valley catchment (Saunders *et al.* 1989), a view which is consistent with the hedgerow dates.

Where do the hedgerows come from?

The correlation between hedgerow dates and local historical chronology leaves the question of *how* the hedges originated; whether from relict strips (or boundaries) of old woodland, cleared for the creation of the park and its later conversion to farmland, or from the enclosure (or sub-division) of open pasture and land under open field cultivation. The orthodox view is that species richness in hedges reflects assart origins while species-paucity implies enclosure (Pollard *et al*. 104). In this area both processes, judging by field patterns and species content, appear to have operated together.

Most deer-parks were wood-pasture environments which included protected woodland. Woodland has been present hereabouts since at least the early 13th century. It is now mostly contained in a gorge, and its early extent across the park is unclear. Place names in the east are associated with woodland. 'Lunnon' (Welsh *Llwyn-on* = Ash Grove) and *Pengwern* (= Head of Alder Marsh) are documented in the mid 14th century. 'Furzeland' and 'Furzehill' imply a scrub environment, and these appear later in the record. The possibility that some clearance was needed to make way for the grange is therefore quite strong. It is also clear, on the basis of field shape, that many hedges enclose land that was already open. The enclosures on former grange land are mostlt rectilinear. Fields on the west, in contrast, are irregular in shape and show an unplanned pattern consistent with assart origins (WEC 1998). The data sub-sets were therefore assessed for clues to hedgerow origins.

Species profiling

Woodland relict hedges conventionally show a mixed composition, whereas enclosure hedges contain a more limited range of species, with one, or perhaps two, being dominant (Pollard *et al*. 1974). Histograms were constructed to compare species richness by group (see Fig.1 below). Hawthorn and Blackthorn are present in most of them, but given the frequency with which other species occur, the profile of each dataset could be described as 'mixed'. No subset has a profile of the unequivocal 'enclosure' kind (Pollard *et al*. 1974; Kissock 1991). Hedges bounding rectilinear parcels at Lunnon do not have clear enclosure profiles despite their telling field pattern.

Regarding species, there are some distribution patterns. Oak *Quercus* is more prevalent on the east and along the pale. Elm *Ulmus* is also more common on the east. Some species were omitted from the histograms because their low frequency failed to show a revealing distribution. There were only six records for spindle *Euonymus europaeus*, exclusively in eastern hedges, including the pale. Gorse appears only on the east as does Field Maple *Acer campestre*, which was noted only at Lunnon and Willoxton. But records for Privet *Ligustrum vulgare*, another local rarity, are scattered across the park.

A recent survey in Gower identified several species characteristic of 'assart areas', including English Elm *Ulmus procera*, Wych Elm *U. glabra* and Field Maple (WEC 1998). Other species purportedly found mostly in assart hedges, include Sycamore *Acer pseudoplatanus* and Goat Willow *Salix caprea*, with oak, Holly and Hazel having their greatest frequencies there. In this study, none of these species was found restricted to boundaries of any particular form. All appear in hedges of undoubted enclosure origin. Hazel, in particular (a 'poor' coloniser), is well represented, appearing in 90% of test sample hedges of recent date. Despite the strong circumstantial and morphological evidence for both assarting and enclosure processes, species profiles do not offer conclusive distinctions. Accordingly, alternative approaches to understanding hedgerow composition were considered.

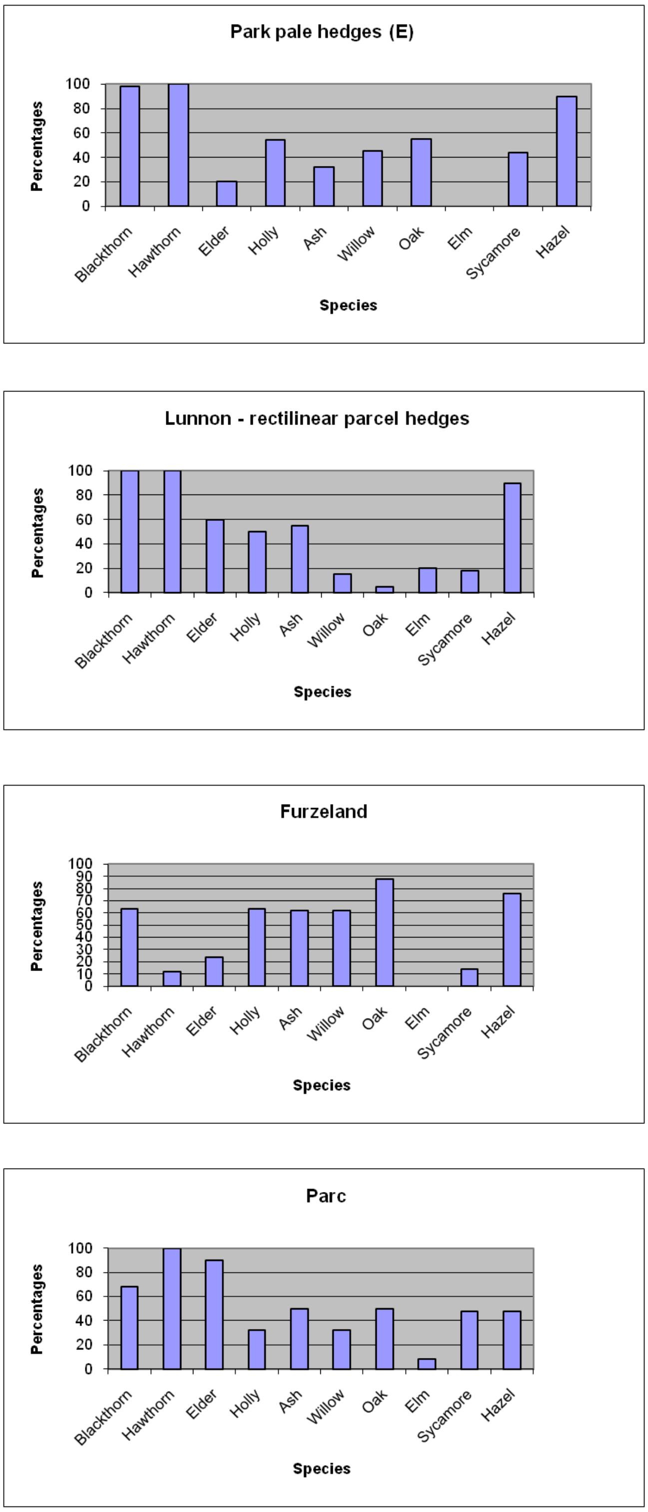


Figure 1 Histograms showing percentage of hedges which contain certain species from different holdings of the park and from its eastern boundary

Ancient-woodland indicators

The presence of certain vascular plants known as Ancient Woodland Indicators (AWIs) in hedgerows is sometimes used to identify woodland relict hedges (Rackham 2003). Several such plants were recorded during survey, but no clear relationship with the species richness of hedges was detected.

Structure of local ancient woodland
Knowing the composition of woodland which has since been cleared is invaluable for identifying relict hedges. Information is best obtained from dated palynological records, and some local evidence is available. The data from Ilston Cwm show a progressive decline of mixed (oak-Hazel-Birch *Betula*) woodland with increases in grasses and other forbs as the environment opened up for agriculture from later prehistory onwards, but the record ends in the early 12th century (Saunders *et al*. 1989).
Profiles of local modern woodland have instead been taken by some researchers to indicate the structure of assarted precursors (Kissock, 1991). Oak, Hazel, Beech *Fagus sylvatica*, Birch and Ash *Fraxinus excelsior* are the most common species, with Sycamore and Holly also present. The assumption is that the composition of modern natural woodland accurately reflects the medieval source woodland, and by implication the 'wildwood' or cleared primary woodland. Aside from the problem of determining primary status, the composition of woodland changes over time under the influence of climatic, edaphic and other factors, especially human intervention (Day 1993). The presence of Sycamore, a 16th-century introduction (and not widespread before the later 18th century), and of Beech (here growing outside its normal geographical range assisted by planting) testify to the anthropogenic character of supposedly 'natural' woodland. Documented records of oak, elm and Ash in the 17th century are the only direct evidence for the composition of the park woodland, which today is heavily coniferised. Modern woods were therefore not used in this study as reference points for woodland relict hedges.

Assarting and woodland history

An assumption underpinning the case for assart-derived hedges is that cleared woodland was sufficiently dense to facilitate hedgerow creation. Various objections to this model have been put forward (Muir and Muir 1987). The documentary evidence for the condition of local woods in the 13th and early 14th centuries was reviewed. Woodlands in Gower were clearly under pressure, and increasing in value. The earliest local reference (about 1220) uses the Latin *silva*, a word implying wood-pasture (Wager 1998. In the 1280s, following the suppression of rebellion, woodland - in preference to other lands - was forfeited by a principal insurgent (Seyler 1924). Charters of liberties granted in 1306 included restrictions on the taking of wood, signifying the need for conservation, and recorded an attempt to impark woodland a few miles east of Parc le Breos (Leighton 1997). Elsewhere in lowland Glamorgan, at Cefn Hirgoed, near Bridgend, analysis of pollen indicates the disappearance of woodland by the 14th century, coinciding with heightened grazing activity and unrestricted felling (Walker *et al*. 1997).
Imparkment itself exerted pressure on woodland, through the construction and maintenance of the timber pale. The cyclical harvesting of trees within parks is well known, and enclosure banks still visible in Park Woods are evidence for the protection of wood parcels from grazing livestock. However, woodland outside the protected areas of the park would have suffered attrition. If a broad definition of assarting is the intake of previously uncultivated land, or 'waste', then agricultural conversion here meant the enclosure of a largely open environment, with insufficiently dense woodland for hedgerow creation.
The oldest hedges - their dates supported by Hooper's Rule - are the most species-rich but were clearly created after the eastern pale bank and were therefore planted. On the basis of averaged counts, species richness is directly related to age. But where did the trees and shrubs for these hedges come from? Residual woodland and any established hedges are obvious sources for planting and repairs, and as seed stores for natural colonisation. Mixed planting may also have been practised.

Single- or twin-species planting is usually assumed. But a review of the literature shows that, until recently, mixed hedges were generally preferred, if only to ensure the availability of different kinds of wood as well as fruit and other products of value to farm households (Johnson 1978). If mixed planting was a factor in the establishment and management of hedges, the correlation between diversity and age in averaged counts may mean that changes have occurred in the colonising behaviour of some species over the last few centuries.
Since assarting is unlikely to account for the irregular shape of the western fields, other explanations must be sought. One possibility is that uneven local topography would have required frequent changes of direction during boundary construction, not only to avoid natural obstacles but also to incorporate any trees in the pasture landscape. Throughout the post-medieval period local woodland was exploited as an exclusive resource by land-owners, farm leases containing covenants against the 'tapping' of trees. Wood products derived from routine hedgerow maintenance would therefore have had a particular significance for tenants.

An old Hawthorn in a former hedge. Its history of laying is revealed by its shape (Kerry Edwards)

Conclusions

In this study of hedgerow age and origins, species content was found to be a dependable guide to hedgerow succession. Species richness is conditioned by several factors, of which age is one, and doubts have been cast on the validity of assart origins for hedgerows. The importance of 100% sampling in smoothing out anomalies cannot be overstated. The wide range of species counts within data subsets highlights the dangers of random or selective sampling strategies. Widely divergent dates may be obtained according to selections made, perhaps yielding results which coincide with preconceptions of landscape change. The initial discovery of a relationship between species diversity and age was made in research which recognised that the complexity and ecological value of hedges went some way beyond the mere numbers of species within them. This is an appropriate perspective when investigating their age and origins.

The results of this study were obtained through taking a broad, holistic, view of hedgerows, and show the value of an interdisciplinary approach in maximising data to provide a more accurate picture of the chronology of landscape change. The methodology applied involves more analysis than dating, but Hooper's Rule arose in this way.

Under favourable circumstances the analysis of species diversity can provide supportive dating for historical models, but it does not offer a 'fast track' solution to chronological problems of landscape change. Close examination of archaeological evidence for boundary development, on the other hand, may enable older hedges to be separately identified, allowing the scope of their ecological study to be broadened. Such is a possible outcome of this study, where the wealth of collected data has only been touched upon in this article.

References

Beswick, P and Rotherham, I D (eds) 1993 *Ancient woodlands - their archaeology and ecology*: *a coincidence of interest*. Landscape Archaeology and Ecology vol.1. Landscape Conservation Forum, Sheffield.

Cadw/CCW 1998 *Register of landscapes of outstanding historical interest in Wales* Cadw: Welsh Historic Monuments, and Countryside Council for Wales, Cardiff.

Cameron, R A D and Pannett, D J 1980 Hedgerow shrubs and landscape history: some Shropshire examples. *Field Studies* 5: 177-94.

Clements, D K and Tofts, R J 1992 Hedges make the grade - a look at the wildlife value of hedges. *British Wildlife* 4 (2): 87-95.

Day, S P 1993 Origins of medieval woodland *in* Beswick, P and Rotherham, I D (eds) 1993: 12-25.

Dowdeswell, W H 1987 *Hedgerows and verges*. Allen & Unwin, London

Edwards, K T 2000 *An investigation to determine the accuracy of Hooper's dating system for hedgerows in Gower with a view to understanding the landscape development of the Parc-le-Breos deer park*. Unpublished dissertation, Department of Biological Sciences, University of Wales Swansea.

HMSO 1997 *Hedgerows Regulations*. Statutory Instruments 1160.

Hodges, R 1991 *Wall-to-wall history: the story of Roystone grange*. Duckworth, London.

Johnson, W 1978 Hedges - a review of some early literature. *The Local Historian* 13: 195-204.

Kissock, J A 1991 Farms, fields and hedges: aspects of the rural economy of north-east Gower, *c*. 1300 to *c.* 1650. *Archaeologia Cambrensis* 140: 130-147.

Leighton, D K 1997 The land-use history of Clyne Wood and the evolution of the Clyne landscape. *Studia Celtica* 31: 135-59.

Leighton, D K 1999 A fresh look at Parc le Breos. *Journal of the Gower Society* 50: 71-79.

Muir, R & Muir, N 1987 *Hedgerows*. Michael Joseph, London.

O'Shaunessy, R A 1998 *A comparison of the ecology and age structure of hedges on three Gower farms*. Unpublished M.Sc. dissertation, University of Wales Swansea.

Pollard, E, Hooper, M D, & Moore, N W 1974 *Hedges*. Collins, London.

Rackham, O 1976 *Trees and woodland in the British landscape*. Dent, London.

Rackham, O 2003 *Ancient Woodland*. Castlepoint, Dalbeattie. 2nd edition.

Saunders, G E, Wood, S J & Burrin, P J 1989 Late-glacial and Holocene environmental change in the Gower peninsula: evidence from the alluvial valley fill of the Ilston river. *Quaternary Newsletter* 59: 14-23.

Seyler, C 1924 The early charters of Swansea and Gower. Part 2. *Archaeologia Cambrensis* 79: 299-325.

Sutherland, M J 1999 *The age, importance and floristic diversity of hedgerows on Brynmoel Farm, South Wales.* Unpublished dissertation, Department of Biological Sciences, University of Wales Swansea.

Wager, S J 1998 *Woods, wolds and groves: the woodland of medieval Warwickshire*. British Archaeological Reports 269, Oxford.

Walker, M J C, Lawler, M & Locock, M 1997 Woodland clearance in medieval Glamorgan: pollen evidence from Cefn Hirgoed. *Archaeology in Wales* 37: 21-26.

WEC, 1998 *Gower hedgerow project*. Swansea City and Council. Wessex Ecological Consultancy, Bristol.

Archive note:
Details of all hedgerows and species counts which form the basis of this work, with historical data appended, are included in Edwards (2000), archived at the Department of Biological Sciences, UCW Swansea. A copy of the relevant species tables together with historical source references may also be consulted at the National Monuments Record of Wales at RCAHMW in Aberystwyth (ref: NPRN 300001).

Kerry Edwards and Paul Llewellyn, Department of Biological Sciences, University of Wales, Swansea. David Leighton, Royal Commission on the Ancient and Historical Monuments of Wales, Aberystwyth.