BREEDING BIRDS AND WOODLAND
MANAGEMENT IN SOME
LINCOLNSHIRE LIMEWOODS

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Cocklode Wood, Lincolnshire: unthinned derelict coppice, last cut 30-40 years ago.

Ivy Wood, Lincolnshire, last coppiced 30-40 years ago and subsequently thinned in the early 1970s.

Hatton Wood, Lincolnshire, one year after thinning. This wood was last coppiced over 70 years ago and now exhibits a high forest structure.

Great West Wood North, Lincolnshire: a high forest stand last coppiced at least 70 years ago and thinned in the mid 1970s. This management has created a varied structure with a tall but fairly open canopy over a vigorous shrub layer.

SUMMARY

1. In May 1982 a team of bird census workers, under the organisation of the British Trust for Ornithology, carried out an ornithological survey of eight ash-lime woods in Bardney Forest, Lincolnshire.

2. Several of these semi-natural stands have been subjected to a process of thinning by the Forestry Commission with the eventual aim of promoting the neglected coppice to high forest.

3. The study was designed with two questions in mind: a) What are the short-term effects of thinning? b) What ornithological changes are likely to accompany the transition from abandoned coppice to high forest? Accordingly two classes of woodland were studied: plots which were last coppiced 30-40 years ago and plots last felled 70 years ago. Within both classes, unthinned and thinned plots were chosen.

4. The total numbers of species recorded ranged from 26 to 41; numbers of territory holding species ranged from 19 to 32.

5. Fewest species were found in the 30 year unthinned woods and the largest numbers in the 70 year woods. The 30 year thinned woods were intermediate in species richness.

6. There was no significant relationship between number of species and plot area. However, when species number was plotted against wood area two groups were evident. The two unthinned 30 year plots and one thinned 30 year plot were

comparatively poor in species but the remaining plots were approximately equal in species richness despite considerable variation in plot area.

7. Species richness was negatively correlated with estimates of canopy cover ($r_s = -0.79$).

8. The limewoods held high densities of birds: the densities of passerines alone exceeded 100 territories per 10 hectares.

9. Densities were highest in the more mature woods and total bird density was positively correlated with canopy height ($r_s = 0.80$).

10. Lists of dominant species were similar for all plots. Four species - Robin, Blackbird, Willow Warbler and Chaffinch - contributed more than 5% of the bird community in all woods. Willow Warbler was the dominant species in five woods.

11. Density of Turdidae (thrushes and allies) was greatest in the unthinned 30 year plots. Song Thrush and Blackbirds, in particular, decreased in thinned woods. Overall density of Turdidae was positively correlated ($r_s = 0.84$) with canopy cover.

12. Density of warblers was lowest in unthinned 30 year woods but apparently increased in response to thinning. A 70 year plot thinned six years previously, held an outstanding warbler population most notably of Garden Warblers. The structure of this plot - a tall but fairly open canopy with a prolific shrub

layer - was probably ideal for a large and varied warbler population.

13. Overall densities of tits and finches tended to be greater in 70 year woods than 30 year woods. An unthinned 70 year plot held an exceptionally high density of Chaffinches.

14. Overall densities of hole and crevice nesting birds were correlated strongly ($r_s = 0.96$) with the number of trees supporting large dead branches.

INTRODUCTION

In May 1982 the British Trust for Ornithology carried out an expedition to census birds in several woodlands in Bardney Forest, Lincolnshire. These woods were studied because they provided an excellent opportunity to assess the influence of certain types of woodland management on breeding bird populations. The study plots were all ancient, broad-leaved stands within the so-called "Lincolnshire Limewoods". All were formerly coppiced and were broadly similar in tree species composition. There was, however, much structural variation between plots, resulting mainly from the recent history of management. The woods differed in the time they were last coppiced and some had been thinned within the previous ten years by the Forestry Commission. This process of thinning is aimed at promoting derelict coppice to mixed high forest stands of native trees. From the viewpoint of nature conservation, thinning is one possible alternative to traditional coppice systems, especially in mixed coppices with adequate numbers of stems suitable for promotion (Peterken 1981).

Each study plot was censused to obtain comparable estimates of the composition of the bird community and the population sizes of the various species present. The expedition was designed with two main questions in mind:

(i) What are the short-term ornithological effects of thinning?

(ii) What are the likely long-term ornithological implications of promotion from neglected coppice to high forest?

Information of this kind is one of many ingredients required for balanced management prescriptions in woodlands where nature conservation is an important objective. This report provides the results of a preliminary analysis aimed at the above questions.

THE STUDY PLOTS

The general location of the eight study plots is shown in Figure 1. The plots fell into Peterken's (1981) group of ash-lime woodlands, principally within his stand type 4A (acid birch-ash-lime* woods). Each plot was chosen for its apparent internal homogeneity, although inevitably some variation in structure and composition was present within each stand.

It was obviously desirable that the plots should be as similar as possible in terms of their physical locations and areas. However, a major problem in comparing ancient woodlands is their great variation which Rackham (1980) summarises as follows:

"Ancient woods are highly individual and unpredictable. No two are the same, and it is not uncommon to find three or four types of woodland in a wood of 50 acres. They come in comparatively small samples: there are not many semi-natural woods bigger than 250 acres, and the larger a wood the more likely it is to have suffered recent alterations which make its natural and historical elements difficult to reconstruct."

It was inevitable, therefore, that the plots should differ to some degree in their shape, areas, and neighbouring vegetation: this irregularity is a fact which English woodland ecologists have little option but to accept. Nevertheless, every effort was made to reduce the variation between plots to a minimum (Table 1). Areas ranged from 8.5 to 14.0 hectares. A plot size of at least 10 ha was aimed for, but in two of the eight plots (Cocklode and Great

* Scientific names of tree species are given in Table 3.

West North) the total stand area available was less than 10 ha. Plot boundaries were selected to be as square or rectangular as possible. Altitudes were less than 25m and the plots were either level or only slightly sloping with a W aspect (notably the Great Wests and Hatton). Every plot was part of a larger unit of forest which in all cases included substantial areas of coniferous plantation. The plots represented 4-29 per cent of the total forest area in their units. In all but two cases (Hardy Gang and Great West South) this percentage was less than fifteen. The percentage of semi-natural woodland covered by each plot within its unit was 19-47. Each plot was positioned on the edge of its forest unit so that part of the boundary was formed by open farmland. Only in the case of Newball North did the farmland contribute more than 50 per cent of the plot perimeter. Nearest-neighbour distances between the centres of plots ranged from 0.4 to 2.3 km. The two plots farthest apart were separated by 8.5 km. All the plots were traversed or bordered by open grassy rides.

In terms of management (Table 2), two broad categories of plots could be distinguished on the basis of the time since they were clear felled as coppice. Five plots were last cut 30-40 years ago and the remaining three plots were last coppiced at least 70 years ago. These classes are subsequently referred to as "30 year" and "70 year" woods respectively. Within each of these categories, both unthinned and thinned stands were selected. In the 30 year stands thinning was achieved by singling the coppice; in 70 year stands a proportion of the standards were removed.

METHODS

Bird Census methods

Bird populations were assessed using a territory mapping method similar to that recommended by the International Bird Census Committee (1969). The most important difference was that all the fieldwork was condensed into the period 15th - 29th May. Intensive expedition censuses of this type have been used previously in studies of woodland and plantations in Scotland and Ireland (eg Batten 1976, Williamson 1969a, 1974, 1975). O'Connor (1980) has shown that the patterns of bird community composition obtained from short-term censuses in May can compare very favourably with those obtained from more conventional mapping censuses in which visits are spread throughout the breeding season. The main bias associated with intensive censuses performed in May is likely to be an under-estimate of very early nesting species (eg Mistle Thrush*). However, May censuses do have the advantage that several species of migrant passerines (eg Sylvia warblers) are particularly vocal and conspicuous at this time (pers. obs.).

The census procedure adopted in the limewoods was as follows. Each plot was visited on ten occasions on which the positions and activities of all birds were plotted on 1:2500 scale maps. Each plot had previously been gridded with bright red tape markers, usually at 50m intervals, so that positions could be placed accurately on the maps. At the completion of ten visits to each plot the bird registrations were transcribed onto individual species sheets (ie one sheet per species). These registrations

* Scientific names of birds are listed in the Appendix.

were then interpreted in terms of clusters in accordance with the rules used in the BTOs Common Birds Census. These clusters were equated with territorial pairs. The minimum requirement for acceptance of a cluster was three registrations recorded on different visits, with the exception of crepuscular or nocturnal species for which two registrations were acceptable. The fieldwork was performed by five teams of observers. The following precautions were taken to ensure that the census results obtained from different woods were as comparable as possible:

(i) To cancel out biases due to differences in the ability of observers, the teams visited the plots on a strict rotation.

(ii) Biases between observers were further reduced by ensuring that inexperienced census workers were paired with an experienced worker. Teams never comprised more than two people and were usually one observer alone

(iii) On each visit the full area of the plot was covered as evenly as possible.

(iv) Three separate census periods were recognised: "early morning" (approx08.00-11.00 hours), "late morning" (approx 10.30-14.00 hours) and evening (18.00-dusk). Each plot received four visits in the early morning, four in the late morning and two in the evening. This avoided major biases due to diurnal variations in song output.

(v) Census routes were changed at random as a further precaution against biasing the distribution of registrations within each plot.

(vi) Little guidance was given to teams about the duration of visits because this could have introduced a bias. More time was required to census high density than low density areas; also some of the woods were physically much easier to walk through (and to observe birds in) than others.

Methods of measuring the woodland habitat

A modified version of James and Shugarts' (1970) technique was employed to obtain quantitative information on a range of habitat variables considered to be of potential ornithological significance. Four 25m diameter circles were positioned at random in each plot. Within each circle the species and breast height diameters (BHD) of all trees greater than 10 cm BHD were recorded. The numbers of live trees with large dead branches and all standing dead trees (including all stumps standing at least 1m above the ground) were counted. Maximum canopy heights were estimated. Profiles of the distribution of foliage between canopy, shrub and field layers were sketched following the method used by Moss (1978). Two transects were laid across each circle on N-S and E-W alignments and the following measurements were taken: (a) counts of dead wood on the ground within 1m (b) numbers of woody stems less than 10 cm BHD within 1m - this was taken as a measure of shrub abundance.

The sample areas, with four circles in each plot, covered approximately 2 per cent of a 10 hectare plot. This is obviously a small sample but we believe that in the limewoods this gave an adequate and realistic reflection of the gross variations in the tree composition and physical structure between plots. The method was inadequate to record the detailed variations that undoubtedly occurred within plots, therefore additional visual estimates of the foliage structure were made at every intersection on the 50m grid.

RESULTS

Woodland structure and tree species composition

Some of the structural differences associated with the management status of the woods are summarized in Figure 2 which illustrates frequency distributions of tree sizes in terms of breast height diameter (BHD). Methods of measuring vegetation are described in the following section. All the 30 year woods were dominated by stems less than 20 cm BHD. Seventy year woods were typified by much lower numbers of small stems and a more even age distribution, with a relatively strong representation of trees more than 30 cm BHD. Within the 30 year class, thinning had reduced the numbers of small trees but these appeared to increase with the time since thinning (compare Hardy Gang and Ivy Woods in Figure 2). Similarly, in 70 year woods, trees less than 30 cm BHD predominated in an unthinned plot (Newball North) but in a recently thinned plot (Hatton) their dominance was much reduced. Several years after thinning, an understorey coppice growth is present and this is reflected in the numbers of small stems counted on Great West North.

Although the plots were drawn from one broad botanical parent population (Peterken's ash-lime woods) there was much variation in tree species composition (Table 3). Ash, oak and lime were generally the most abundant trees. Ivy Wood was notable for its relatively high abundance of birch, Newball North for an abundance of ash, and Hatton for high dominance by lime.

Inevitably, even between superficially comparable stands such variations in tree composition and woodland structure will exist as a result of differences in management (for example selective thinning of certain sizes or species of trees) and edaphic factors.

Numbers of bird species

The numbers of species recorded ranged from 26 in Cocklode to 41 in Great West North but in all woods several of the species were not considered to be holding territory (Table 4). Fewest species were found in the 30 year unthinned woods and the largest numbers in the 70 year woods. There was no significant correlation between numbers of species and plot area ($r_s = 0.28$). When the numbers of species were plotted against the areas of the plots (Figure 3) two groups of plots were evident. The two unthinned 30 year woods and Hardy Gang were comparatively species poor; the remaining plots formed a group of approximately equal species richness despite a large variation in plot size. The species richness of Great West North (the 70 year plot thinned six years ago) was strikingly high for its small area. Preliminary analysis suggested that species richness was related to the canopy cover with the more open woods supporting more breeding bird species than closed woods (Figure 4). Opening the canopy is, of course, one of the structural changes brought about by thinning and it appears that this management has a generally beneficial effect on avian species richness.

Total bird density

A striking feature of the limewoods was the high density of birds present on each plot. The densities of passerines alone exceeded 100 clusters per 10 hectares in all cases (Table 4 and Figure 5). There has not been any comprehensive review of bird densities in British woodlands to provide a framework within which the limewoods can be judged. It is evident from published densities (eg Williamson (1972) gave a range of 200 - 1800 pairs per km^2) that the limewoods are good woods for overall numbers of birds. Densities were highest in the more mature woodlands (Figure 5) reflecting a relationship between bird density and canopy height ($r_s = 0.80$, $P < 0.05$).

Ivy Wood was intermediate, in terms of both species richness and density, between the remaining 30 year woods and the 70 year woods. There is no clear reason why this should be so, although Ivy differed from Hardy Gang and Great West South in the following two respects. First, its structure was different (Figure 2), with a higher number of small trees. Second, it contained more birch than any other plot (Table 3). The latter factor could influence bird density if some of the commoner British woodland birds prefer to forage in certain species of trees (in this case birch) in the same way that has been demonstrated for some North American forest species by Holmes and Robinson (1979). Whilst such factors may be involved, it is unlikely that simple-minded explanations will cast much light on the deviation of Ivy Wood from the general pattern.

Community composition

The lists of dominant species were similar for all plots (Figure 6). In five cases Willow Warbler was dominant and in three it was the second most abundant species. Four species - Robin, Blackbird, Willow Warbler and Chaffinch - contributed more than 5 per cent of the bird community in all woods. Species which assumed particular significance in certain woods, with ranks in brackets, were Song Thrush (Cocklode 1), Wren (Hatton 1, Ivy 2), Chaffinch (Newball North 1), Garden Warbler (Great West North 2), Starling (Great West North 4, Hatton 7).

The rest of this section considers the densities of the main taxonomic groups and individual species. The latter are catalogued in Table 5; densities for major groups of passerines are illustrated in Figure 7 and for the dominant species individually in Figure 8.

The predominantly resident Turdidae (Robin, Nightingale, Blackbird and Song Thrush) were represented most strongly in the unthinned 30 year woods (Figure 7). Thinning appeared to result in decreased densities of Song Thrushes and Blackbirds (Figure 8) - this was even evident within the 70 year woods with Newball Wood holding the greatest densities. The overall density of Turdidae was particularly strongly associated with the canopy cover ($r_s = 0.84$, $P < 0.01$). The more closed woods thus had greater populations of thrushes and this probably explains why Ivy Wood, which was thinned several years earlier than the other two 30 year woods, held particularly high densities in this class.

Densities of warblers (Figures 7 and 8) showed an almost opposite trend to the thrushes. Overall densities were lowest in the two unthinned 30 year plots; the three thinned 30 year woods supported 20-69 per cent more warblers. In the 70 year woods, Hatton was poorest for warblers, possibly because the very recent thinning had left it largely denuded of an understorey. Great West North, however, held an outstanding population of warblers which was 47 per cent larger than the plot with the second highest density (Great West South). Preliminary analyses failed to isolate any single vegetation parameters which were strongly correlated with the warbler densities. However, Figures 7 and 8 provide good evidence that management influenced the warbler populations because (with the above exception of Hatton) within both 30 and 70 year woods the thinned woods held higher densities than unthinned. In the case of Great West North the combination of a tall but fairly open canopy with a prolific coppice regeneration probably provided optimal conditions for a diverse and abundant population of warblers. It is worth noting also that this plot was especially important for several other migrants - Turtle Dove, Nightingale and Spotted Flycatcher.

For both the tits and finches (Figure 7) there was some suggestion that densities were higher in the 70 year woods. Generally though, the differences between the woodland types were not large and Ivy - a thinned 30 year wood - held the largest tit populations. The exceptionally high finch population (mainly Chaffinches Figure 8) in

Newball North cannot be explained readily - neither for finches nor for tits could important site parameters be identified.

The overall densities of hole and crevice nesting species were correlated very strongly with the number of trees with dead branches (Figure 9). This relationship persisted whether Starlings were included or not. There was no correlation between bird densities and standing dead trees, nor with dead wood contacts on the ground.

DISCUSSION

How typical was 1982?

Had the limewoods expedition been mounted in 1981 a rather different picture might have emerged. The winter of 1981/82 was particularly severe across much of the country and this left populations of several resident breeders somewhat depressed in 1982. Provisional indices for the 1981-82 Common Birds Census comparison (Marchant 1983) show significant decreases in Wren, Dunnock, Robin, Song Thrush, Blackbird and Great Tit. It is likely, therefore, that in previous recent years, overall bird densities would have been even higher in the limewoods and that Willow Warbler would not have been the dominant species in so many plots. It is also possible that patterns of habitat occupancy for resident species may have been different in 1981. The habitats occupied by Wrens (Williamson 1969b) and Kestrels (O'Connor 1982) at high population levels are known to be different to those occupied when numbers are low. Similar phenomena probably occur quite widely in bird populations. The optimal habitats (where breeding success should be greatest) will be those occupied at low population levels. For conservation purposes therefore, 1982 was a good year in which to census the limewoods because it may have clarified the habitat preferences of the resident species.

An appraisal of the ornithological effects of the limewoods management

We now return to the two questions posed in the introduction. Firstly, what are the short-term effects of thinning on the bird communities in the limewoods? Results from the 30 year plots are the most helpful in answering this question because replicates of both unthinned and thinned stands were available. Thinning resulted in a substantial opening of the canopy and this was associated with an increase in the numbers of breeding species. Hardy Gang Wood, which was thinned in 1978-79 held lower numbers of species than the other thinned 30 year woods. This was possibly due to the fact that the contractors had removed a higher proportion of the better timber in Hardy Gang than elsewhere. Thinning apparently induces substantial changes in the composition of the bird community. Song Thrush and Blackbird decrease, although in years when overall population levels are higher this may be less evident. Warblers, especially Willow Warblers, increase in response to thinning which is in accordance with the finding of Wilson (1978) who compared coppiced willow scrub with mature willow. Unlike Wilson, however, we found no evidence of a consistent increase in total bird density following thinning.

The second question was: what are the likely long-term ornithological implications of promoting abandoned coppice to high forest? Comparisons of 30 and 70 year woods gave several insights. Total bird density was consistently greater (by 8-56 per cent) in 70 year woods than in 30 year woods. Species richness was much higher (by 36-68 per cent) in 70 year woods than in unthinned 30 year woods. High densities and species richness were even maintained in Hatton Wood in the breeding season immediately following thinning. Populations of finches (especially Chaffinch) were greatest in 70 year woods as were densities of Sylvia warblers. There was evidence that thinning within 70 year woods gave the opportunity to develop structural conditions which were highly beneficial to warblers and other summer visitors. Garden Warbler and Nightingale in particular were strongly represented in Great West North. By contrast, several residents - Wren, Robin, Blackbird and Song Thrush - did not appear to be favoured by this management.

Hole and crevice nesting species are of particular interest in studying effects of woodland management for two reasons. First their special nesting requirements may make them dependent on woods with large numbers of mature trees and secondly several of these species feed mainly on wood boring insects. Thus they may be expected to be particularly sensitive to the removal of large and especially dead timber. Surprisingly there is virtually a complete absence of quantitative information on relationships between birds and dead wood. One exception was a study by Nilsson (1979) in which he found positive correlations between bird densities and abundance of dead wood in southern Swedish forests. The limewoods project provided a further piece of evidence that dead wood (in the form of dead branches on live trees) is ornithologically important. It is not known whether it was the dead branches themselves which were important to birds or whether these were correlated with some other beneficial attribute of the woodland environment. The latter seems likely. It is possible, for example that the number of trees with large dead branches was an efficient index of woodland maturity of which abundance of dead wood and availability of holes may be two major components. Certainly the best two woods for crevice and hole nesters were 70 year plots. Whatever the biological significance of the relationship may be, the results indicate that promotion from neglected coppice to high forest will benefit hole and crevice nesting birds.

Future Work

Predictions of the effects of the thinning management can at present be inferred only from comparisons of eight plots in a single year. Some of the differences summarised above are very striking and are undoubtedly attributable to the gross structural variation introduced by the management programme. Nevertheless it would be desirable to repeat censuses of some, if not all, of the plots in about five years time. This would enable some of the predictions concerning short-term effects of thinning to be tested. Hatton for example may exhibit a strikingly different bird community once the vegetation starts to redevelop following thinning. The opportunity might also be taken to assess the effects of new thinnings performed in other plots.

Thinning is only one of several options open to woodland reserve managers. Thinning and clear felling followed by the planting of native species are the two most promising techniques where nature conservation is required to integrate with timber production (Peterken 1981). Ornithological comparison of the two approaches may seem desirable but in practice it might not be particularly illuminating because, as Peterken points out, the techniques are mainly applicable to very different kinds of woodland. Thinning is best for the more natural stands of mixed coppice while planting is most suitable for uniform stands eg. northern and western oak and southern hazel coppice. Comparison of mixed coppice stands managed by thinning, as in the present study, and managed under traditional coppice systems with and without standards would be very worthwhile.

The Lincolnshire limewoods expedition of 1982 demonstrated that, given careful planning and organisation, intensive expeditions can provide much useful information on the ornithological implications of woodland management techniques. Other specific issues that could be tackled by teams of trained competent BTO census workers include: the effects of grazing in northern birchwoods and oakwoods; altitudinal differences in birchwood avifaunas; management in beechwoods (especially the Chilterns); comparison of different coppice rotations and species mixtures in coppice; successional changes (eg developing woodlands and scrub).

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TABLE 1. LOCATIONS AND PHYSICAL DETAILS OF LINCOLNSHIRE LIMEWOODS STUDY PLOTS IN 1982

Plot number	Plot name	Grid reference	Plot area (ha)	Plot altitude (m)	% of perimeter that was wood/ forest	% of total forest area in unit	% of total semi-natural woodland area in unit
1	Cocklode Wood	TF 104 766	8.9	12	72	13	28
2	Newball Wood South	TF 085 767	10.3	15	52	10	19
3	Hardy Gang Wood	TF 093 750	10.7	8	69	29	47
4	Great West Wood South	TF 108 762	12.0	15	69	18	38
5	Ivy Wood	TF 145 737	10.9	15	56	4	25-35
6	Newball Wood North	TF 082 769	10.6	15	17	10	20
7	Hatton Wood	TF 164 748	14.0	25	76	5	35-45
8	Great West Wood North	TF 109 766	8.5	15	76	13	27

Notes (a) The same sequence of numbering the plots is used throughout this report

(b) Each plot was part of a more extensive separate unit of forest and semi-natural woodland. The last two columns indicate the percentage of its particular forest block that each plot contributed.

TABLE 2. MANAGEMENT STATUS OF LINCOLNSHIRE LIMEWOODS STUDY PLOTSIN 1982

Plot number	Plot name	Years since last coppiced	Approx. year of thinning
1	Cocklode Wood	30 - 40	unthinned
2	Newball Wood South	30 - 40	unthinned
3	Hardy Gang Wood	30 - 40	1978-79
4	Great West Wood South	30 - 40	1974-76
5	Ivy Wood	30 - 40	1970-72
6	Newball Wood North	70+	unthinned?
7	Hatton Wood	70+	1980-81
8	Great West Wood North	70+	1976-77

TABLE 3. TREE SPECIES COMPOSITION IN THE EIGHT STUDY PLOTS

Plot name	% OF TREES COUNTED			
	Ash *Fraxinus excelsior*	Birch *Betula spp.*	Oak *Quercus robur*	Small-leaved lime *Tilia cordata*
Cocklode Wood	40	11	4	32
Newball Wood South	32	3	16	36
Hardy Gang Wood	13	3	37	40
Great West Wood South	50	1	9	38
Ivy Wood	11	53	6	28
Newball Wood North	61	0	16	16
Hatton Wood	6	0	29	65
Great West Wood North	32	11	11	45

NOTE: 1. Tree species composition was estimated by counts of trees greater than 10 cm Breast Height Diameter in four 25 m diameter circles in each plot.

2. Figures shown are the percentage of the total that were contributed by each of the four dominant species.

TABLE 4. ESTIMATED DENSITIES (CLUSTERS/10 ha) AND NUMBERS OF SPECIES RECORDED IN THE LIMEWOODS STUDY PLOTS

	Cocklode	Newball South	Hardy Gang	Great West South	Ivy	Newball North	Hatton	Great West North
Total number of species recorded	26	28	34	35	37	37	40	41
Number of territory-holding species	19	22	24	29	30	30	32	32
Total density (excluding Woodcock, Woodpigeon, Starling, House Sparrow)	123.1 (119.6)	119.8 (114.7)	114.5 (110.8)	116.0 (109.8)	148.1 (146.5)	178.6 (168.1)	160.6 (147.3)	171.1 (155.1)
Total density of passerines (excluding Starling and House Sparrow)	114.6 (114.6)	111.9 (111.0)	106.4 (106.4)	107.7 (105.2)	143.3 (143.3)	169.7 (163.1)	154.1 (142.7)	155.9 (142.9)

NOTE: The territory mapping method was developed as a method for delineating the approximate territories of territorial passerines: it is less suitable for many species of non-passerines. Furthermore, some passerines (e.g. Starling and House Sparrow) do not cluster readily. It is for this reason that several estimates of density are given. The ranked orders of the four density estimates are, however, highly consistent between sites (Kendall's coefficient of concordance $W = 0.84$, $P < 0.01$).

TABLE 5. ESTIMATED DENSITIES (CLUSTERS PER 10 ha) FOR ALL SPECIES JUDGED TO BE HOLDING TERRITORY ON AT LEAST ONE PLOT. ASTERISKS INDICATE SPECIES REGARDED AS HOLE OR CREVICE NESTERS.

Species	Cocklode	Newball South	Hardy Gang	Great West South	Ivy	Newball North	Hatton	Great West North
Kestrel				0.7				
Pheasant	0.8	0.9	0.9	0.7		1.9	0.6	3.3
Woodcock	0.8	2.5	0.7	1.4	0.9	3.0	1.2	0.9
Woodpigeon	2.8	1.7	3.0	2.3	0.6	0.8	0.7	2.1
Turtle Dove	3.0		1.8	0.8	0.7		0.4	5.5
Cuckoo		0.9	1.0	0.9	0.9	1.3	1.1	0.9
Tawny Owl*	1.1	1.0	1.7				0.4	1.2
Green Woodpecker*						0.3	0.4	
Gt. Spotted Woodpecker*		1.0		1.6	1.6	1.5	1.9	1.2
Tree Pipit					0.2		2.0	
Wren	7.8	6.7	7.9	9.0	17.8	20.3	20.9	7.2
Dunnock	1.1	1.5	2.4	1.2	0.9	5.9	1.4	2.0
Robin	15.7	18.6	15.3	14.3	17.6	17.1	13.6	8.9
Nightingale							0.1	3.4
Blackbird	13.6	15.8	7.6	6.7	12.8	15.9	12.9	8.7
Song Thrush	19.0	13.6	8.0	7.2	9.5	10.5	8.3	6.7
Whitethroat			0.8	0.3	0.7			0.9
Garden Warbler	2.5	3.3	7.1	3.1	5.0	7.5	3.5	15.1
Blackcap	2.9	3.2	2.5	5.5	3.9	6.6	6.4	9.1
Chiffchaff				2.2			0.1	5.3

(Cont'd)

TABLE 5 (cont'd)

Species	Cocklode	Newball South	Hardy Gang	Great West South	Ivy	Newball North	Hatton	Great West North
Willow Warbler	18.1	22.0	29.4	28.7	24.5	22.5	18.4	27.9
Goldcrest	4.5				3.8	0.9	2.7	2.1
Spotted Flycatcher		0.8		0.7	0.9	2.8	1.8	3.5
Long-tailed Tit				0.8	2.2	0.9		1.1
Willow Tit*		0.9		0.8	0.9			1.2
Coal Tit	2.0		0.9	1.4	4.1		0.9	1.2
Blue Tit*	5.4	7.2	5.6	6.5	8.7	7.2	11.9	8.0
Great Tit*	6.5	4.9	3.6	6.8	11.3	6.9	9.3	8.5
Treecreeper*				2.1	1.8	2.8	4.2	2.4
Jay		0.8	1.7	0.8	1.0	0.9	1.3	1.2
Carrion Crow					0.9	0.9	0.6	
Starling*		1.0		2.5		5.7	11.4	12.9
House Sparrow						0.9		
Tree Sparrow *					0.9	1.9	4.1	
Chaffinch	13.4	11.0	8.7	6.0	10.3	27.3	17.1	14.7
Greenfinch						1.9		
Linnet			0.8					
Redpoll			0.8	0.3	0.9	0.5		1.2
Bullfinch	2.1	0.8	1.6	0.8	0.7	0.7	0.7	1.2
Yellowhammer			1.6		1.9	1.2	0.4	1.7

APPENDIX

SCIENTIFIC NAMES OF BIRDS MENTIONED IN THE TEXT

Kestrel *Falco tinnunculus*

Pheasant *Phasianus colchicus*

Woodcock *Scolopax rusticola*

Woodpigeon *Columba palumbus*

Turtle Dove *Streptopelia decaocto*

Cuckoo *Cuculus canorus*

Tawny Owl *Strix aluco*

Green Woodpecker *Picus viridis*

Great Spotted Woodpecker *Dendrocopos major*

Tree Pipit *Anthus trivialis*

Wren *Troglodytes troglodytes*

Dunnock *Prunella modularis*

Robin *Erithacus rubecula*

Nightingale *Luscinia megarhynchos*

Blackbird *Turdus merula*

Song Thrush *Turdus philomelos*

Whitethroat *Sylvia communis*

Garden Warbler *Sylvia borin*

Blackcap *Sylvia atricapilla*

Chiffchaff *Phylloscopus collybita*

Willow Warbler *Phylloscopus trochilus*

Goldcrest *Regulus regulus*

Spotted Flycatcher *Muscicapa striata*

Long-tailed Tit *Aegithalos caudatus*

Willow Tit *Parus montanus*

Coal Tit *Parus ater*

Blue Tit *Parus caeruleus*

Great Tit *Parus major*

Treecreeper *Certhia familiaris*

Jay *Garrulus glandarius*

Carrion Crow *Corvus corone*

Starling *Sturnus vulgaris*

House Sparrow *Passer domesticus*

Tree Sparrow *Passer montanus*

Chaffinch *Fringilla coelebs*

Greenfinch *Carduelis chloris*

(Cont'd)

Linnet *Carduelis cannabina*

Redpoll *Carduelis flammea*

Bullfinch *Pyrrhula pyrrhula*

Yellowhammer *Emberiza citrinella*

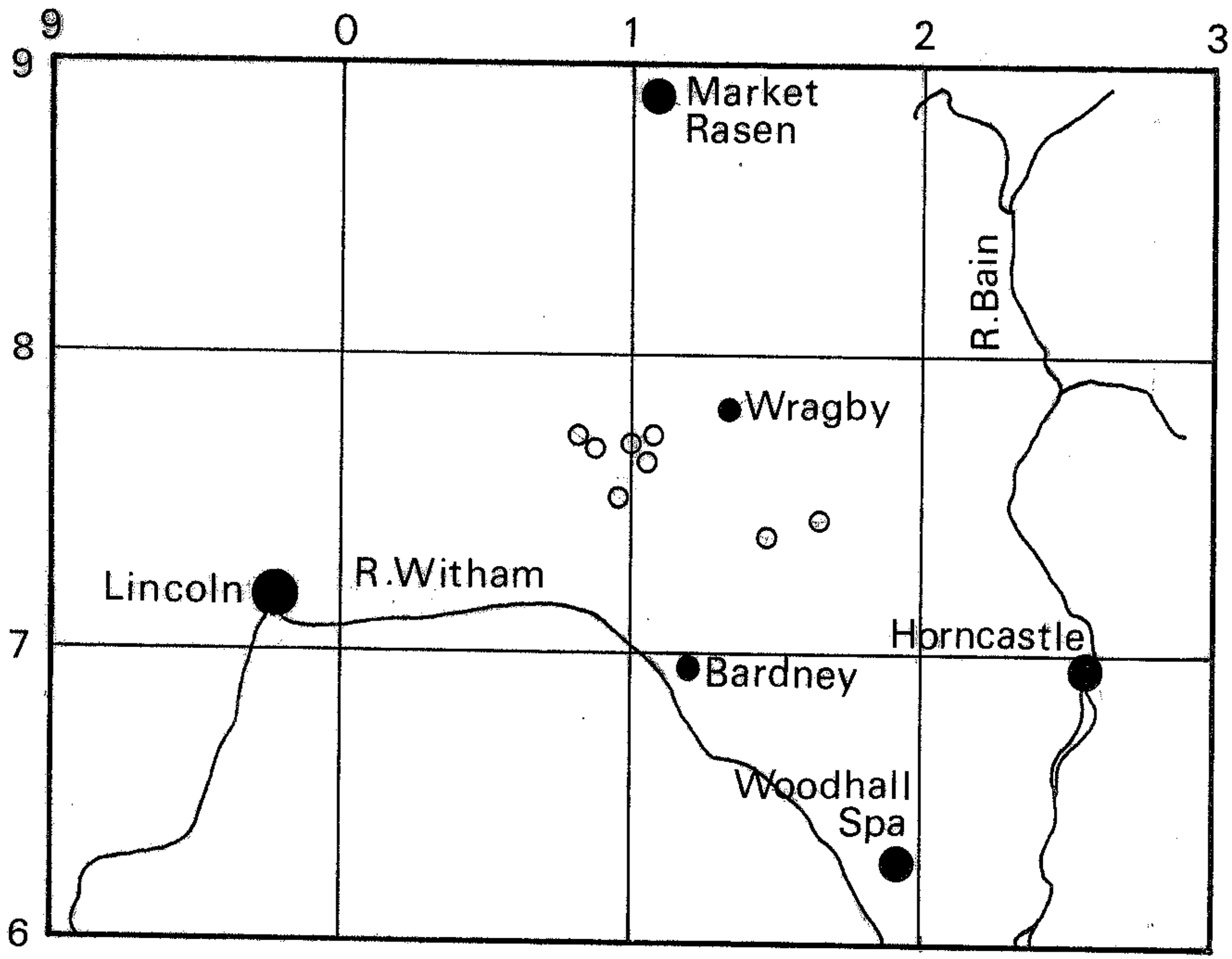

FIGURE 1. The general location of the eight limewoods study plots which are shown as open circles. Ten kilometre square grid lines are indicated. Scale = 1:250,000.

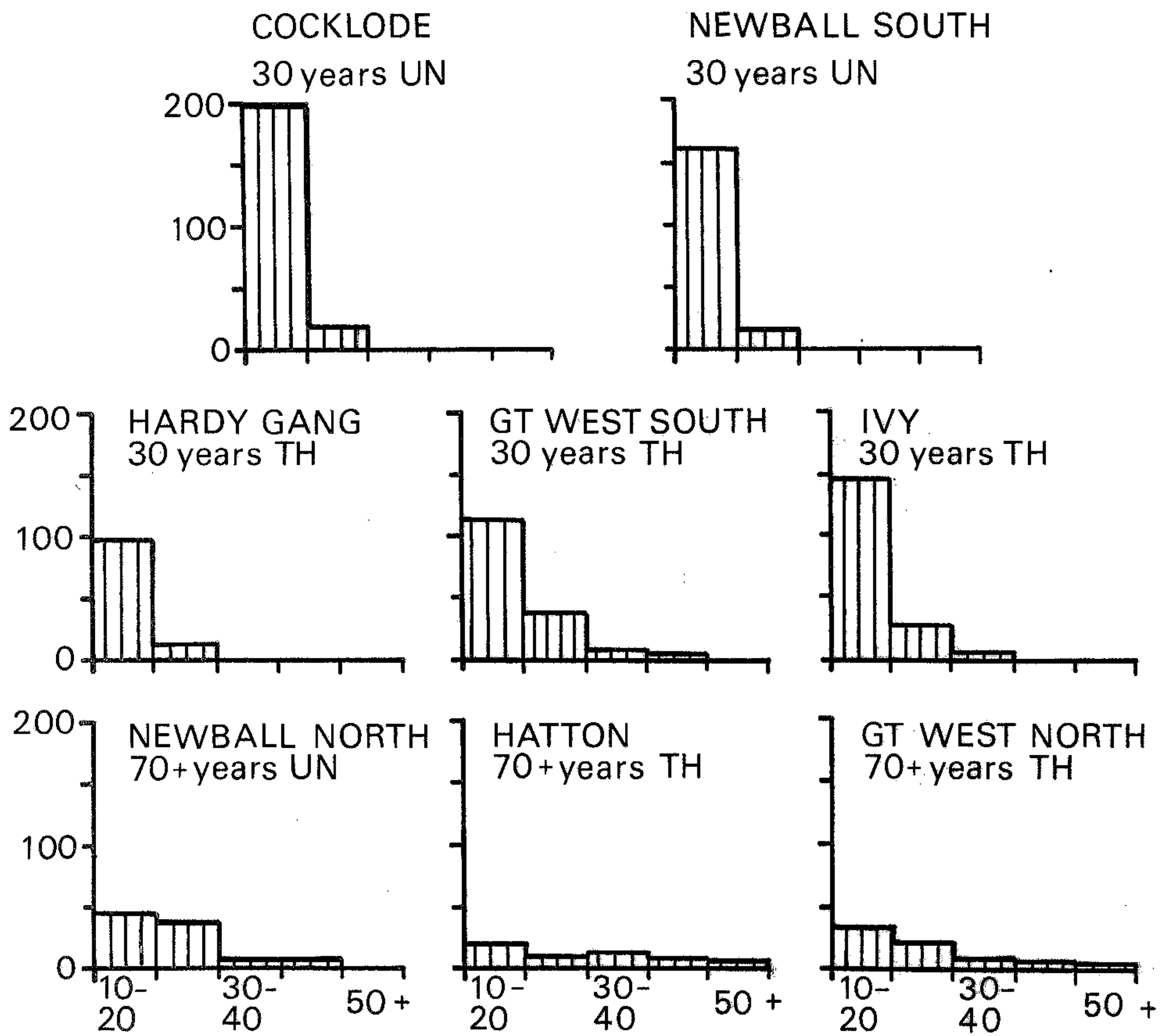

FIGURE 2.

Number of trees (vertical axis) in five classes of breast height diameter (horizontal axis). The classes are in 10 cm divisions starting at 10 cm. Equal samples of four 25 m diameter circles were taken in each plot.

UN = unthinned; TH = thinned.

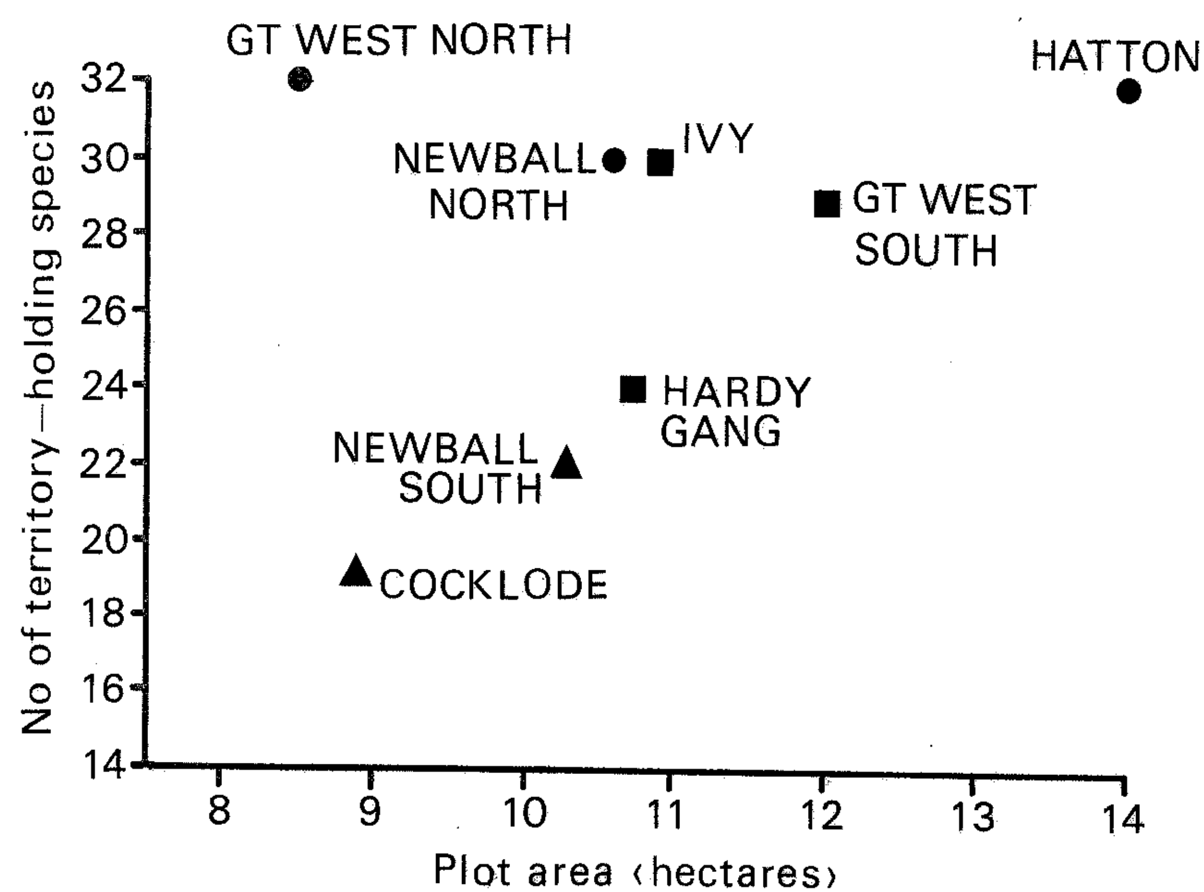

FIGURE 3. Number of territory-holding species in relation to plot area.

▲ - 30 year unthinned; ■ - 30 year thinned; ● - 70 year

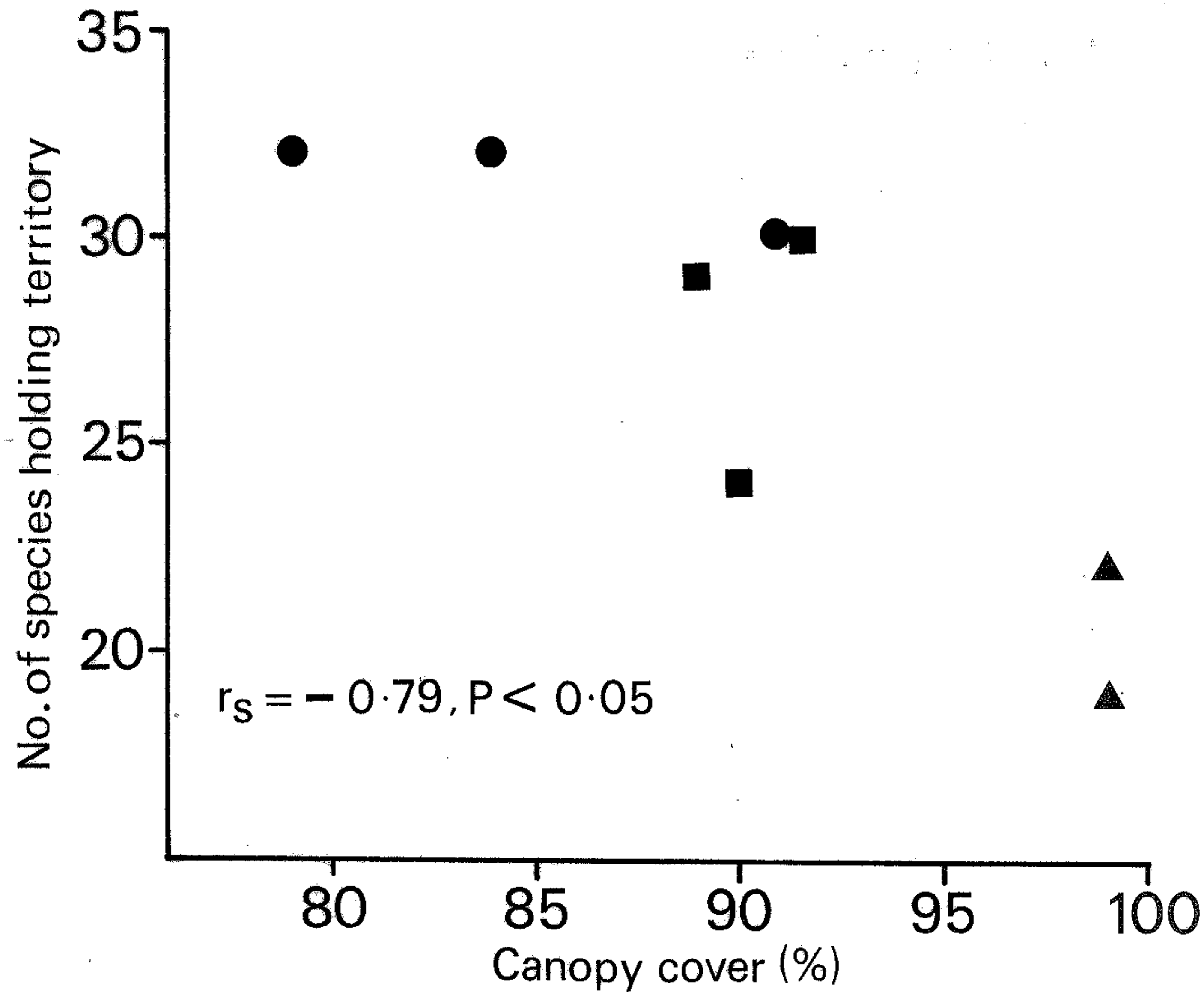

FIGURE 4. Numbers of species holding territory in each plot in relation to the estimated canopy cover.

▲ - 30 year unthinned; ■ - 30 year thinned; ● - 70 year

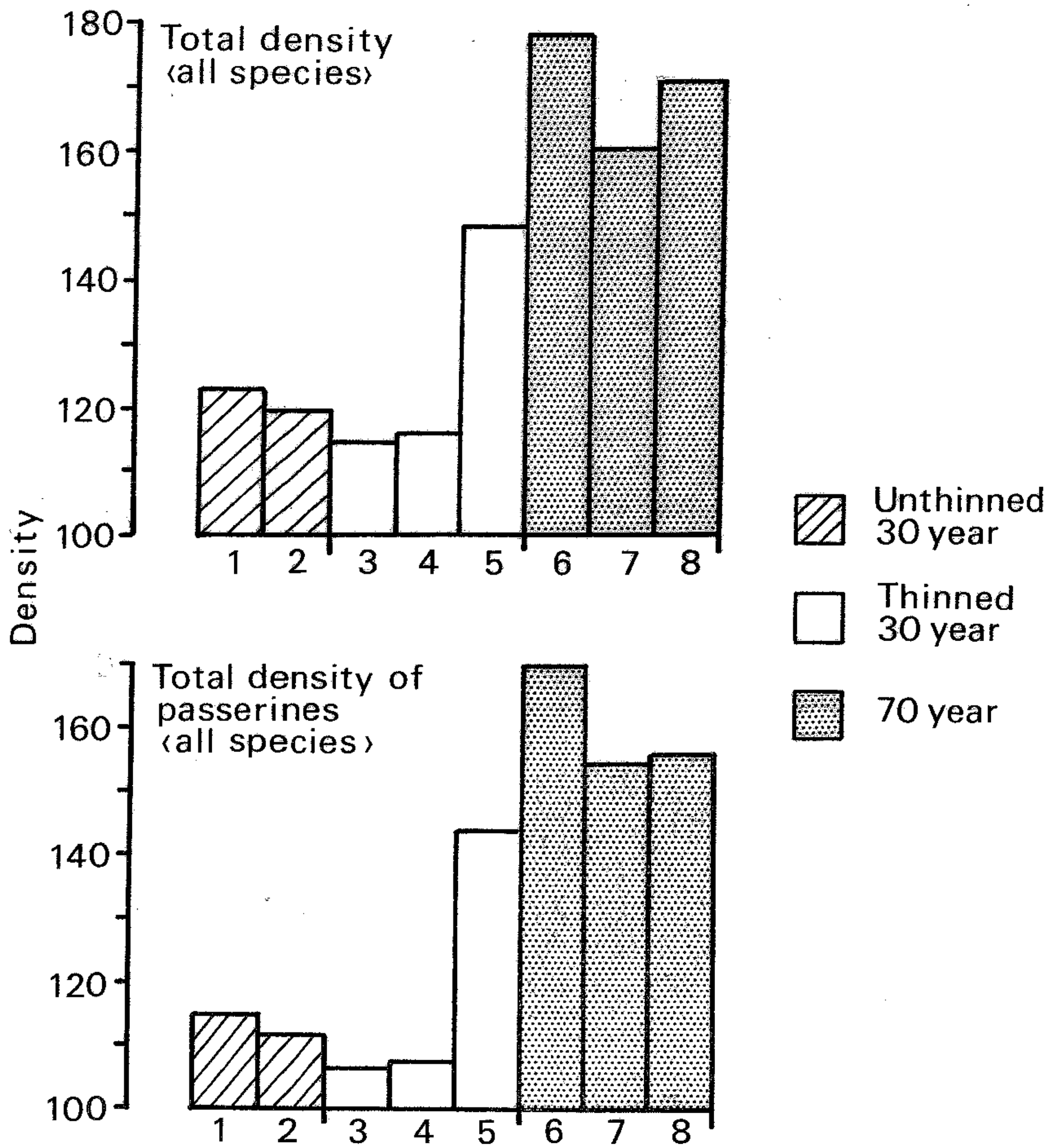

FIGURE 5. Total densities of birds on the limewoods plots. Densities are in clusters per 10 ha and are drawn from Table 5. The plots are numbered as in Table 1.

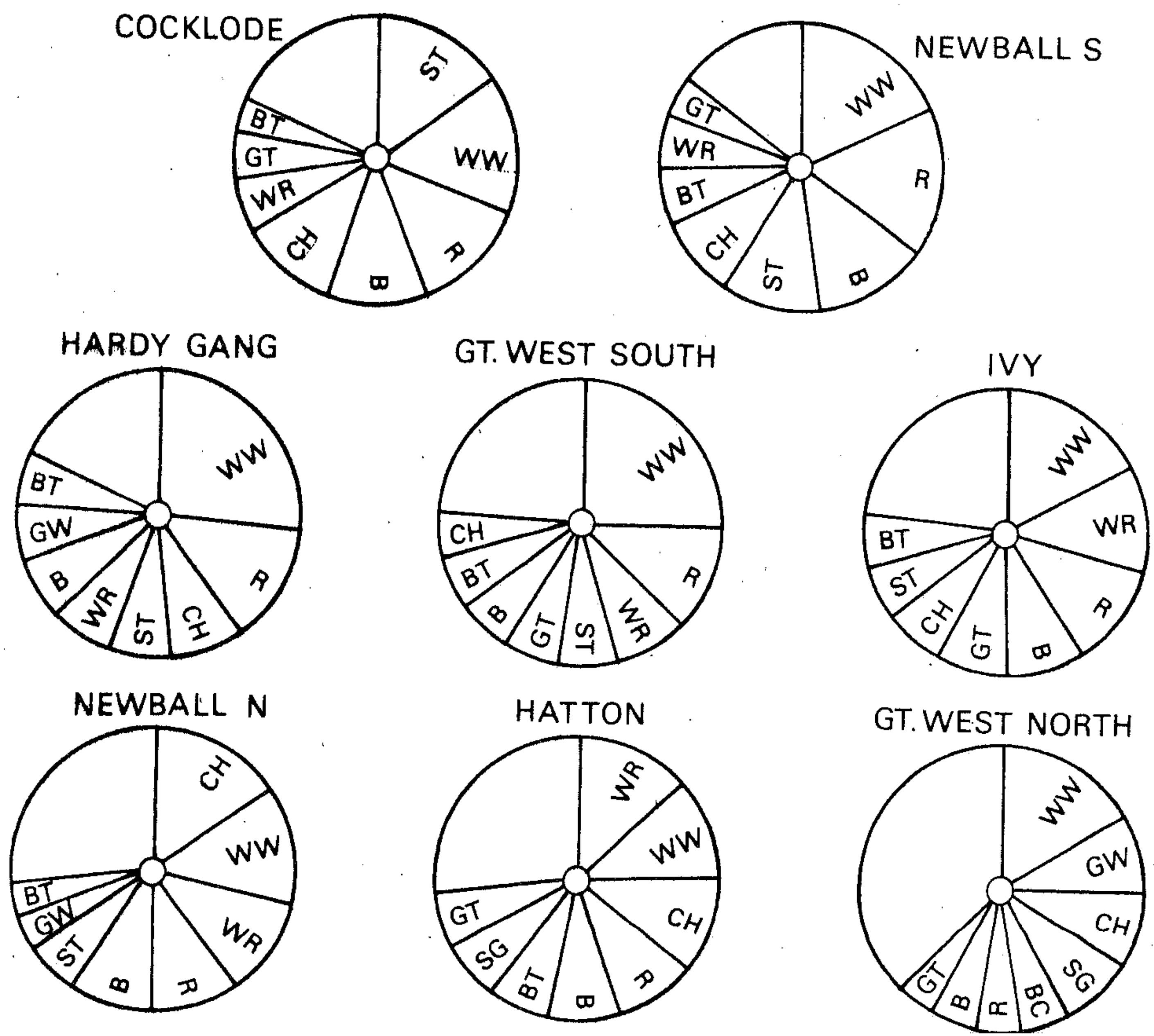

FIGURE 6.

The compositionof the breeding bird communities in each plot.
The eight dominant species are shown in terms of the proportion of territories they contribute.
Symbols:

WR - Wren
R - Robin
B - Blackbird
ST - Song Thrush
GW - Garden Warbler
BC - Blackcap
WW - Willow Warbler
BT - Blue Tit
GT - Great Tit
SG - Starling
CH - Chaffinch

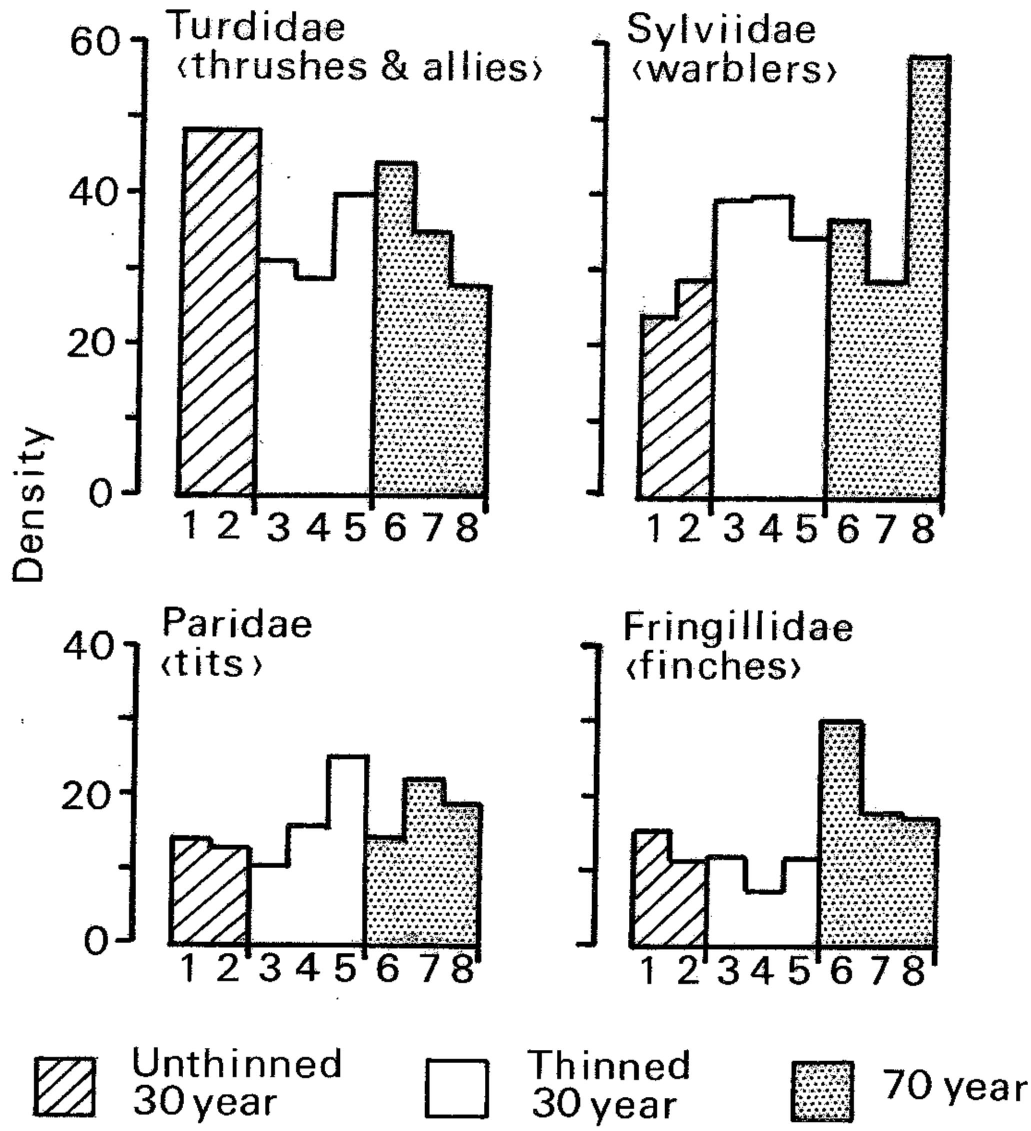

FIGURE 7. Densities (clusters/10 ha) of major groups of passerine birds in the limewoods. The plots are numbered as in Table 1.

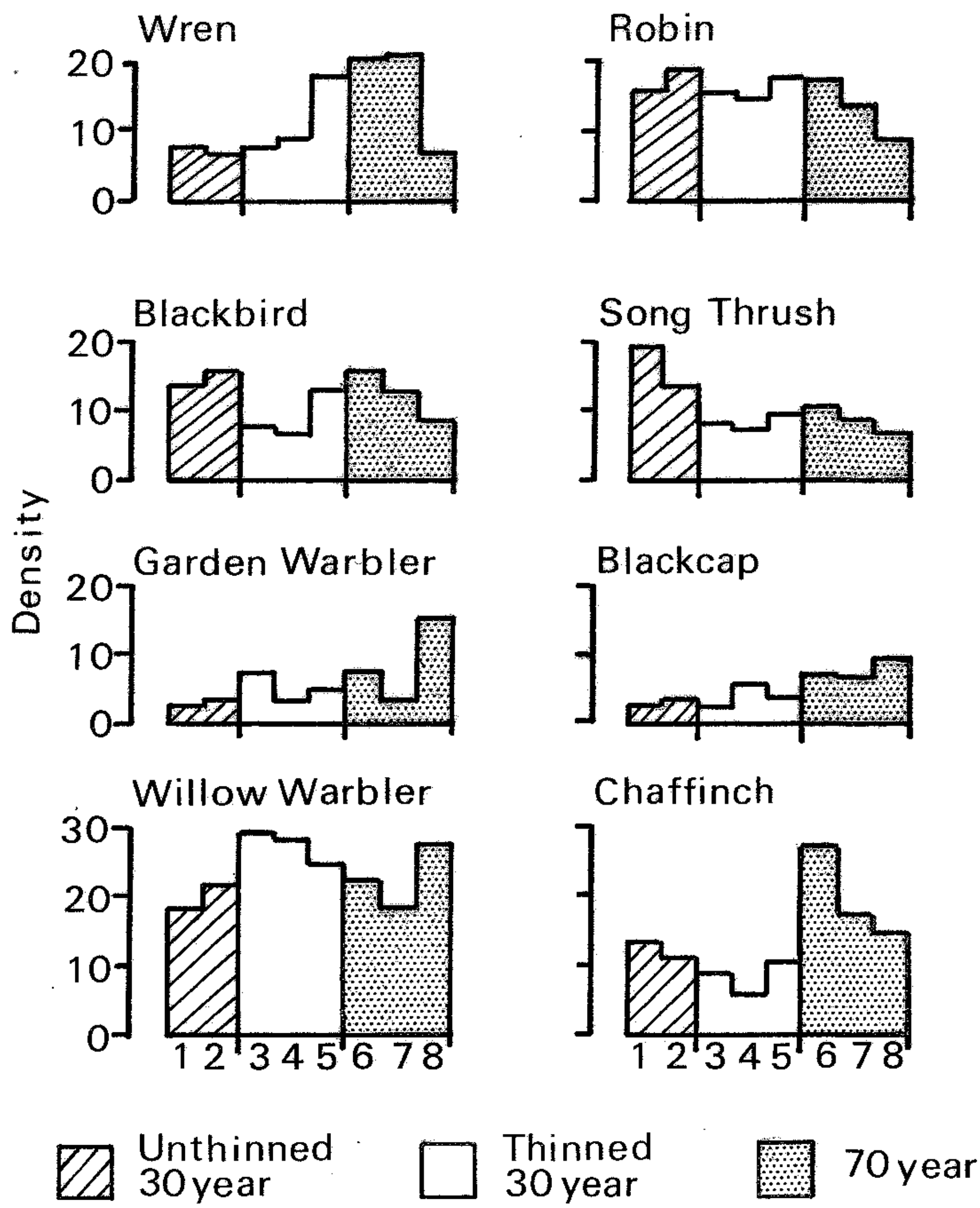

FIGURE 8. Densities (clusters/10 ha) of selected species in the limewoods. The plots are numbered as in Table 1.

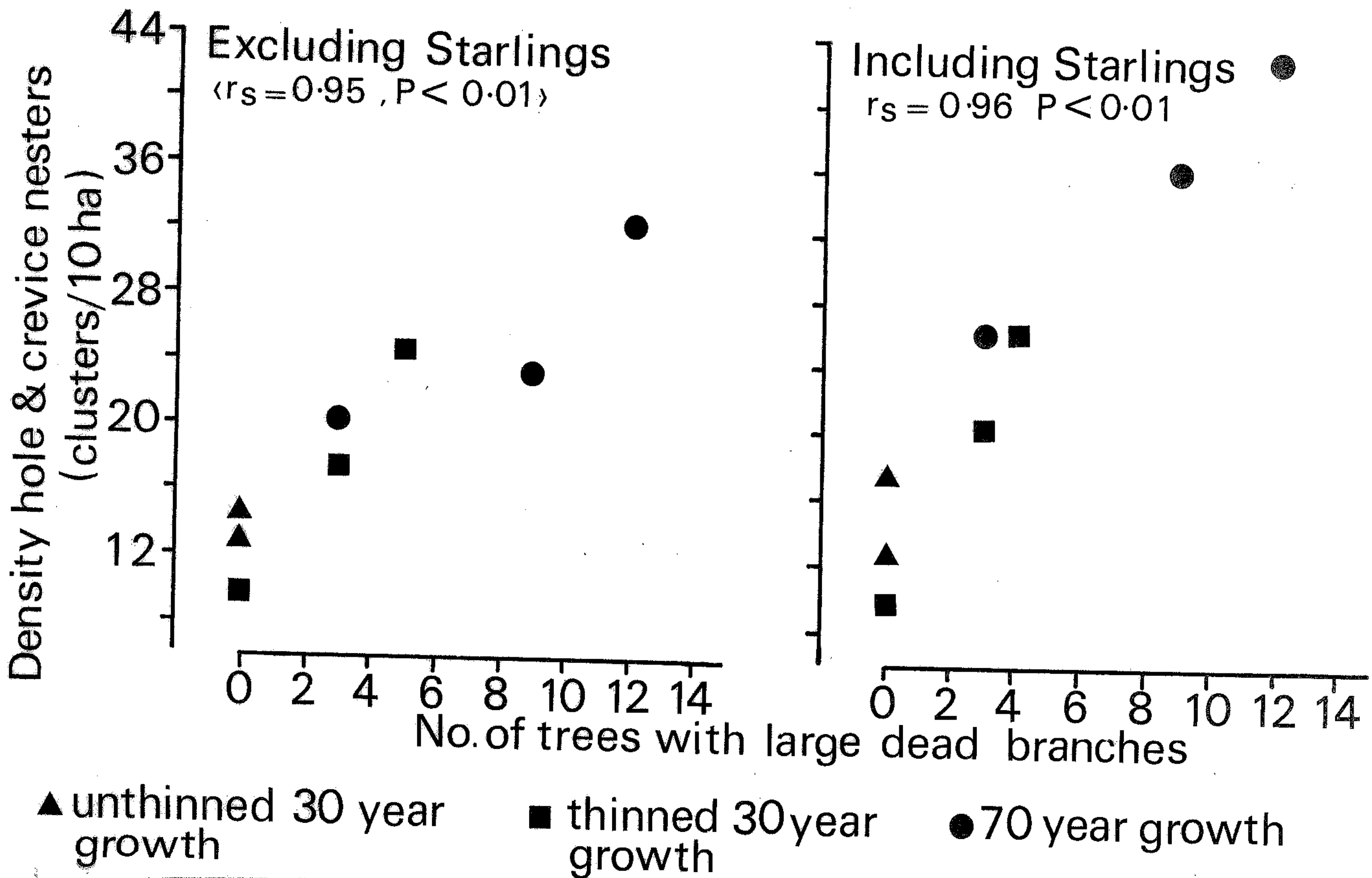

FIGURE 9. The density of hole and crevice nesting species in relation to the number of trees with large dead branches that were counted in four 25m diameter circles in each wood.