Changes in the distribution of *Erica ciliaris* L. and *E.* × *watsonii* Benth. in Dorset, 1963–1987

S. B. CHAPMAN* and R. J. ROSE**

Furzebrook Research Station, Natural Environment Research Council, Institute of Terrestrial Ecology, Wareham, Dorset, BH20 5AS

ABSTRACT

The distribution in south-eastern Dorset of *Erica ciliaris* (Dorset Heath) and *E.* × *watsonii* (Ericaceae) is described. Between 1963 and 1987 the distribution of these taxa and their relative proportions within populations changed. These changes have been caused mainly by the afforestation of the area which forms the centre of the plant's distribution, and by heathland fires. Further evidence for the hypothesis that *E. ciliaris* is still spreading in Dorset is provided.

KEYWORDS: afforestation, heathland, *Erica tetralix*.

INTRODUCTION

Erica ciliaris L. (Dorset Heath) has a 'Lusitanian' distribution, being found in Morocco, the coastal regions of Portugal, Spain and France, and locally in southern England (Fig. 1) and western Ireland. The plant is listed in the *British red data book* (Perring & Farrell 1983), and is classified as rare in Great Britain. It occurs at a single site in Ireland (Webb 1966). In southern England, *E. ciliaris* is most abundant on the heathlands of south-eastern Dorset where it was first recorded in 1848 (Mansel-Pleydell 1895). *E.* × *watsonii* is a hybrid of *E. ciliaris* and *E. tetralix* L.; backcrossing may occur as a range of variants intermediate between the two parent species are found (Gay 1957; McClintock 1971). The distribution of *E. ciliaris* has been described by a number of workers. Good (1948) commented on the static nature of the population, stating that "local geographical limits follow no obviously recognisable edaphic or climatic boundary". Gay (1957, 1960) suggested that the population was contracting as a result of introgressive hybridisation, and Chapman (1975) proposed that the pattern of distribution of *E. ciliaris* and *E.* × *watsonii* "can be explained in terms of an expanding population".

Evidence that *E. ciliaris* was increasing its range in Dorset was provided by Haskins (1978) who examined sub-fossil seed remains in peat deposits. The oldest sub-fossil seeds were found in peat from Wytch Heath, near the centre of the present distribution of *E. ciliaris*, with more recent remains at locations on the edge of the present range.

This paper examines the current distribution pattern of *E. ciliaris* and discusses changes in the relative proportions of *E.* × *watsonii* in certain populations against the background of changes in heathland in Dorset over a period of 24 years.

METHODS

THE SURVEY

The distribution of *E. ciliaris* was mapped by field surveys in 1963, 1973 and 1987. In 1963 and 1973 the boundaries of its populations were mapped and measured by planimetry. In 1973 and 1987 the

* Present address: Hope House, Winterborne Zelston, Blandford, Dorset, DT11 9EU.
** To whom correspondence should be addressed.

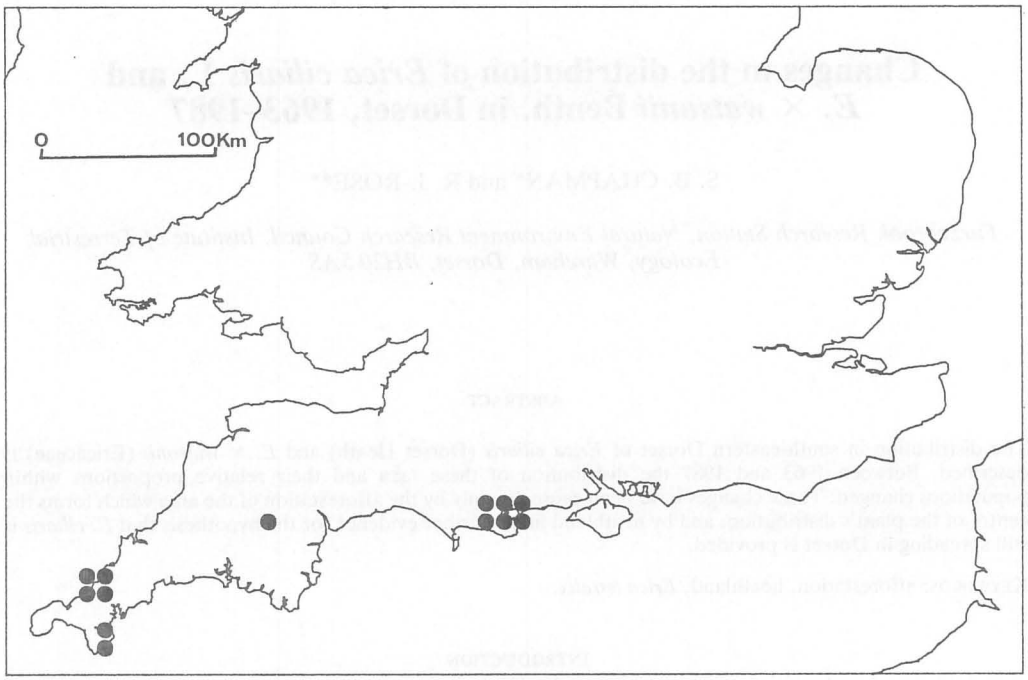

FIGURE 1. The distribution of *Erica ciliaris* in Great Britain; 10-km square records from the *Atlas of the British flora* (Perring & Walters 1962) with recent additions.

abundance of *E. ciliaris* in 200 m × 200 m grid squares was recorded. This size of sampling unit and a similar method were employed in more general surveys of heathland in Dorset (Webb & Haskins 1980; Chapman, Clarke & Webb 1989; Webb 1990). Within each grid square abundance was recorded using a four point scale of cover:

1 = present as only single or isolated plants, <1% of the grid square area.
2 = more than isolated plants, 1% to 10% of the grid square area.
3 = plants present in 10% to 50% of the grid square area.
4 = present in more than 50% of the grid square area.

Estimates of the areas of vegetation containing *E. ciliaris* have been derived using the mid-values of the scores for each grid square. For example, squares with a score of category 4, which has a mid-score value of 75%, were taken to have a mean area of 3 ha. Similarly, squares with scores of 3, 2, and 1 were assumed to have mean areas of 1·2, 0·2 and 0·02 ha respectively.

VEGETATION CLASSIFICATION

In 1973 the dominant heathland vegetation type in each square was recorded. In 1987, data relating to general heathland features such as classification of vegetation types, changes in land use and heathland fires were taken from the Dorset heathland survey databases for 1978 (Webb & Haskins 1980) and 1987 (Webb 1990). These surveys were based upon the same 200 m × 200 m recording grid used for the *E. ciliaris* surveys described in this paper.

Some populations of *E. ciliaris* situated in areas that were formerly heathland are now within conifer plantations. Data from these sites have been included in the distribution maps and analyses, but omitted from the analysis of the population composition and vegetation type.

POPULATION COMPOSITION

In the field *E.* × *watsonii* can be distinguished from its parents by its more robust growth form and the intermediate nature of the inflorescence shape. Where there was difficulty in assigning plants to

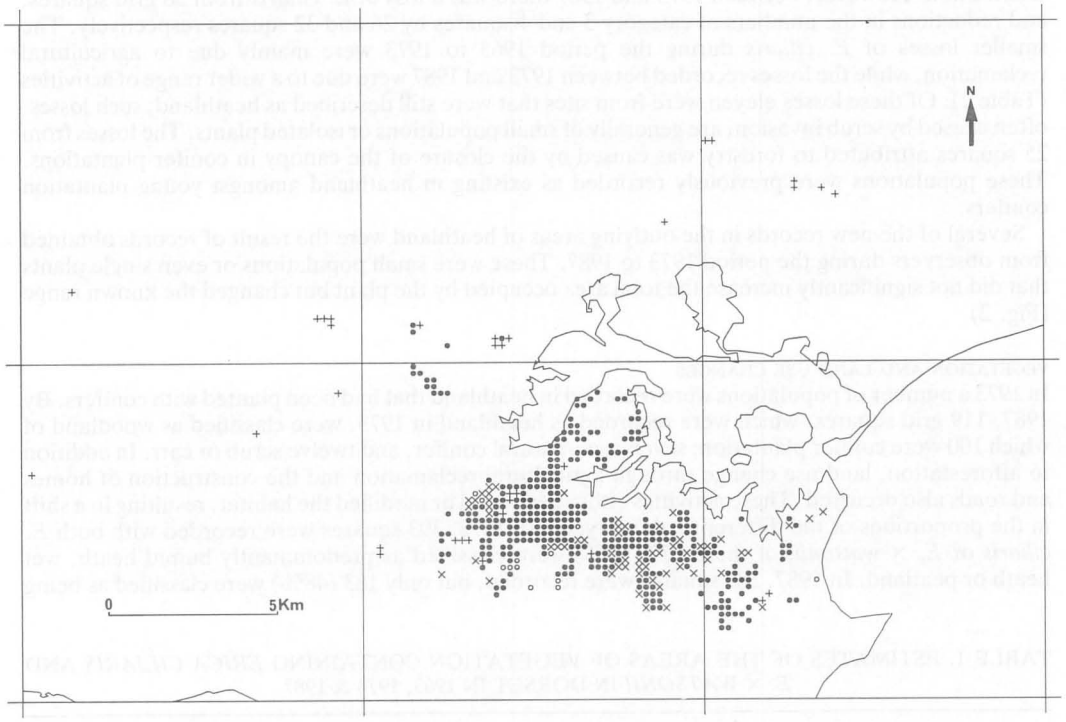

FIGURE 2. Distribution of *Erica ciliaris* populations in Dorset (10-km grid lines shown): ● indicates present 1963–1987; + new records 1973–1987; ○ sites lost 1963–1973; × sites lost 1973–1987.

a taxon the presence or length of the anther awns was examined. This character is the most reliable for separating *E. ciliaris, E. tetralix* and *E.* × *watsonii* (Chapman 1975).

In 1973 and 1987 the grid squares were classified according to the relative proportions of *E. ciliaris*, *E. tetralix* and *E.* × *watsonii* (Chapman 1975). This classification, and a simple four category version in which the population was deemed to be mixed if no one taxon dominated and pure if one of the three taxa of *Erica* accounted for more than 50% of the population.

The degree of change in population composition using the four category classification was represented by a three point scale; no change, class 1 change and class 2 change. A class 1 change was defined as a change from a pure population to a mixed population or vice versa. A class 2 change represents a change from one pure population to another pure population.

RESULTS

DISTRIBUTION AND ABUNDANCE OF *ERICA CILIARIS*

The total area in which populations occurred was measured in 1963 and 1973 by planimetry and for all three surveys using the mid-value scores for the 4 point abundance scale. The two methods were in close agreement (Table 1) with less than 5% error in the mid-score abundance value estimate. The changes in total area between 1963 and 1973 were very small; however, in the 14 years between 1973 and 1987 a reduction of 199 ha (27·7%) occurred.

The distribution of *E. ciliaris* and *E.* × *watsonii* in south-eastern Dorset is shown in Fig. 2. *E. ciliaris* populations have been recorded from 445 grid squares in the period 1963 to 1987; from 423 grid squares in 1963, 411 in 1973, and 388 in 1987 (Table 1). The loss of populations from 13 grid squares between 1963 and 1973 (all in abundance categories 1 and 2) and the discovery of only one new population (abundance category 1) resulted in little change in the overall abundance or

distribution. However, between 1973 and 1987 there was a loss of *E. ciliaris* from 58 grid squares, and reductions in the numbers of category 3 and 4 squares by 26 and 32 squares respectively. The smaller losses of *E. ciliaris* during the period 1963 to 1973 were mainly due to agricultural reclamation, while the losses recorded between 1973 and 1987 were due to a wider range of activities (Table 2). Of these losses eleven were from sites that were still described as heathland; such losses, often caused by scrub invasion, are generally of small populations or isolated plants. The losses from 25 squares attributed to forestry was caused by the closure of the canopy in conifer plantations. These populations were previously recorded as existing in heathland amongst young plantation conifers.

Several of the new records in the outlying areas of heathland were the result of records obtained from observers during the period 1973 to 1987. These were small populations or even single plants that did not significantly increase the total area occupied by the plant but changed the known range (Fig. 2).

VEGETATION AND LAND USE CHANGES

In 1973 a number of populations were recorded in heathland that had been planted with conifers. By 1987, 119 grid squares, which were recorded as heathland in 1973, were classified as woodland of which 100 were conifer plantation, seven semi-natural conifer, and twelve scrub or carr. In addition to afforestation, land use change through agricultural reclamation and the construction of homes and roads also occurred. These activities either destroyed or modified the habitat, resulting in a shift in the proportions of the different habitat types. In 1973, 393 squares were recorded with both *E. ciliaris* or *E.* × *watsonii*; of these 373 (95%) were classified as predominantly humid heath, wet heath or peatland. In 1987, 383 squares were recorded, but only 183 (48%) were classified as being

TABLE 1. ESTIMATES OF THE AREAS OF VEGETATION CONTAINING *ERICA CILIARIS* AND *E.* × *WATSONII* IN DORSET IN 1963, 1973 & 1987

	1963	1973	1987
Number of squares in each area category			
Cat. 1	38	29	22
Cat. 2	167	163	205
Cat. 3	145	145	119
Cat. 4	73	74	42
Total number of squares	423	411	388
Number of new squares	–	1	35
Number of lost squares	–	13	58
Area (ha) (from mid-value scores)	427	429	310
Area (ha) (from planimetry)	419	408	–

TABLE 2. LOSSES OF *ERICA CILIARIS* FROM NUMBERS OF 200 M × 200 M GRID SQUARES IN DORSET, ACCORDING TO THE LAND USE, OR CHANGES OF LAND USE, OF THOSE GRID SQUARES, IN THE PERIODS 1963–1973 AND 1973–1987

	Period	
Land use	1963–1973	1973–1987
Heathland	1	11
Agriculture	11	21
Forestry	0	25
Other	1	1
Total	13	58
Area (ha)	+2	−119

TABLE 3. PROBABILITY VALUES OF ASSOCIATIONS BETWEEN POPULATION TYPE AND VEGETATION FROM SITES ASSESSED IN 1973, USING A 2-SIDED VERSION OF FISHER'S EXACT SIGNIFICANCE TEST

	Vegetation type			
Population type	Dry	Humid	Wet	Peatland
Erica ciliaris	0·13	0·40	0·21	1·00
Erica × *watsonii*	1·00	0·0053(−)	0·057	0·000002(+)
Erica tetralix	0·62	1·00	0·0048(+)	0·092
Mixed	1·00	0·37	0·60	0·89

humid heath, wet heath or peatland. However, those sites which have not undergone land use change remained remarkably constant between the 1973 and 1987 survey data.

POPULATION COMPOSITION

The distribution of the different population types, classified according to the proportions of *E. ciliaris*, *E. tetralix* and *E.* × *watsonii* in 1973, was presented by Chapman (1975). Several associations between vegetation type and the population composition were shown. These analyses were repeated in 1987 but no significant associations were found. This was due to the changes that took place in the afforested areas of central Purbeck; these reduced the number of populations and make it impossible to make comparisons or reassessments of grid squares where a part of the original habitat had been lost.

Using the simplified classification of populations, the same 1973 data were re-examined using a 2-sided version of Fisher's exact significance test. Significant associations were found between *E.* × *watsonii* populations and humid heathland and peatland (Table 3).

When this analysis was repeated for the 1987 data no significant associations were found. This was due to fewer squares being classified as *E.* × *watsonii*. Thus changes in population composition between years, in different vegetation types, could not be analyzed. However, no significant differences in the proportion of change of population composition in humid heath, wet heath and peatland were found.

Having established that changes in population composition were not related to vegetation type, the data were examined for changes after fire. Using the 1978 heathland survey data to identify areas that had been burnt in 1974–1977, a significant association between burnt sites and change towards *E.* × *watsonii* populations ($p<0.001$, Fisher's exact test) was found (see Fig. 3).

In Fig. 3, in addition to the association with fire, it can be seen that a line of six grid squares (arrowed) show two class changes in an unburnt area; these six squares are roadside sites and the changes are probably due to increased management (mowing) of the road verge between 1973 and 1987.

DISCUSSION

Since the survey in 1973, isolated or small populations of *E. ciliaris* have been recorded from several locations outside the centre of distribution. The history of origin of these populations is uncertain. Some sites are near houses or under power lines and may have been introduced by human activity. Whether any introduction has been made intentionally is not known. However, these isolated sites should be monitored closely as their performance and survival should provide data to test the hypothesis that *E. ciliaris* may still be establishing and colonising suitable habitats in south-east Dorset.

The reduction in the number of *E. ciliaris* sites between 1973 and 1987 was not the result of additional afforestation during this period, but due to the closure of the canopy of existing plantations. Such losses indicate that the potential for future loss remains as plantations mature even if further afforestation of heathland is prevented.

Apart from the loss of populations of *E. ciliaris*, the continuing fragmentation and increased

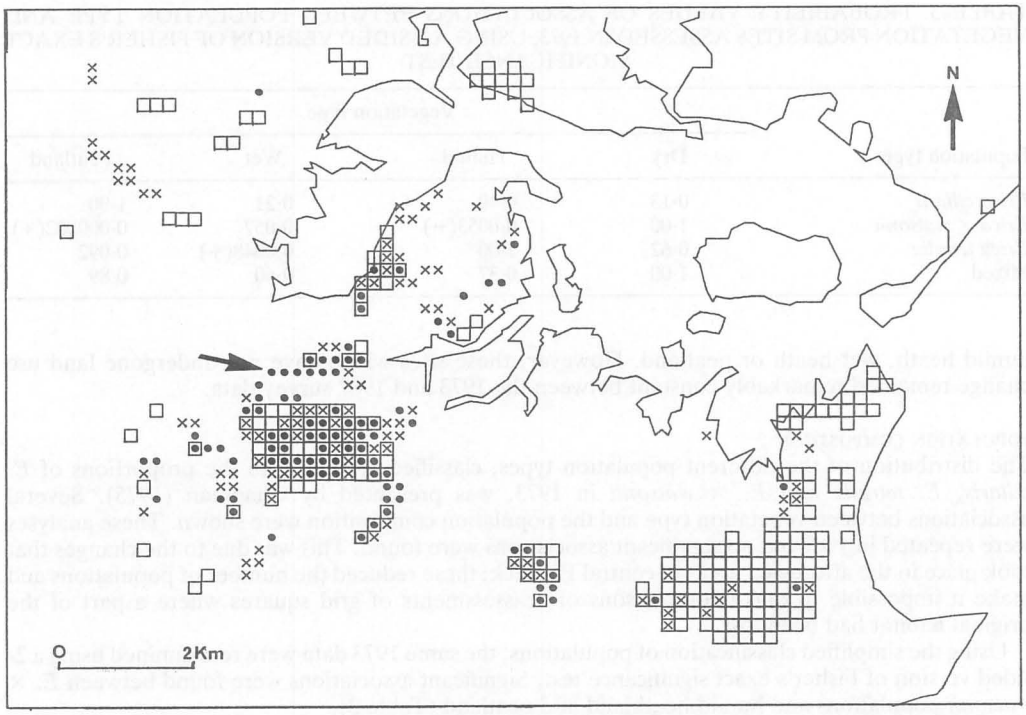

FIGURE 3. Change in population composition of *Erica ciliaris* sites in relation to heathland fires during the period 1973 to 1987 in south-eastern Dorset: ● site with a changed hybrid status, unchanged sites are marked ×; burnt areas are shown □.

isolation of the remaining heathlands (Chapman *et al.* 1989) is likely to have an important effect on future spread, and on colonisation, of suitable sites. Colonisation and establishment of fragmented or isolated areas will be more dependent on chance introductions than natural dispersal.

The results obtained by Chapman (1975) showed a number of significant associations between particular population types and the dominant vegetation types present in the 200 m × 200 m grid squares. However, within a period of 14 years the loss of sites and changes due to afforestation have produced a situation where the examination of data and the testing of a hypothesis relating particular types of population and habitat are no longer possible. Such a situation demonstrates the need for detailed recording of information regarding less common species especially where they are subject to loss of habitat or changes in land use.

Mowing and burning appeared to promote the establishment of *E.* × *watsonii*, whereas more severe disturbance, such as ploughing on Soussons Down in Devon, and in the Purbeck Forest, encouraged the establishment of *E. ciliaris* and *E. tetralix*. This may be related to the more vigorous vegetative regrowth of *E.* × *watsonii* after mowing or burning, and regrowth of *E. ciliaris* and *E. tetralix* from seed following ploughing.

In Dorset, *E. ciliaris* occurs in areas of peat and wet heathland and does less well in drier heathland communities. However, in Cornwall and elsewhere in Europe the plant favours dry heathland. More comparative work is needed on the requirements and behaviour of the plant under different edaphic and climatic conditions.

Although *E. ciliaris* may be expanding its range in Dorset, concern must be expressed about the decline in the area the plant occupies. While there was little change in the distribution of *E. ciliaris* between 1963 and 1973, there was a marked loss of populations in the period 1973 to 1987. Furthermore many of the populations that have been lost were predominantly *E.* × *watsonii*. The

fragmentation of the heaths and changes in population composition make it difficult to predict the natural spread of the plant over its potential range in south-eastern Dorset.

ACKNOWLEDGMENTS

We thank English Nature and the individual landowners who have allowed access to their property over the period of this study. Thanks are also due to Dr L. E. Haskins for site records and permission to quote from her Ph.D. thesis, and BP Petroleum Development Ltd for funding of a survey, the results of which provided the impetus for the remaining survey that was completed in 1987.

REFERENCES

CHAPMAN, S. B. (1975). The distribution and composition of hybrid populations of *Erica ciliaris* L. and *Erica tetralix* L. in Dorset. *Journal of ecology* **63**: 809–824.

CHAPMAN, S. B., CLARKE, R. T. & WEBB, N. R. (1989). The survey and assessment of heathland in Dorset, England, for conservation. *Biological conservation* **47**: 137–152.

GAY, P. A. (1957). *Aspects of the phytogeography of some Lusitanian Ericaceae in the British Isles*. Unpublished Ph.D. thesis, University of London.

GAY, P. A. (1960). A new method for the comparison of populations that contain hybrids. *New phytologist* **59**: 218–226.

GOOD, R. (1948). *A geographical handbook of the Dorset flora*. Dorchester, Dorset Natural History and Archaeological Society.

HASKINS, L. E. (1978). *The vegetation history of south-east Dorset*. Unpublished Ph.D. thesis, University of Southampton.

MANSEL-PLEYDELL, J. C. (1895). *The Flora of Dorsetshire*, 2nd ed. Dorchester.

MCCLINTOCK, D. (1971). Recent developments in the knowledge of European Ericas. *Botanische Jahrbücher* **90**: 509–523.

PERRING, F. H. & FARRELL, L. (1983). *British red data book 1, Vascular plants,* 2nd ed. Nettleham.

PERRING, F. H. & WALTERS, S. M. eds. (1962). *Atlas of the British flora*. London.

WEBB, D. A. (1966). *Erica ciliaris* L. in Ireland. *Proceedings of the Botanical Society of the British Isles* **6**: 221–225.

WEBB, N. R. (1990). Changes on the heathlands of Dorset, England, between 1978 and 1987. *Biological conservation* **51**: 273–286.

WEBB, N. R. & HASKINS, L. E. (1980). An ecological survey of heathlands in the Poole basin, Dorset, England, in 1978. *Biological conservation* **17**: 281–96.

(*Accepted October 1993*)