

Chiltern Gentian, *Gentianella germanica* (Willd.) Börner (Gentianaceae) in Britain: distribution and current status

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ABSTRACT

The distribution and current status of *Gentianella germanica* and its hybrid with *G. amarella* (= *G. xpamplinii*) in Britain have been assessed from existing records and seven years of field work. *Gentianella germanica* is largely restricted to the Chilterns in England and has been recorded from 174 sites, but is currently known in 83 sites (44% decline). The decline has occurred mainly since the 1940s, throughout its range, equally across all habitats, and is on-going. *Gentianella xpamplinii* is recorded in 44 sites and has shown a similar pattern of decline to *G. germanica*. The main causes of the decline of *G. germanica* are agricultural improvement and development of scrub woodland and there is little evidence of hybridisation causing loss of populations. Many populations of *G. germanica* are small with less than 100 plants, but some have populations over 1000. Appropriate habitat management is urgently required for its conservation.

KEYWORDS: conservation, *Gentianella amarella*, *Gentianella xpamplinii*, hybridisation, rare species.

INTRODUCTION

Gentianella germanica (Willd.) Börner (*Gentiana germanica* Willd.), Chiltern Gentian or German Gentian, is an annual or biennial herb of chalk grassland and scrub edges with a British distribution centred on the Chilterns in Buckinghamshire. It is a Nationally Scarce species which is becoming close to qualifying as a Red Data Book species; Stewart *et al.* (1994) reported that it had only been recorded from 21/32 hectads (10 km × 10 km squares) since 1970 (34% decrease), and it was thought to be declining due to loss of habitat and hybridisation, especially at the margins of its range. Preston *et al.* (2002) mapped it as present in 20/34 native hectads since 1987, but noted that although some populations had been lost, the distribution had remained stable since the 1962 *Atlas* (Perring & Walters 1962).

Gentianella germanica has a Local Biodiversity Action Plan in Buckinghamshire (BBONT 1997). As relatively little recent information was available about its distribution and status, we decided to gather detailed information for its conservation and for the restoration and management of its chalk grassland sites in Buckinghamshire. *Gentianella amarella* (L.) Börner and its hybrid with *G. germanica* (= *G. xpamplinii* (Druce) E. F. Warb.) were also investigated to provide additional data.

There are two main identification problems relating to *G. germanica* in Britain. First, *G. germanica* hybridises with *G. amarella* and some populations show introgression (Pritchard 1961). Second, in some *Gentianella* species which occur as both annuals and biennials (Pritchard 1959, 1961), the annual plants often look very different to the more prevalent robust biennials. Small annual plants may be responsible for some erroneous *Gentianella* records, especially of *G. anglica* Pugsf. These two problems were investigated using comparative morphology to ensure the records were as reliable as possible.

W. Pamplin had possibly found *G. germanica* prior to 1841 growing near Tring (Anon 1841) but it was first confirmed as present in Britain by the outstanding Hertfordshire botanist W. H. Coleman (we do not agree with Edgington (2003) that the W. Pamplin record is more likely to relate to *G. ciliata* (L.) Borkh.). Coleman's identification stimulated much debate about the identity of the plants (e.g. Brown 1844; Babington 1864), which continued until the issue was finally clarified by Pritchard (1961). The earliest record traced is a herbarium specimen from St Albans, collected sometime before 1743 (Dony 1967). We agree with Webb & Coleman (1849) that the reference by Gerard (1597, 1633) to Bastard Felwort plants growing 'upon a chalkie banke in the high way betweene Saint Albons and Goramberrie' could refer to *G. germanica* but the illustration shows a plant with a low corolla:calyx ratio and a high leaf length:width ratio, which is more likely to be *G. amarella*. Britten (1909) also argued that the plant described by Ray (1690, 1696) as '*Gentiana fugax Autumnalis elatior*, etc.' was *G. germanica*.

METHODS

IDENTIFICATION

After an initial screening of the characters used to separate *G. germanica* from *G. amarella* (cf. Pritchard 1961), those best suited for measurement and distinguishing the taxa were narrowed down to five for the field identification:

1. Number of internodes above the basal rosette. It was not always easy to distinguish between the basal rosette and the lowest node; the first obvious gap was taken as the lowest internode. A number of plants had an extra solitary, small leaf above the terminal node; this leaf was ignored.
2. Leaf length and width (mm). The length and width of the largest stem leaf from about the middle of the stem was measured. From these measurements, the leaf length:width ratio was calculated.
3. Corolla shape.
4. Corolla length (mm), measured from the base of the calyx to the tip of the lobes on the terminal flower or the largest flower if the terminal one was unavailable.
5. Calyx length (mm), measured from the base of the calyx to the tip of the longest calyx lobe on the same flower as the corolla was measured. The corolla:calyx length ratio was calculated from these measurements.

Plants were separated into *G. germanica*, *G. amarella* and *G. ×pamplinii* as appropriate using these characters.

DISTRIBUTION AND HABITATS

Historical information was abstracted from the literature, herbaria (**ABD, AYBY, BEL, BIRA, BIRM, BM, BON, BRISTM, CGE, DBN, DZS, E, HDD, K, LTN, LTR, MANCH, MBH, NMW, OXF** and **RNG**; herbaria abbreviations follow Kent & Allen (1984)), the Biological Records Centre at Monks Wood (BRC), the Threatened Plants Database (TPDB), local biological records centres and correspondence with botanists. Requests for information were also circulated in newsletters and magazines. Some data from record centres were questionable, especially where grid references referred to the centre of sites or tetrads, and were rejected or queried if they appeared suspect.

A conservative approach was taken when analysing the records. Localities with the same name were assumed to refer to the same site unless other evidence indicated to the contrary. Erroneous records and introduced sites were excluded from all analyses. Some historical records were assigned to the most likely tetrad (2 km × 2 km square).

The historical records were used to direct searches for extant populations, and other likely sites were also searched. Field surveys were carried out from 1998 to 2004. For each population discovered, the number of plants was estimated, notes made on the condition of the habitat and associated species, and morphological measurements made to investigate possible hybridisation. If populations could not be refound, possible reasons for loss were considered.

Habitat types were compiled for each site from the information associated with each historical record, or from field work. For some old sites where no specific habitat was mentioned, the habitats were allocated by comparison with the current habitat (e.g. the presence of species-rich calcareous grassland was a good indicator that the site had been grassland for many years). The vegetation was visually allocated to national vegetation types (Rodwell *et al.* 1991–2000) but no detailed quadrats were recorded.

CAUSES OF CHANGE

To indicate when major changes might have occurred, the number of sites known per decade was calculated. Due to the variation in recording of sites through time, the species was assumed to have been present at the site until it was last recorded. It is likely to have been present continuously at most sites on species-rich grasslands, but is less likely to have been present in quarries though it would probably have been present on the adjacent grasslands. Some sites in disturbed places such as quarries could be new sites. Also, it is rarely known exactly when a site went extinct, so the last record is a proxy measure only. To determine whether decline in *G. germanica* has occurred randomly throughout its range or has been greater at the margins (cf. Stewart *et al.* 1994), two methods were used. First, the proportion of extant records in each hectad was plotted as a function of distance from the centre of distribution for a series of timescales (pre/post 1900, pre/post 1950, pre/post 1970, pre/post 1987). The centre of distribution was calculated as the 'average' hectad at the approximate centre of the range (SU78). If decline has occurred more at the margins than throughout the range, the proportion of extant sites would be expected to decrease with increasing distance from the centre of the distribution. Second, the proportion of extant sites in the 50% of hectads at the edge of the range (selected by eye) were compared with those in the 50% of squares in centre of the range for the same series of date classes. If it has declined more at the edge of the range than at the centre there would be expected to be a significance difference between these two set of squares.

To determine whether loss has occurred selectively from one habitat type more than others, the frequencies of *G. germanica* and *G. x pamplinii* in each habitat were compared for all records with recent (post-1987) records. Repeat records from the same habitat for each site were not included. Different habitats listed within each site were counted separately.

RESULTS

IDENTIFICATION

Gentianella germanica was relatively easy to recognise, characterised by its large numbers of internodes, large corollas with a narrowly funnel-shaped tube and its broad leaves (Fig. 1). The two main variants from typical plants (Fig. 1a) were dwarf, squat plants on dry chalky banks (sometimes only a few cm tall; Fig. 1b) and some plants in Bedfordshire which had characteristic open inflorescences with flowers on long pedicels (Fig. 1c); this variation also occurs on the continent. Occasional annual *G. germanica* plants occurred which differed in being generally smaller in all their parts, lacking a basal rosette and often having cotyledons still present (Fig. 1d).

Gentianella amarella had consistently small, cylindrical, much less showy corollas, and narrow leaves (Fig. 1f). Tall, robust specimens of both *G. germanica* and *G. amarella* can be found in denser grassland swards; they look superficially similar and could be misidentified unless examined carefully. In general plants intermediate between these two distinct species were recorded as the hybrid *G. x pamplinii* (Fig. 1e). Table 1 summarises the measurements used for identification of fresh material.

DISTRIBUTION AND HABITATS

The historical records were often incomplete, poorly documented and vague. It was difficult to be certain where some sites were, or whether different locality names were used for the same site. Some records are errors or are suspect (there is a tendency for any large *Gentianella* plants in the Chilterns to be named *G. germanica*), some may have resulted from mislabelled specimens and some had incorrect grid references. Details about records published in floras with tetrad maps were often lacking.

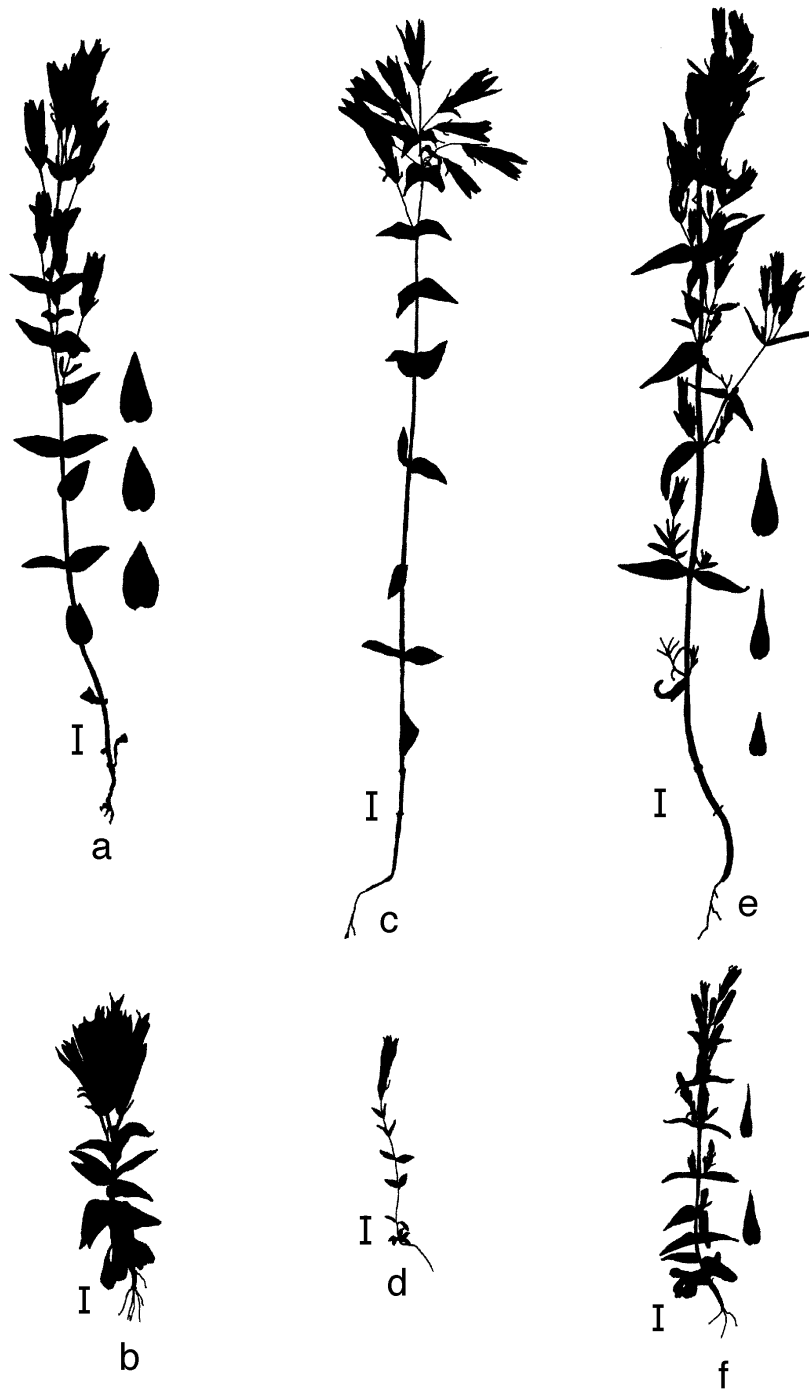


FIGURE 1. Silhouettes of *Gentianella* specimens. a, *G. germanica* typical biennial (NMW). b, *G. germanica* dwarf biennial (NMW). c, *G. germanica* with lax inflorescence (BEL). d, *G. germanica* annual (NMW). e, *G. x pamplinii* (NMW). f, *G. amarella* (NMW). Scale bars all 1 cm.

TABLE 1. SUMMARY OF CHARACTERS USED TO IDENTIFY FRESH FIELD MATERIAL OF *GENTIANELLA GERMANICA*, *G. AMARELLA* AND THEIR HYBRID *G. ×PAMPLINII*

Character	<i>G. germanica</i>	<i>G. ×pamplinii</i>	<i>G. amarella</i>
Height	Robust, (3.5–)12–36(–54) cm, often branched above only	Robust, (7.3–)13–35(–44) cm tall, often branched above and below	Smaller, (2–)3–15(–24) cm tall, often branched above and below
No. of internodes above rosette	(5–)8–13(–16), usually long	(5–)8–11(–12), usually long	(3–)5–9(–11), usually short
Middle stem leaves	(6–)14–32(–43) mm long × (2.5–)7–17(–22) mm wide, ovate-lanceolate to triangular-ovate	(13–)20–38(–49) mm long × (5–)8–14(–18) mm wide, ovate-lanceolate,	(6–)9–26(–40) mm long × (2–)3–10(–18) mm wide, lanceolate to ovate-lanceolate
Leaf length:width ratio	(1.0–)1.6–2.0(–3.8)	(1.7–)2.2–3.0(–3.7)	(1.5–)2.2–3.6(–5.0)
Corolla	(11.5–)25–32(–37) mm, tube narrowly funnel-shaped	(15–)18–21(–23) mm, tube intermediate	(10–)13–19(–21) mm, tube cylindrical
Calyx	(5–)12–20(–24) mm	(9–)11–16(–18) mm	(5.5–)7–12(–14) mm
Corolla: calyx ratio	(1.2–)1.5–2.2(–3.2)	(1.0–)1.2–1.7(–1.8)	(1.2–)1.5–2.3(–2.9)

Figures are given as (minimum–) 10th percentile – 90th percentile (–maximum).

We have visited virtually every site that was practical to do so. In some instances it was difficult to find extant populations in the field, or to be sure the populations found were actually the same as those recorded previously. Access permission to some private land could not be obtained.

GENTIANELLA GERMANICA

A total of 793 records for *G. germanica* were traced (of which 40 were errors). The native records are summarised in Table 2 at various scales (see Appendix 1 for fuller details). The species has been recorded in nine vice-counties, in 27 hectads, in 115 tetrads and in 174 sites. It is currently known in only 18 hectads and nearly qualifies for inclusion in the Red Data Book (Wigginton 1999). There are four introduced sites.

The records are mapped at the tetrad level in Figure 2, which reveals more detail than the hectad map in Preston *et al.* (2002). The main cluster of records is in the Chilterns, with smaller groups in north Hampshire, Berkshire and Bedfordshire, and outlying records in Wiltshire, mid Hampshire and Essex, and a doubtful record from north Buckinghamshire. This tightly clustered distribution could have arisen from one initial colonisation event followed by local spread with secondary dispersal events.

TABLE 2. SUMMARY OF STATUS OF NATIVE *GENTIANELLA GERMANICA* AND *G. ×PAMPLINII* IN BRITAIN AT FOUR SCALES

	Vice-counties	Hectads	Tetrads	Sites
<i>G. germanica</i>				
Present 1987+	7	18	56	83
Extinct 1987+	2	9	54	65
Not investigated/exact site unknown	-	-	5	26
Estimated decline	22%	33%	49%	44%
<i>G. ×pamplinii</i>				
Present 1987+	7	11	20	18
Extinct 1987+	3	8	18	18
Not investigated/exact site unknown	-	1	2	8
Estimated decline	30%	42%	47%	50%



FIGURE 2. Distribution of *Gentianella germanica* in tetrads.
 ● 1987–2004, ○ pre-1987, ? doubtful record, × error, * deliberate introduction.

The Wiltshire (all v.c. 8, South Wilts) records have recently been reviewed by Rich & McVeigh (2002). It was first reported in Wiltshire from Mere Down by E. F. Linton (Tatum 1893; Grose 1957), and a small population with hybrids was refound in 2001 (NMW). It was also recorded in a chalk pit near Shalbourne Church up to 1919, but by 1999 (and probably long before) the pit had been filled with spoil. Another site reported beyond Ham/Reivar (Grose 1957) is in Berkshire. In Hampshire (all v.c. 12, North Hants), it has been recorded in seven sites on the chalk escarpment between Kingsclere and the Berkshire border, and in one isolated site to the south at Worthy Down; it is currently only known from the verges of the A34 and at Ashmansworth. It was recorded prior to 1849 in a meadow in North Essex (v.c. 19); this record does not fit the pattern of the other records but is supported by a voucher in **BM**; the area has heavy clays and no suitable habitat remains. It has been recorded in 19 localities scattered along the Chiltern escarpment in west Hertfordshire (v.c. 20) and is currently present in 12 sites, and has been deliberately introduced to three other sites to the east. There are no details available for two tetrad records in Dony (1967). In Middlesex (v.c. 21) it was recorded from 1883 onwards in one area centred on Springwell chalk pit, but was last recorded in 1977 and is now extinct (Kent 2001). In Berkshire (v.c. 22) it has been recorded in 15 localities, some on the small section of escarpment south of Inkpen, the south, top and northern escarpment of the Lambourn Downs, and in the Thames valley at Streatley, with a couple of records elsewhere; it is currently known in four sites. In Oxfordshire

TABLE 3. TOTAL NUMBER OF RECORDS FOR EACH HABITAT OF *GENTIANELLA GERMANICA* AND *G. ×PAMPLINII* IN BRITAIN, WITH PERCENTAGE OF KNOWN HABITATS

Habitat	<i>G. germanica</i>	<i>G. ×pamplinii</i>
Calcareous grassland, including recolonised superficial workings, grassy scrub and lynchets	108 (70%)	21 (55%)
Chalk pits/quarries	23 (15%)	11 (29%)
Scrub/wood	8 (5%)	2 (5%)
Railway	7 (4%)	1 (3%)
Road verge	4 (3%)	2 (5%)
Disturbed ground	3 (2%)	1 (3%)
Orchard	1 (0.6%)	-
Heath/Common	1 (0.6%)	-
Unknown	19	6
Total	174	44

Duplicate records for the same site are excluded.

(v.c. 23) it has been recorded from 26 localities, mostly associated with Chiltern escarpment between Aston Rowant and Swyncombe and associated valleys and plateaux to the south-east; it is still locally plentiful and has been recorded in at least 15 sites recently. There is one tetrad record in Killick *et al.* (1998) for which no details have been traced. There are at least 93 recorded localities in Buckinghamshire (v.c. 24), mostly on the Chiltern escarpment and associated valleys. It has been recorded recently in at least 44 sites. In Bedfordshire (v.c. 30) it has been recorded in a group of nine sites north of Luton, especially associated with chalk quarries and workings; it has only been seen in five sites recently.

Pritchard (1961, 1972) refers to signs of introgression from *G. germanica* into *G. amarella* in Kent and Surrey and, like him, we have seen no *G. germanica* material from these areas (but see *G. ×pamplinii* below). Other *G. germanica* records for v.c.c. 5, 7, 45, 51, 57 and 64 (cf. Luxford 1844; Druce 1932) have not been accepted (cf. Pritchard 1961 and Appendix 1).

The habitats of *G. germanica* are predominantly unimproved, open, chalk grassland with various degrees of light scrub, and less frequently in open quarries or chalk pits where it may have colonised from adjacent grasslands (Table 3). Currently, most grassland sites are either grazed by cattle and/or sheep, or are ungrazed except by rabbits and deer. It occasionally occurs in mown sites such as on roadside banks, but only where these are either infrequently mown, or mown once early in the year. The main grassland types (*sensu* Rodwell *et al.* 1991–2000) are the CG2 *Festuca-Avenula*, CG3 *Bromus*, CG6 *Avenula* and MG1 *Arrhenatherum* grasslands. The main scrub type is open W21 *Crataegus-Hedera* scrub. It is found rarely in dense, closed scrub or woodland, or by railways and road sides. The vast bulk of the sites are on calcareous soils, usually derived from chalk.

Assessment of the decline depends at which scale it is analysed (Table 2). The crudest scales of vice-counties and hectads show smaller declines than at the finer scales of tetrads and sites; the latter gives the best indication of decline, showing it has been lost from nearly half of its sites. A comparison of current habitats (Table 4) with all habitats (Table 3) indicates that the main losses have been from calcareous grassland (56% decline) and chalk pits (48% decline). It has been lost from improved or re-seeded grasslands, grasslands which have changed to rank *Arrhenatherum* swards, and where dense scrub or woodland have developed. Some sites have also been lost to development or in-filling of quarries. A comparison of the proportions of all and current records show that the losses have been proportional across all habitats ($\chi^2 = 0.917$, $P > 0.9$).

GENTIANELLA ×PAMPLINII

A total of 68 records for *G. ×pamplinii* were traced and are summarised in Table 2. It has been recorded in ten vice-counties, in 20 hectads, in 40 tetrads and 44 sites. The records are mapped at the tetrad level in Figure 3. The maps shows a more restricted distribution than *G. germanica* and suggests it is most characteristic of the Chiltern escarpment. There are only four tetrads with *G. ×pamplinii* where *G. germanica* has not been recorded.



FIGURE 3. Distribution of *Gentianella x pamplinii* in tetrads, ● 1987–2004, ○ pre-1987.

Gentianella x pamplinii has been recorded at two sites in Wiltshire (both v.c. 8, South Wilts) and still persists in small quantity at Mere Down. In Hampshire (v.c. 12, North Hants) it has been recorded in eight sites associated with *G. germanica* on the chalk escarpment between Kingsclere and the Berkshire border; it still occurs in four sites. There are interesting reports of *G. x pamplinii* in Kent and Surrey outside the area in which *G. germanica* currently grows (Pritchard 1961, 1972; specimens in **K**). Convincing hybrid material was found at Deal and Lyminge (both v.c. 15; **BM**, **LTR**), both close to the Channel opposite Calais where *G. germanica* occurs today. Occasionally in south-east England there are plants with long corollas (c. 20–21 mm) which may show some relict of introgression from *G. germanica* (cf. Pritchard 1961) but they cannot be definitely identified from corolla size alone, and no material supporting records for Surrey (v.c. 17) has been seen (cf. Salmon 1931). *Gentianella x pamplinii* is still present in one of its two Hertfordshire (v.c. 20) sites. It was first described from Letcombe Castle by Druce (1896), and is still present in low numbers but has gone from five other sites in Berkshire (v.c. 22). It has been recorded in eight sites on the Chiltern escarpment in Oxfordshire (v.c. 23), and two to the south-west; it is currently known in three sites. It has been recorded in ten sites on the Chiltern escarpment in Buckinghamshire (v.c. 24), surprisingly few given the large number of localities for which both *G. germanica* and *G. amarella* occur, and has been seen recently in five sites. In Bedfordshire (v.c. 30), there are four localities of which it is still present in three. There is also an interesting specimen for Clipsham Quarry (v.c. 55, Leicestershire) which is outside the range of *G. germanica*; investigations in 2003 only revealed *G. amarella*.

TABLE 4. NUMBER OF CURRENT (1987–2004) RECORDS FOR EACH HABITAT OF *GENTIANELLA GERMANICA* AND *G. ×PAMPLINII* IN BRITAIN, WITH PERCENTAGE OF KNOWN HABITATS

Habitat	<i>G. germanica</i>	<i>G. ×pamplinii</i>
Present 1987 onwards		
Calcareous grassland, including recolonised superficial workings, grassy scrub and lynchets	60 (72%)	11 (55%)
Chalk pits/quarries	11 (13%)	5 (25%)
Scrub/wood	4 (5%)	1 (5%)
Railway	2 (2%)	1 (5%)
Road verge	2 (2%)	1 (5%)
Disturbed ground	3 (4%)	1 (5%)
Orchard	1 (1%)	-
Heath/Common	0 (0%)	-
Total present	83	20
Taxon no longer present	65	17
Site not visited/no suitable habitat traced	26	7
Total	174	44

Duplicate records for the same site are excluded.

The pattern of decline of *G. ×pamplinii* is very similar to that of *G. germanica* (cf. above), and it occurs in similar habitats (Tables 3 and 4). As with *G. germanica*, the bulk of the *G. ×pamplinii* records are from calcareous grasslands, but there are relatively fewer from scrub/woods (perhaps because the other parent *G. amarella* is rarely present in scrub). There are higher percentages for disturbed habitats (e.g. quarries, verges) than for *G. germanica* as might be expected for a hybrid as hybridisation is often more frequent following disturbance, but the differences are not statistically significant ($\chi^2 = 0.18$, $P > 0.9$). Like *G. germanica*, *G. ×pamplinii* has also declined proportionally across all habitats.

CAUSES OF CHANGE

Analysis of the number of sites recorded in each decade gives some indication of when the major declines in *G. germanica* have occurred (Fig. 4). There was a minor gradual loss of sites until the 1940s, and then an increased rate of loss, possibly resulting from the ploughing during the Second

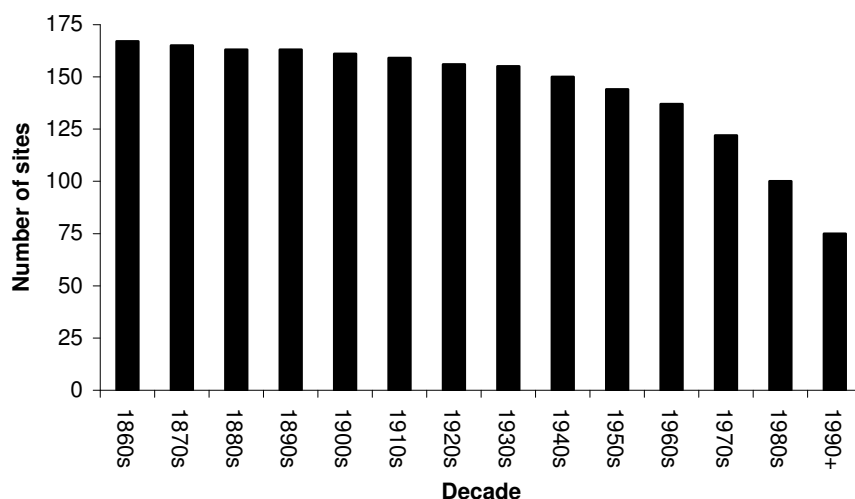


FIGURE 4. Changes in the number of sites of *Gentianella germanica* per decade with time, assuming present at all sites prior to the last record. The last date class includes records from 1990–2004.

World War and the loss of traditional extensive grazing, followed by increasingly steeper rates of decline to the present day. The decline is on-going; if it continues at the same rate as for the last 50 years, *G. germanica* could become extinct in Britain by 2050 assuming no recruitment of new sites.

The *G. germanica* pre/post 1970 map in *Scarce Plants of Britain* (Stewart *et al.* 1994) was interpreted as showing decline at the edges of its range, as there were more hectads at the edges where it had not been seen since 1970 than there were in the middle of the range. The tetrad distribution map (Fig. 2) shows more sites per square in the middle of the range than at the edge, and thus it could also have declined throughout its range to the same extent as at the edges, but this would be hidden in a hectad map as one extant site in a hectad would mask the loss of lots of sites. Figure 5 shows the relationship between the proportion of extant sites and the distance from the centre of the distribution for four date classes; the data are summarised in Table 5. If *G. germanica* was declining more at the edges of its range, an increasingly lower proportion of extant sites would be expected further away from the centre of the distribution. No significant correlations were found between distance from the centre and number of extant sites for the four date classes, suggesting *G. germanica* is declining as much at the centre of its range as at the edges. (To test if the two distant hectads SU83 and TL52 might be having a disproportionate effect on the correlation coefficients, the analysis was repeated excluding them and similar results were obtained with the exception of the pre/post 1987 date class where a correlation was found at the 0.05 level of significance.) Similar results were also obtained for an analysis of the proportions of extant tetrads with increasing distance from the centre of the distribution (data not presented).

TABLE 5. PROPORTION OF EXTANT SITES OF *GENTIANELLA GERMANICA* FOR EACH HECTAD FOR FOUR DATE CLASSES

Hectad	% extant sites pre/post 1900	% extant sites pre/post 1950	% extant sites pre/post 1970	% extant sites pre/post 1987
SP70	86	71	57	29
SP80	77	77	15	15
SP81*	50	50	0	0
SP90	100	100	100	100
SP91	75	75	63	63
ST83*	100	100	100	100
SU35*	100	100	0	0
SU36*	100	33	0	0
SU37	100	100	50	50
SU38*	100	100	40	60
SU43	100	0	0	0
SU45*	100	80	40	40
SU55*	100	0	0	0
SU57	100	50	50	0
SU58	67	33	0	0
SU69	67	67	67	67
SU78	100	92	50	50
SU79	100	100	57	57
SU88	100	60	40	30
SU89	92	88	58	54
SU99*	100	100	50	50
TL00	100	100	50	50
TL01*	100	100	50	50
TL02*	100	83	50	50
TL10*	0	0	0	0
TL52*	0	0	0	0
TQ09*	80	80	20	20
Average	85%	68%	37%	35%

* Hectads at the edge of the range.

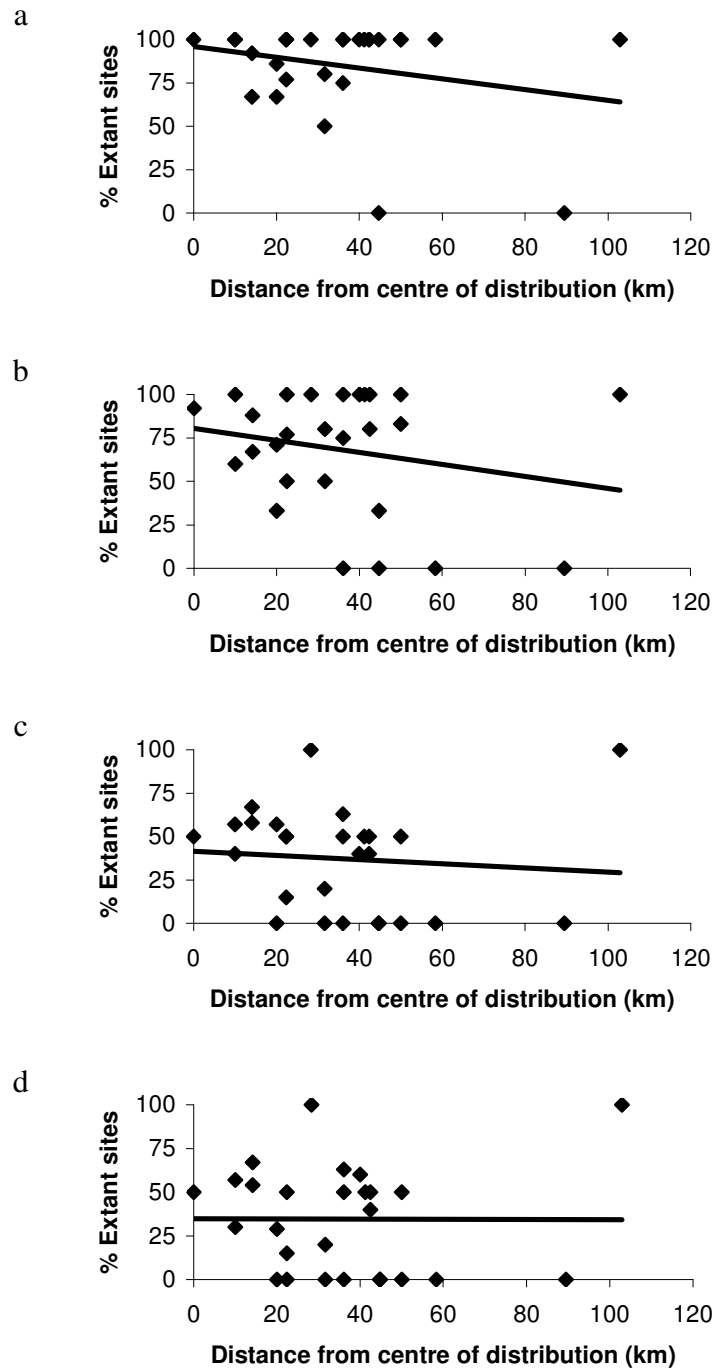


FIGURE 5. Percentage of extant sites per hectad of *Gentianella germanica* plotted as a function of the distance from the centre of its distribution. a, pre/post 1900 ($r = -0.25$, $P > 0.1$). b, pre/post 1950 ($r = -0.221$, $P > 0.1$). c, pre/post 1970 ($r = -0.09$, $P > 0.1$). d, pre/post 1987 ($r = 0.004$, $P > 0.1$).

TABLE 6. PROBABLE REASONS FOR LOSS OF *GENTIANELLA GERMANICA* AND *G. ×PAMPLINII* BY HABITAT (PERCENTAGE OF KNOWN LOSSES)

Probable reason for loss	<i>G. germanica</i>	<i>G. ×pamplinii</i>
Calcareous grassland semi-improved or improved or converted to arable	24 (35%)	3 (19%)
Calcareous grassland neglect becoming tall and rank	7 (10%)	-
Calcareous grassland converted to plantation	4 (6%)	-
Calcareous grassland scrubbed over	2 (3%)	-
Chalk pit scrubbed/wooded over	5 (7%)	2 (13%)
Chalk pit filled in	1 (1%)	1 (6%)
Scrub succession to woodland	5 (7%)	1 (6%)
Development (building)	4 (6%)	-
Railway line scrubbed over	3 (4%)	-
Possible introgression with <i>G. amarella</i>	3 (4%)	-
Taxon gone but suitable habitat still present	10 (15%)	9 (56%)
Unknown reason for loss	23	10
Total	91	26

A problem with this proportion-distance analysis is that it assumes the distribution as circular (it is more of an ellipse). A second method of dividing the hectads into half from the edge of the range and half from the centre was used (hectads marked in Table 5) and the differences in the proportions of extant sites were tested using T-tests. There were no significant differences between these two sets of squares for any date classes ($t = 0.41$ for pre/post 1900, $t = 0.16$ for pre/post 1950, $t = 0.02$ for pre/post 1970, $t = 0.15$ for pre/post 1987; all $p > 0.5$ with 25 degrees of freedom). This also suggests *G. germanica* is declining as much at the centre as at the edges of its range. Again, similar results were obtained for an analysis of the proportions of extant tetrads at the edge or centre of the range (data not presented).

An analysis of the probable reasons for losses (Table 6) shows that in most cases apparently suitable habitat is still present and there is no obvious reason for loss. Where the reasons for loss can be inferred, the main explanations are improvement and neglect of calcareous grasslands (resulting in long rank grass) and scrub development. Successional development of scrub and woodland has also contributed to the decline from chalk pits and partly-scrubbed sites. Interestingly, although introgression with *G. amarella* has often been suggested as a reason for loss (e.g. Pritchard 1972; Stewart *et al.* 1994), it may only have accounted for loss of *G. germanica* at three sites. This is in direct contrast to the conclusion of Pritchard (1972) who suggested introgression was the major cause of decline. The hybrid also seems to disappear from sites for no apparent reason. Many sites were found where *G. germanica* and *G. amarella* grow together with no obvious hybrids.

POPULATION SIZES

Population estimates for 64 of the 83 sites of *G. germanica* seen since 1987 are given in Table 7. The average maximum population size for the 64 populations counted was 876 plants. About half of the sites had fewer than 200 plants, and 11 of these had less than ten plants. These small populations are the most susceptible to further loss, and they typically occur at the edges of scrub or wood, on the narrow unimproved margins and banks around improved fields and in rank, unmanaged grasslands. Seventeen sites have more than 1000 plants, often on extensive areas of species-rich grassland and extensive quarry workings which have partially revegetated.

Due to time constraints few comparable population data for *G. ×pamplinii*, and virtually none for *G. amarella*, were collected.

DISCUSSION

The collection of morphological data was helpful in clarifying the identification of the taxa present in *Gentianella* populations. Only in a few cases where hybridisation was present were there any real difficulties with identification and, even then, it was usually clear when good *G. germanica* was present. It was more difficult to decide whether some variation in *G. amarella* was the result

TABLE 7. MAXIMUM POPULATION SIZES COUNTED FOR 64 POPULATIONS OF *GENTIANELLA GERMANICA* SINCE 1987 (% OF SITES)

Number of plants	Number of sites	Number of plants	Number of sites
1–19	13 (20%)	500–999	7 (11%)
20–49	8 (13%)	1000–1999	4 (6%)
50–99	6 (9%)	2000–4999	11 (17%)
100–199	4 (6%)	5000+	2 (3%)
200–499	9 (14%)		

of introgression from *G. germanica* or simply variation within *G. amarella*. Pritchard (1972) also noted it was easier to find hybrid populations that were closer to *G. amarella* than to *G. germanica*.

Despite the difficulties associated with collation of historical records and the field work, the large number of sites investigated during seven years of field work can be used to generalise about the current status and causes of decline. The systematic collection of data has allowed much more detailed analysis of the causes of change than is usually feasible. The tetrad map (Fig. 2) significantly updates the maps in Stewart *et al.* (1994) and the hectad map in Preston *et al.* (2002). There is little doubt that there are still new localities to be found, and the authors would welcome details of any further sites.

Gentianella germanica is restricted to a relatively small range of chalk grassland types and scrub in southern Britain. Elsewhere in Europe it occurs in a wider range of grasslands from lowland to alpine regions of west and central Europe and in the mountains of the Balkans, where its typical habitats are south-facing, nutrient poor, calcareous grasslands, especially *Mesobromium* communities (Meusel *et al.* 1978; Ellenberg 1988). This may either indicate that *G. germanica* is a late post-glacial arrival in Britain and has not, as yet, managed to colonise other geological formations, or that only a limited range of genotypes are present which can only survive in these habitats; morphologically it is certainly more uniform in Britain than the *G. germanica* group is in Europe (cf. Pritchard & Tutin 1972). Pritchard (1961) suggested that *G. germanica* colonised the Chilterns via the North Downs, but the pattern of distribution is more indicative of one longer range dispersal event with secondary colonisation, despite the 'relict' hybrids on the Kent coast. Other examples of species especially frequent in the Chilterns and rare or absent from much of the North Downs are *Cardamine bulbifera* (L.) Crantz, *Fumaria vaillantii* Loisel., *Hordelymus europaeus* (L.) Jess ex Harz and *Iberis amara* L.

The field work shows clearly that *G. germanica* is declining, and the finer the scale investigated generally the larger the decline (Table 2). The number of sites gives the most direct estimate of the status of the species. With the detail associated with many modern records it is usually possible to determine the number of sites reasonably easily, but it is less easy for older records where sites may have been noted, and different recorders may define sites differently. Frequency estimates based on tetrads or hectads give a poorer measure of the number of populations, and the *G. germanica* decline does not show on summary hectad maps where there is a concentration of sites in a small area, as one extant site can mask loss of any number of other sites. Analysis of distribution data at the hectad level (e.g. Preston *et al.* 2002) may thus indicate little decline except at the grossest of levels, and finer scale data are required to monitor the status of many rare plants. The false generalisation that decline has occurred mostly at the edge of the range (Stewart *et al.* 1994) is also a consequence of visual analysis of hectad data. The site-based information collected for this study will form a baseline for more effective monitoring in the future.

There are few comparable data for declines in other *Gentianella* taxa in Britain to compare with the 44% decline in *G. germanica* (Table 2). *Gentianella x pamplinii* has declined to a similar extent as *G. germanica* (Table 2). In a study of 21 vice-counties, Rich *et al.* (1996a, 1996b) found that *G. anglica* had disappeared from 71/99 sites (71% decline) although this excluded the core populations in Hampshire, the Isle of Wight and Wiltshire. *Gentianella ciliata* is currently only known in one of its two sites, and *G. uliginosa* in four of its eight sites (both 50% decline). To judge from the hectad data in Preston *et al.* (2002), *G. campestris* (L.) Börner has also declined dramatically in lowland England and Wales, and to a lesser extent so has *G. amarella*. Pritchard (1972) noted all British *Gentianella* taxa except possibly *G. amarella* were declining for a variety

of reasons. Declines in the number of sites of eight other Red Data Book or Nationally Scarce species we have studied in southern England are as follows for comparison: *Cardamine bulbifera*, 22% decline (Showler & Rich 1993; Nicholson *et al.* 2004), *Cyperus fuscus* L., 54% decline (Rich 1999a), *Thlaspi perfoliatum* L., 80% decline (Rich *et al.* 1998), *Carex depauperata* Curtis ex With., 86% decline (Rich & Birkinshaw 2001), *Filago lutescens* Jord., 93% decline (Rich 1999b), *F. pyramidata* L., 97% decline (Rich 1999c), and *Bromus interruptus* (Hack.) Druce and *Filago gallica* L. both 100% decline (Rich *et al.* 1999, Rich & Lockton 2002).

There are no comparable site-based data on declines of *G. germanica* in Europe. Fischer & Matthies (1998) noted *G. germanica* has become endangered in many parts of central Europe such as Switzerland and Germany, and that the remaining populations were often small and isolated. Lennartsson & Svensson (1996) found marked declines in *G. amarella*, *G. campestris* and *G. uliginosa* in Sweden. It is likely that many *Gentianella* species are declining throughout their ranges across Europe.

The major causes of change are loss of unimproved calcareous grassland to agriculture, especially by 'improvement' through addition of fertilisers and/or herbicides (Table 6). Some loss has also occurred through neglect of grassland management, resulting in a dense, tall, closed sward unsuitable for germination and survival in the first year. Some sites have developed into scrub and woodland. The change from widespread, small-scale, intermittent quarrying to fewer major quarries in recent decades has also severely limited the potential for local patchwork colonisation of such sites, as occurred with several *Gentianella* taxa in the last century. The timing of the increased rates of loss from the 1950s onwards is probably linked to the agricultural revolution resulting in 'improvement' and ploughing of grasslands. It is possible that the myxomatosis plagues in the 1950s reduced rabbit grazing pressure on some sites which allowed development of rank grasslands and scrub (Prichard 1961), though *G. germanica* seems to persist in more rank sites than *G. amarella*.

Hybridisation does not seem to be a significant cause of loss. Hybridisation might only occur where specific pollinators which visit both species are present, but this has not yet been studied. *Gentianella germanica* is usually pollinated by Diptera and solitary bees, but self-pollination rates are high (Fischer & Matthies 1997). Both *G. germanica* and *G. amarella* are self-compatible and the amount of seed produced depends strongly on the extent of self- or cross-pollination (Fischer & Matthies 1997).

Many of the populations found were very small (Table 7). At sites where the available habitat is limited, such populations are likely to be vulnerable to loss from both environmental and genetic effects. Where large populations are present over extensive areas of habitat, they are likely to be more persistent. In a study of *G. germanica* at a range of sites in the Jura Mountains, Fischer & Matthies (1997, 1998) found that reduced reproductive performance of plants from small populations was best explained by genetic effects (inbreeding depression) rather than environmental quality, but they also found that out-breeding depression occurred suggesting plants were locally adapted to their sites. They pointed out that use of artificial inter-population gene flow as a conservation management tool to counter genetic erosion should be used with caution. Given the greater homogeneity of sites in England, this latter phenomenon may be less of a problem but should be investigated experimentally before different populations are crossed with each other in the field.

As populations of *Gentianella* taxa are known to vary dramatically from year to year (e.g. Runge 1963, 1968; Dierschke 1986), it is difficult to draw firm conclusions about the longer term viability of individual sites from our limited population data. A preliminary analysis of data from one north-facing site in Berkshire showed an increase in *G. germanica* over a twenty year period might be linked to increased summer temperature (Osmond *et al.* 2005). Runge (1968) noted that in Westphalia, Germany, *G. germanica* decreased markedly after dry periods in spring and summer, but increased again after wet summers.

The 44% decline in the number of sites of *G. germanica* is cause for concern and indicates that *in situ* conservation action is needed throughout its range in Britain. 40% of the sites are protected as Sites of Special Scientific Interest or nature reserves or are in sympathetic ownership (e.g. National Trust) and 37% are County Wildlife Sites, but 27% of the sites have no designation or protection. The designations may help to protect the sites from development or agricultural improvement, but they do not always ensure appropriate management for *G. germanica*. As the

micro-structure of the grassland is important in determining growth and hence reproductive output of individual plants, especially during the second year when plants flower (Verkaar *et al.* 1983b), the key requirement is to ensure appropriate management of the vegetation to maximise reproductive success. Our provisional thoughts on best management are that sites should be lightly grazed with cattle and/or sheep all year, or heavily grazed for short periods only in late autumn to open up the sward for seed germination, which occurs during December to March (Schenkeveld & Verkaar 1984). *Gentianella* taxa are not selectively eaten by stock due to the bitter chemicals they contain. The sward should be 2–10 cm tall with many small gaps 1–5 cm across (Grubb 1976), although *G. germanica* is noted for its ability to persist in taller turf. For sites where grazing is not practical, physical disturbance with machinery may be required to maintain open ground, or mowing, the timing of which is again crucial (Van Tooren *et al.* 1987).

Restoration of extinct sites through habitat management may not be practical as *G. germanica* has been reported to have a non-persistent, or only short-lived, seed bank (Schenkeveld & Verkaar 1984, Pons 1991). Conservation work should be directed towards maintaining the existing sites before restoration of old sites is attempted. Seed dispersal by shaking out of the capsules is also very limited, mostly within 1 m of the parent plant (Verkaar *et al.* 1983a), though it may be dispersed further by cattle and horses as has been reported for *G. amarella* and *G. campestris* (Ridley 1930). *Gentianella germanica* is currently unlikely to have a meta-population with dynamic colonisation and loss of individual sites within the range in Britain due to habitat fragmentation, and this limited dispersal also means that recolonization from adjacent sites is likely to be low.

Gentianella taxa are notoriously difficult to grow in cultivation, and *ex situ* collections are likely to be difficult to maintain. One British *G. germanica* seed collection from the Warburg Nature Reserve, Nettlebed is currently held in the Millennium Seedbank (S. Flynn, pers. comm. 2005).

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APPENDIX 1

RECORDS OF *GENTIANELLA GERMANICA*

Records are ordered by vice-county, locality name, and date. Tetrad letters follow standard B.S.B.I. nomenclature. Unsourced records are field records held at the Biological Records Centre, Monks Wood. Erroneous records are given in square brackets at the end of each vice-county. Sites labelled * are deliberate introductions. Our records are listed with our initials only. Full details are held by AM & JC and are available on request.

[SOUTH SOMERSET (V.C. 5)

Listed in Druce (1932), probably in error.]

[NORTH WILTS (V.C. 7)

Listed in Druce (1932) and rejected by Grose (1957).]

SOUTH WILTS (V.C. 8)

Mere Down, ST83G: 1891, E. F. Linton (Tatum 1893; Grose 1957). 5 plants, hybrids also present, 12 September 2001, TR.

Shalbourne, old chalk pit north of, SU36B: 23 September 1910, C. P. Hurst (**BM, OXF**). 30 September 1910, C. P. Hurst (**OXF**). 1913, G. C. Druce (**OXF**). 1919, C. P. Hurst (Grose 1957). Not refound, 22 August 1999, AM & JC.

[The Pitton record for *G. germanica* queried by Grose (1957) is *G. ciliata*.]

NORTH HANTS (V.C. 12)

Ashmansworth (Privet Copse, sometimes erroneously called Pilot Hill), SU45D & E: 9 September 1914, 15 September 1915 & September 1924, W. C. Barton (**BEL, BIRM, BM, BRISTM, CGE, LTR, MANCH, MBH, NMW, OXF**). Chalk grassland, 3 October 1939, E. C. Wallace (**RNG**). Very few plants dried up by drought, 4 October 1955, N. M. Pritchard (**ABD**). Scrubby ground at edge of plough, 25 September 1956 (annuals), N. M. Pritchard (**ABD, OXF**; Brewis *et al.* 1996). 3 plants, open chalk scrub, 6 September 1969, R. P. Bowman (Brewis *et al.* 1996). 1973, F. Rose. 1979, R. A. Boniface (**NMW**). Chalk grassland, 24 September 1979, E. C. Wallace (**RNG**). 700+ plants, 1982, R. P. Bowman. 1985, Hampshire County Council. 19 August 1987, NCC England Field Unit. Brewis *et al.* (1996) reported site 'now ploughed' [second site survived]. 4 plants and 30 hybrids in one site, the other lost to scrub encroachment, 24 August 2004, A. R. G. Mundell.

Ecchinswell, chalk pit near (= Nothing Hill), SU55E: Specimens here varied a great deal, 21 September 1895, 10 September 1896, 22 September 1897 & 27 August 1923, A. B. Jackson (**BM, K, NMW**). Small chalk pit, 15 September 1935, J. E. Lousley (**BM, RNG**). 19 September 1937, P. M. Hall (**BM**; Brewis *et al.* 1996). Not refound, chalk pit overgrown, 21 August 1999 & 4 September 2001, AM & JC.

Facombe, south of, SU35Y & 45D: 2 September 1958, F. Partridge (Brewis *et al.* 1996). Not refound but areas of relict calcareous grassland had *G. amarella* and *G. x pamplinii*, 22 August 1999 & 4 September 2001, AM & JC.

Great Litchfield Down, disused railway, SU45S: Thousands of plants, 1969, R. P. Bowman (Brewis *et al.* 1996). Not refound, the population now appears to be entirely comprised of *G. amarella* and hybrids, 21 August 1999, AM & JC.

Highclere-Old Burghclere, old railway line, SU45T & U: 1976, M. Boniface (Brewis *et al.* 1996). 1977, M. Boniface. 1986, W. M. Keens. Not refound, 21 August 1999 or 24 August 2002, AM & JC.

Seven Barrows, A34, SU45S: 31 August 1964, R. P. Bowman. New A34 verge, numerous, 1980, P. R. Brough (Brewis *et al.* 1996). 1987, W. M. Keens. c. 10,000 plants – very diverse population, much evidence of introgression, 21 August 1999, AM & JC. Many hundreds, 10 August 2001, A. R. G. Mundell.

Sydmonton (Watership chalk pit, including North Sydmonton?) SU45Y: 1895, G. C. Druce (**OXF**). 21 September 1895 & September 1896, A. B. Jackson (**BIRM, K**). 19 September 1937, E. C. Wallace (**RNG**). Not refound, 24 August 2002, AM & JC.

Worthy Down, SU43M: 1940, Lady J. C. Davy, since ploughed (Brewis *et al.* 1996). Not refound but suitable habitat still occurs, 21 August 1999, AM & JC.

[SURREY (V.C. 17)

No material supporting the J. S. Mill *G. germanica* record from between Banstead and Chipstead (Brewer 1863) have been seen; Salmon (1931) suggested the record might be of hybrids but we have seen no evidence of these either, despite much field work in the area and numerous herbarium specimens.]

NORTH ESSEX (V.C. 19)

Chickney – Henham, meadow near a wood, TL52U: pre-1849, E. Forster (**BM**; Gibson 1862). No suitable habitat remaining and not refound, 15 September 2001, AM & JC.

HERTS (V.C. 20).

Aldbury Downs, SP91R: September 1872, H. Groves (**BM**). September 1913, E. J. Salisbury (**K**). 19 August 1921, A. W. Graveson (**HTN**, **NMW**). Chalky field, September 1923, P. W. Richards (**OXF**, **NMW**). 2 October 1929, C. E. Salmon (**BM**). 1956, F. Rose. Undated (Dony 1967). 100+ plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 1980, R. M. Bateman. Small field containing 500+ plants including annuals, but gone from another sub-population, 11 September 2001, AM & JC (**NMW**).

Aldbury Nowers, wood, SP91L: 1863, W. H. Coleman (Webb & Coleman 1849, Pryor 1887). Not refound but suitable habitat present, 11 September 2001, AM & JC.

Aldbury, Cootswold House Bank, SP91R: 1984, N. M. Pritchard (**HTN**). 261 plants, 29 August 1998, AM & JC.

Beechengrove Wood, below, TQ09N: 27 May 1979, J. G. Dony & P. Tate. 1991, G. Salisbury & J. Saunders (T. J. James database). 58 plants, 24 August 2001, AM & JC.

*Essendon, Howe Green (Bedwell) chalk pit, TL20Z: Believed to have been deliberately introduced to this site in the early 1970s (pers. comm. T. J. James, 2003). Several hundred plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 1971, J. Reid. Old chalk pit, quarter of a mile E of village. 10,000 plants on semi-open grassy vegetation on bare chalk or very thin, sand-rich soil, 19 August 1972, H. J. Killick (NCC Rare Plant forms). 1973, T. J. James. 15 August 1974, H. J. Killick. In great abundance, 4 September 1974, J. E. Lousley (**RNG**). 1981, C. David, C. M. & T. J. James. 1990, T. J. James & G. J. White. Dead stems frequent, 19 April 1991, T. J. James & G. White (T. J. James database). Site bulldozed but 50 + plants still present, June 2004, T. J. James (T. J. James, pers. comm. 2004).

Flamstead, Jacks Dell, TL01W: August 1902, H. J. Riddelsdell (**BM**). 1967, J. G. Dony. c. 20 plants – diminishing because of scrub invasion, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). Not refound, quarry overgrown, 11 August 2001, AM & JC.

Flaunden Bottom-Hanging Croft, TL00A & TQ09E: 1958, E. W. B. H. Milne-Redhead. 1967, J. G. Dony (Dony 1967). Several hundred plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). Not refound, 24 August 2001, AM & JC.

Flaunden Quarry, TL00A: August 1989, G. Salisbury & J. Saunders. Not refound, quarry infilled, 20 September 2004, AM & JC.

Great Gaddesden, Hoo Wood, TL01G: pre-1820, W. Blake (**OXF**). August 1822 (**LTN**). 1962, J. G. Dony (Dony 1967). Slope below Hoo Wood, rabbit grazed north facing slope, 10 September 1962, C. M. & J. G. Dony (Dony 1967). Several hundred plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 1979, R. M. Bateman. 1985, P. Collins. 18 June 1998, F. Hall & B. Harold (T. J. James database). Eight plants, 29 August 1998, AM & JC.

*Little Hadham, chalk pit, TL42L: A deliberate introduction in about 1980 (pers. comm. T. J. James, 2003). 1988, S. Watson. Not refound, no access, 15 September 2001, AM & JC.

Oddy Hill, Wigginton (including Holloway Down), SP91F: pre-1841, W. Pamplin (Webb & Coleman 1849; Pryor 1887). 1846, herb. E. Forster (**BM**). 'In a hilly wood near', 1846, R. A. Pryor (Pryor 1887). 1956 & 1957, F. Rose (**NMW**). North facing slope, in short turf with hybrids, 11 August 1962, J. G. & C. M. Dony & D. E. Allen (Dony 1967). October 1962, F. Rose (**NMW**). 12 September 1964, E. C. Wallace (**RNG**). 1967, J. G. Dony. 1968, F. Rose (**RNG**). 100+ plants, 1970, C. M. & J. G. Dony. 19 September 1975, S. L. Jury (**RNG**). 1979, R. M. Bateman. 1984, N. M. Pritchard. 6 August 1988, M. Demidecki & T. J. James. c. 2000 plants, *G. amarella* and hybrids also present, 29 August 1998, AM & JC.

Pitstone Quarry, SO91L: 1998, G. Salisbury (T. J. James database).

Ravensdell, TL01C: 1951–1966 (Dony 1967). 1000+ plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 1980, C. M. & J. G. Dony. 21 September 1987, NCC England Field Unit. 17 September 1997, P. Baker (C. R. Boon Database). 13 plants, 31 August 2003, AM & JC.

Sarratt, under Blunts Wood, TQ09N: Undated (Pryor 1887). Not refound, area now arable, 24 August 2001, AM & JC.

St Albans (Verulamium), TL10I: Near the walls of, pre-1743, R. Tilden (**BM**; Dony 1967). Assumed lost to development.

Studham, Greencroft Barn, TL01G: In rough pasture, 1895, D. M. Higgins (Dony 1953). 29 August 1943, J. G. Dony (**LTN**, Dony 1946, 1953). 17 August 1946, P. Taylor (**K**). Slope below barn, c. 50 plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). Not refound, habitat improved, 28 August 2004, AM & JC.

Tring, nr (including Tring Park), SP91F: 1812, W. Anderson & J. Dickson (Pryor 1887, Druce 1926). 4 September 1846, C. C. Babington (**CGE**). In a wood, 1846 (Pryor 1887). 1864, A.G. More (Druce 1926 incorrectly as Aston Abbots). Undated, C. Conway (**NMW**). 20 September 1850, F. Y. Brocas (**K**). August 1871, J. Cunnack (**BM**, **DBN**). In a fir wood, 29 June 1872, F. J. Hanbury (**BM**). August 1874, E. A. Lomax (**MANCH**). September 1874, J. Cunnack (**BM**). 17 September 1922, A. W. Graveson (**HTN**). 27 September 1931, A. N. Galston (**BM**). 10 plants, 17 October 1990, T. J. James *et al.* (T. J. James database). 12 plants, August 2001, AM & JC.

*Ware, Chadwell chalk banks, TL31L: A deliberate introduction in about 1980 (pers. comm. T. J. James, 2003). 1984, J. C. Doyle. 19 August 1984, T. J. James. 13 June 1989, A. Boucher & T. J. James. Not refound, 15 September 2001, AM & JC.

SP90U: Undated (Dony 1967). Not refound, area improved, 30 August 2004, AM & JC.

SP91Q: Undated (Dony 1967). Not refound, area improved, 30 August 2004, AM & JC.

MIDDLESEX (V.C. 21)

Harefield, Garrett Wood (including Springwell chalk pit), TQ09L: 1883, E. de Crespigny (**MANCH**). 1884, field below, 22 August 1892, J. Benbow (**BM**; Kent 1975). 17 September 1904 (**BM**). 17 & 19 September 1910, H. W. Pugsley (**BIRM**, **BM**). 6 September 1913, J. E. Cooper (**BM**). 11 August 1945, B. Welch (**NMW**). 17 August 1945 (**BM**). 1 September 1945, J. E. Lousley (**NMW**, **RNG**). 25 August 1946 (**BM**). 15 August 1947, B. Welch (**NMW**). 21 August 1949, R. A. Boniface (**NMW**). 3 October 1954, E. B. Bangerter and LNHS (**BM**). 2 small seedlings only, 1965, B. P. Pickess (Kent 1975). 1977 (Kent 2001). Not refound, 13 September 2002, AM.

BERKS (V.C. 22)

Cleeve Hill, SU37I: 1966, H. J. M. Bowen (Bowen 1968). 1973, N. E. King & L. F. Durrell. 1974, J. Buchanan. 27 September 2004, G. Osmond, TR & AM (**NMW**); for detailed population counts 1985–2004 by G. Osmond, see Osmond *et al.* (2005).

Coombe Hill (Combe Hill), SU36Q: Undated (Druce 1918). Not refound, area improved, 27 September 2004, AM & TR.

Gramp's Hill, Wantage, SU38S: 1000+ plants in high quality grassland, 1991, M. Reed & P. H. Wilson.

Hurley Pit, SU88A: 1964, V. N. Paul (Bowen 1968). Not refound, 10 September 2001, AM & JC.

Inholmes, SU37G: 1965, H. J. M. Bowen (Bowen 1968). Not refound, 23 August 2001, AM, JC & TR.

Inkpen Hill, Rivar Copse (Reiver Wood, including near Ham), SU36L: August & September 1910, C. P. Hurst (**OXF**, Bowen 1968). 22 September 1937, J. D. Grose (card index held at **DZS**). 3 October 1937, B. Welch (**NMW**). Undated, C. P. Hurst & J. D. Grose (Grose 1957). 1955, F. C. Partridge (Bowen 1968). 1956, J. D. Grose (Bowen 1968). In rough chalk grassland, 13 October 1957, N. Y. Sandwith & F. Partridge (**K**). Not refound, 7 October 2001, AM & JC.

Letcombe Castle (= Segsbury Camp), SU38X: Abundant, 1890, Mr Bellamy & G. C. Druce (**OXF**; Druce 1897, Bowen 1968). September 1892, B. Taylor (**OXF**). September 1892 & September 1894, G. C. Druce (**BIRM**, **BM**, **BRISTM**, **CGE**, **DBN**, **E**, **MANCH**, **NMW**, **OXF**). September 1903 & 13 September 1905, W. H. Griffin (**BM**, **K**, **NMW**, **RNG**). September 1908, G. C. Druce (**E**). September 1917, R. C. McLean (**NMW**). Grassy bank, 16 September 1934, J. D. Grose (**DZS**). 1950, W. L. Theobald (Bowen 1968). 1956. 13 September 1959, J. E. Lousley (**NMW**). 1960, H. J. M. Bowen. August 1978 & 1982, H. J. Killick. 1986, G. Hawker. Ramparts, 1 plant, 28 August 1991, M. Reed. Ramparts, 2 plants with hybrids, 2000, P. H. Wilson. Mixed population with *G. amarella* NW of hill fort but no hybrids, 23 August 2001, AM, JC & TR (**NMW**).

Letcombe Regis/Letcombe Bassett, SU38S: November 1954, E. F. Warburg. Short turf in scrub and along path in *Chamerion*, 19 September 1956, N. M. Pritchard (**ABD**). September 1960, P. Williams. 25 plants, 23 August 2001, AM, JC & TR.

Park Wood, old railway, SU57H: 1980, W. M. Keens. Not refound, 30 September 2001, AM.

Pit Down, SU38G: 1951, 1953, J. W. Gough (Bowen 1968). Not refound, 23 August 2001, AM, JC & TR.

St Mary, chalky bank, woodland (possibly same as Inholmes), SU37M: 10 September 1965, H. J. M. Bowen (**OXF**).

Streatley – Basildon, hill by wood (assumed to be The Holies), SU57Z: 11 August 1937, H. J. Riddelsdell (**K**). Not refound, 4 September 2001, AM & JC.

Streatley, near, SU58K: 20 September 1937, H. J. Riddelsdell (**OXF**, Bowen 1968). 1962. Not refound, 14 September 2002, AM.

Streatley, near (assumed Lough Down), SU58V: Undated, W. Pamplin (Druce 1897). September 1917, Todd & T. G. Parry (**OXF**, Druce 1918). Great quantity, 13 August 1937, H. J. Riddelsdell (**K**, Bowen 1968). Not refound, 14 September 2002, AM.

Upton, near, SU58D: 1890, Miss Fry (Druce 1897). October 1891, G. C. Druce (**OXF**, Bowen 1968). Not refound, 23 August 2001, AM & JC.

Wether Down, SU38F: September 1969, H. J. M. Bowen. Not refound, 23 August 2001, AM, JC & TR.

[Records for Crog Hill & Scar BBOWT Reserve refer to *G. amarella*; *G. germanica* has never been seen there by G. Osmond (pers. comm. 2004).]

OXON (v.c. 23)

Assendon, SU78H: September 1930, G. C. Druce & Lady J. C. Davy (**K**, **OXF**). In profusion on bank, 10 September 1930, E. Vachell, E. Knowling & Lady J. C. Davy (**NMW**). 22 September 1931, G. C. Druce (**BM**, **OXF**).

Aston Rowant NNR – N of M40, SU79I: 22 August 1990, T. H. Fowler. 19 plants, grassland below old visitor centre, 7 September 1998, AM & JC.

Aston Rowant NNR – Beacon Hill, SU79I: Foot of hill, 18 July 1954, R. S. R. Fitter. Post-1970 (Porley 1996). Foot of hill, 1981, M. R. Hughes. Foot of hill, 1986, B. Marcan. Gone by 1991, H. J. Killick and 21 August 2003, AM & JC.

Aston Rowant NNR – Bald Hill, SU79H & I: August 1903, H. J. Riddelsdell (**BM**). 13 September 1953, J. E. Lousley (**CGE**, **NMW**, **RNG**). Open chalk grassland reverting to scrub, 24 August 1958, R. F. Norris (**RNG**). 16 September 1961 (**AYBY**). 14 August 1964, M. W. (Ambrose & Marcan 1964). 28 August 1965, E. J. Byrne (Ambrose & Marcan 1965). 1966. 9 September 1966, T. C. E. Wells (**ABRN**). 1967, G. Glover. August 1967, A. J. Richards (**OXF**; Killick *et al.* 1998). Foot of hill, 1968, D. B. Eyres. 2 September 1980, P. J. Grubb (**CGE**). 1986. 30 July 1987, NCC. 18 March 1988, H. J. M. Bowen. 720+ plants scattered over hill, 15 September 1991, H. J. Killick. Many 1000s of plants, 7 September 1998, AM & JC. 1 September 2001, B. Laney.

Bix Bottom, SU78J: 1984, S. Webster (Killick *et al.* 1998).

Bledlow Cross, SP70Q: 4 September 1935, E. C. Wallace (**BM**, **E**, **RNG**). Two plants, 4 September 1998, AM & JC.

Bledlow-Chinnor, roadside between, SP70Q: 1886, G. C. Druce (Druce 1886, 1927). Not refound, 20 August 2004, AM & JC.

Buckingham Bottom, SU79H: 2002, R. Barber & N. Snell.

Chinnor Chalk Pit, SP70K & SU79P: Tetrad K, 1970, R. S. R. Fitter (Killick *et al.* 1998). Tetrad P, 21 August 2003, J. M. Campbell.

Chinnor Hill, SU79Q & U: 23 September 1883 & September 1884, G. C. Druce (**E**, **OXF**). 1921, Lady J. C. Davy & G. C. Druce (**OXF**; Druce 1927). Rough hillside, October 1922, E. Vachell & G. C. Druce (E. Vachell diaries, held at **NMW**). 4 September 1935, E. C. Wallace (**BIRM**, **RNG**). chalk grassland, 16 October 1954, F. Rose (**NMW**). 20 September 1954, H. J. M. Bowen (**RNG**). On grassy path, 15 September 1956, E. C. Wallace (**RNG**). 1965, H. J. M. Bowen (TPDB). 1968, H. J. M. Bowen (TPDB). 1969, R. S. R. Fitter (TPDB). 1971, R. S. R. Fitter (TPDB). 1981, H. J. M. Bowen. 14 September 1986, H. J. M. Bowen. 1989, D. J. Dunlop (TPDB). A few small *G. germanica*, plus hybrid swarm, 21 September 1991, H. J. Killick. 5 plants, plus one further up the hill, 21 October 1991, H. J. Killick. 5 plants, 4 September 1998, AM & JC.

Crowell Hill, chalky banks, SU79P, 23 September 1883 & September 1886, G. C. Druce (**ABD, BEL, BIRM, BRISTM, BM, CGE, DBN, E, MANCH, OXF, RNG**, Druce 1927). 14 September 1893, D. C. O. Adams (**BM**). September 1896, G. C. Druce (**NMW**). Growing on steep chalky banks on the lower slopes, 16 August 1913, E. M. Reynolds (**BIRA**). 4 September 1919, T. J. Foggit (**BM, HDD**). September 1921, M. L. Wedgwood & G. C. Druce (**MBH**, Wedgwood 1945). September 1927, D. M. Heath & R. Butcher (**BIRM**). September 1927 & September 1928, G. C. Druce (**BM, K, MBH, OXF, NMW**). 10 September 1933, J. E. Lousley (**BIRM, E, NMW, RNG**). 12 September 1946, N. D. Simpson (**BM**). Not refound, 4 September 1998, AM & JC.

Dame Alice [Alys] Farm, SU69W: 1895, J. Rose (Druce 1927).

Earlwood, near Rotherfield Greys, SU78H: 1963, V. N. Paul. Not refound, 27 August 2001, AM & JC.

Eversdown Valley, Middle Assendon, SU78M: 1970–1979, V. N. Paul. 1979, G. Bellamy. 1980, R. S. R. Fitter (**BBONT** 1997). 1980, J. P. Verge. 1992, NCC. 91 plants, 20 August 1998, AM & JC.

Harpsden, grassland on chalk/Henley golf course, SU78K: September 1954, A. Arrett (**RNG**). 1961, B. Kemp. 1973, V. N. Paul. Not refound, 27 August 2001, AM & JC.

Howe Hill/Howe Wood, SU69V: Plentiful, undated, G. C. Druce (Druce 1927). 13 August 1949, E. F. Warburg (**LTR, OXF**). 13 September 1953, J. E. Lousley (**RNG**). June 1955, E. F. Warburg. 28 September 1955 and long grass on open scrubby hillside, 9 September 1956, N. M. Pritchard (**ABD, OXF**). Undated (Killick *et al.* 1998). *c.* 100 plants, 17 September 2001, AM & TR (**NMW**).

Kingston Blount ('Kingston Hill' of Syme 1872–1893), SU79P: 14 September 1842 (**BM**). 76 plants, 23 August 2004, AM & TR (**NMW**).

Nettlebed, Warburg Reserve, SU78E & I: 4 September 1983 & 1985, T. H. Fowler. Both tetrads, 1992, NCC. 1000+ plants, 27 August 2001, AM & JC (**NMW**). Not refound in Tetrad I, 21 August 2003, AM.

Oakley Hill, SU79P: 1968–69, and 1986–1988, R. S. R. Fitter. 5000+ plants, much introgression, 17 September 2001, AM (**NMW**).

Pyrton Hill, SU79C: 1986, D. Ferguson. Not refound, 23 August 2004, AM & TR.

Shirburn Hill, SU79C: 1986, A. Brickstock. 1986. 22 September 1991, H. J. Killick. Not refound, 17 September 2001, AM & TR.

Swyncombe Downs, SU69Q & V: 1961, J. A. Cole. 1970. 1971, L. E. Cobb. Undated (Killick *et al.* 1998). 205 plants and possibly hybrids, 18 August 1998, AM & JC. Possibly with hybrids, 1 September 1999, H. J. Killick.

Watlington Hill, SU79B: 1858, R. F. Norris. September 1897, G. C. Druce & J. Bull (**BIRM, BM, CGE, K, NMW, OXF**). 13 September 1953, J. E. Lousley (**RNG**). 1961, J. A. Cole. 1968, D. B. Eyre. 32 flowering plants, 27 August 2001, B. Laney & C. Cody. *c.* 700 plants, 17 September 2001, AM & TR (**NMW**).

Whitehill Shaw, SU79F: 1986, D. Ferguson. 151 plants, 23 August 2004, AM & TR (**NMW**).

Wormsley, SU79H: 1961, E. Nelmes. Undated, Mrs Coker Beck (Druce 1927).

SU68A: A record for Battle House, 1979, is unconfirmed and maybe the source of the Killick *et al.* record. Not refound, improved pasture, 24 August 2004, AM & TR.

SU78D: No details traced and undated (Killick *et al.* 1998).

SU79M: Near Wellground Farm, undated (Killick *et al.* 1998). No access, 2004, AM & TR.

SU79N: Stokenchurch, NW of, undated (Killick *et al.* 1998). Details not traced, access restricted and not refound, 2004, AM & TR.

SU79L & R: Ibstone, undated (Killick *et al.* 1998). Details not traced, access restricted and not refound, 2004, AM & TR.

[Records for Bozedown (SU67N), Fiddle Hill (SU68A), Hungry Hill Wood (SU79G), Queen Wood, Priors Grove (SU79B & G), Swan Wood (SU68X), Warren Bank (SU68M), and SP70F from Oxon BRC are unconfirmed, not refound and not accepted, 2004, AM & TR. The record for near Finstock SP31: 1954, C. C. Townsend mapped in Preston *et al.* 2002 is a data extraction error (pers. comm. C. C. Townsend, 2002). A record for 'Cotswolds', 18 September 1955, O. Buckle (**K**) is assumed to be an error for the Chilterns.]

BUCKS (V.C. 24).

Ashfield Barn, near Turville (including Ibstone House Wood), SU79Q: 1967, NCC. Grassland, 27 September 1972, M. T. Horwood, (BBONT 1997). Not refound, 7 September 1998, AM & JC and 23 August 2004, AM & TR.

Aston Clinton (Ragpits), SP81V: 1872, H. Harpur-Crewe (Britten 1872; Druce 1926). September 1898, G. C. Druce (**OXF**). 1966–1981, Godwin (BBONT 1997). 1000s of plants, 27 September 1977, J. Martin & R. J. Pankhurst (BBONT 1997). Not refound, 26 August 1998, AM & JC.

Aston Hill, SP81V: 1848 (**OXF**, Druce 1926).

Bacombe Hill, near Wendover, SP80T: 12 October 1904, A. Wallis (**BM**). Not refound, 6 September 2003, AM & JC.

Beacon Farm Field, SU88J, 9 October 1986, J. Simons (BBONT 1997). 4000+ plants, 21 August 1998, AM & JC (**NMW**).

Beacon Hill, Ellesborough, SP80I: 1897, G. C. Druce (**OXF**). In abundance, August 1913, G. C. Druce (**OXF**, Druce 1926). Chalk pasture at the foot of, 26 August 1913, F. L. Foord-Kelcey (**CGE, K, NMW, OXF**). Not refound, 25 August 1998, AM & JC.

Bellows Hill, SU79Z: Undated (BBONT 1997).

Bennett End, Radnage, SU79Y: 1976, C. Hole. Not refound, 2004, AM.

Bledlow Great Wood, SP70Q: 1981, English Nature (BBONT 1997). 1986, H. J. M. Bowen (BBONT 1997). No suitable habitat remains, 2002, AM.

Bledlow, SP70Q: Undated, H. Wallis, also seen by G. C. Druce (Druce 1926).

Bloom Wood, S of, SU88U: 10 October 1941, H. Wallis (**OXF**). Not refound, 28 August 2002, AM.

Bolter End, near, calcareous grassland, SU79W: 1966 (**AYBY**).

Bradenham, road verge, SU89I: 1967. Not refound, 6 September 2004, AM.

Buckland, SP81W: 1863, H. Harpur-Crewe (**BM**; Britten 1872, Druce 1926). 8 August 1864, H. Harpur-Crewe (**BIRM, BM, BON, CGE, OXF**).

Bufflers Holt near Buckingham (also known as Stonepit Hill), SP63S: Disused limestone quarry, undated, W. Walker (Britten 1872; Druce 1926). Not refound, 26 August 2001, AM & JC.

Buttler's Hangings, SU89D: 1970–73, J. Buchanan. 1973, M. T. Horwood. 1978, R. S. R. Fitter (BBONT 1997). 1979, T. Williams. 1980, J. Roberts. 1981, C. Smith & K. Ibberson. 1983, M. Young (BBONT 1997). 1987, M. Young. 3 September 1988, E. Britnell & B. Marcan. 1988 & 1989, A. Lack (BBONT 1997). Population estimated in the 100s, 1996, M. Young & R. Maycock (BBONT 1997). 2000+ plants, 22 September 2001, AM (**NMW**).

Cadmere End Common, small chalk pit, SU79W: 29 September 1957, R. A. Boniface (**NMW**). Not refound, 2 September 1998, AM & JC.

Cheddington, SP91D: Chalk Pit, 25 August 1963, Lady Barlow, J. Easton & V. G. Scott. 1965, R. S. R. Fitter (BBONT 1997). August 1965, S. Cowdy (Ambrose & Marcan 1965). 29 July 1981, English Nature (BBONT 1997). 25 August 1986, V. G. Scott (BBONT 1997). 3000+ plants, 11 September 2001, AM & JC (**NMW**).

Chequers, SP80H: 9 July 1985, H. Smith (BBONT 1997). Along Cradle footpath, undated, J. Green. Only *G. amarella* and hybrids, September 1997, R. S. R. Fitter. Not refound, 30 August 2003, AM & JC.

Cock Lane Cemetery, SU89W: 1986, M. Young (BBONT 1997). Population estimated in the 100s, 1996, M. Young (BBONT 1997). Not refound, c. 250 plants of hybrid swarm only, 2 September 2001, AM & JC.

Commonhill Wood SSSI, SU79L: 10 September 1986, D. Webb & J. R. Simons. 9 September 1987, D. W. Soden & S. J. Leach. 7 plants, 23 August 2004, AM & TR.

Concord (including Barn Wood/Boswells/Steep Blackmores/The Lee/The Patch/Whitefields, possibly more than one site), SP80Y: 22 September 1957 (**AYBY**). July 1963, S. Cowdy. 28 July 1964, S. Cowdy (Ambrose & Marcan 1964). 14 August 1965, Buckinghamshire Archaeological Society, August 1965, S. Cowdy (Ambrose & Marcan 1965). Poor year, 8 August 1966, S. Cowdy (Marcan 1966a). 8 September 1968, G. Glover. 1973, S. Cowdy. July 1975, A. Swaine. Not refound, 25 August 2001 & 25 August 2004, AM & JC.

Dancersend Waterworks, SP90E: 1980, S. Cowdy. 1986, H. Smith *et al.* c. 500 plants, 8 September 1998, AM & JC.

- Dancersend, SP90E: 29 July 1943, J. E. Dandy (**BM**). Plentiful vegetative rosettes, 14 June 1944, J. E. Lousley (**RNG**). 1951, M. Rothschild. 17 August 1952, G. Taylor (**BM**). 1958, R. S. R. Fitter (**BBONT** 1997). Rides in new plantation on former chalk scrub, 17 September 1960 (**BM**). August 1965, S. Cowdy (Ambrose & Marcan 1965). 1968, H. J. M. Bowen. 1973 & 1974, A. Mount. 27 September 1977, J. Martin & R. J. Pankhurst. 1980 & 22 August 1982, R. M. Bateman. 1986 & 1987, M. T. Horwood (**BBONT** 1997). 1 September 1987, D. W. Soden. Population numbers in 100s at both main sites, 1996, M. Jones (**BBONT** 1997). *c.* 750 plants, 8 September 1998, AM & JC.
- Danesfield/Medmenham, SU88C: Undated, J. C. Melvill (Britten 1872; Druce 1926). 11 August 1945, E. F. Warburg (**LTR**, possibly introgressed). Not refound, 1 October 2004, AM & JC.
- Daws Hill/Janes Field, SU79Z: 1973, M. T. Horwood. 1000+ plants, 26 August 2004, AM & JC (**NMW**).
- Drayton Beauchamp, SP91B: 1863, August 1869 & 30 August 1873, H. Harpur-Crewe (**BM**, **DBN**, **K**, Britten 1872, Druce 1926).
- Eversdown Valley, Woodend Cottage, SU78N: 1980, R. S. R. Fitter (**BBONT** 1997). 1984, M. T. Horwood *et al.* Good patch by footpath, 1997, W. Gray. 9 plants, 20 August 1998, AM & JC.
- Fawley, SU78N: October 1972, M. T. Horwood. No access.
- Fawley Bottom Farm Orchard, SU78N: 27 July 1981, S. Scoggins. 1985, A. Brickstock. 1995, R. D' Ayala (**BBONT** 1997). Masses, 1997, W. Gray. *c.* 2000 plants, 20 August 1998, AM & JC.
- Fawley Bottom Wood, SU78N: 10 September 1991, R. Maycock & A. Woods. 11 plants, 1 October 2004, AM & JC.
- Fawley Church, near, SU78N: 9 August 1961, U. K. Duncan (**E**). Not refound though two other populations known nearby, 21 August 2003, AM.
- Fingest, SU79Q & V: 20 September 1931, C. R. Metcalfe (**K**). Grass bank, 1942, H. Wallis (**OXF**). 11 September 1954, D. H. Kent. September 1955, E. Bull (**AYBY**). 1966, A. Wootton. 1968, A. Woodward. Chalk downland turf slope, 15 September 1973, E. C. Wallace (**RNG**). 2 October 1976, S. R. Diserens. Chalk roadside, 18 September 1980, R. P. Libbey (**LTR**). 1980, Cunningham. 1980, J. Roberts. 1980 (**BBONT** 1997). 1982, A. J. Byfield. 1986, T. H. Fowler (**BBONT** 1997). 1986, A. Brooks & D. Ferguson. 24 September 1989, E. Norman (**BBONT** 1997). 21 plants, 18 August 1998, AM & JC.
- Fingest, scrub above, SU79Q: 31 August 1968, D. B. Eyres. 5 September 1986, D. Webb & A. Brooks. 200 plants, 23 August 2004, AM & TR (**NMW**).
- Flowery Field, SU88P: 1980, English Nature (**BBONT** 1997). 1986, N. Goldsmith & M. M. Dahl. Not refound, 20 August 1998, AM & JC.
- Forty Green, railway embankment, SU99F: 1969, W. Langham (Marcan 1970). Not refound, 20 September 2004, AM & JC.
- Further Bellows Hill, SU79Z: 1971, J. Buchanan. Not refound, 26 August 2004, AM & JC.
- Gillfield Wood, SU89Q: 20 September 1986, T. & V. Marshall (Marcan 1987). July 1991, (**BBONT** 1997). Not refound, 1997, A. J. Showler (**BBONT** 1997).
- Gomm Valley, SU89W: 1992, M. Young (**BBONT** 1997). Not refound, 2 September 2001, AM & JC.
- Gray's Lane Bank, Wormsley/Ibstone Common, SU79L: 1 August 1971 & 30 August 1972, J. Buchanan. 2000+ plants, 6 August 2004, AM & JC.
- Hale Wood, SU79L: 1966, S. Cowdy. 1986 (**BBONT** 1997). 1987, NCC (**BBONT** 1997). Not refound, 18 August 1998, AM & JC.
- Hale Wood, Wendover, SP80Y: 1957, R. S. R. Fitter (**BBONT** 1997). August 1965, S. Cowdy (Ambrose & Marcan 1965). Poor year, 8 August 1966, S. Cowdy (Marcan 1966a). 1967. Not refound, 25 August 1998, AM & JC.
- Hanover Hill Farm, opposite Mousells Wood, SU79V: 1982, Hammerton. 3 September 1986, A. Brooks & D. Ferguson (**BBONT** 1997). Not refound, site improved, 23 August 2004, AM & TR.
- Hartmoor Wood, Ibstone, SU79M: 6 plants in a small glade, 22 September 2001, AM.
- Hatches Bank/Juniper Hill Plantation, Great Kingshill, SU89T & U: 1960, E. J. Byrne (Hyde 1961). Extremely abundant, 26 August 1966, E. J. Byrne (Marcan 1966b). 1986, J. Buchanan. 40 plants in scrubby glade (SU89U), and 300 plants in second glade (SU89T), 6 September 2004, AM (**NMW**).
- High Heavens, meadow, SU88J: 1986–87, N. Goldsmith. 6 August 1987, C. Catling. 90 plants, 21 August 1998, AM & JC.

- High Heavens, site 2, SU88P: 84 plants, 21 August 1998, AM & JC.
- High Wycombe – Little Marlow, SU88U: 7 October 1944, D. E. Kummins (**RNG**).
- High Wycombe, Carver Hill/Desborough Fields, SU89L: 1986, E. Britnell (Marcan 1987). 15 October 1986, B. Marcan. 4 September 1988, B. Marcan. 2 October 1996, W. Gray (BBONT 1997). Not refound, 28 August 2002, AM.
- High Wycombe, Green Street, SU89L: ‘On the many of the chalky commons around High Wycombe as on Keep Hill, Green Street, etc.’ (Britten 1872; Druce 1926). Not refound, 2 September 2001, AM & JC.
- High Wycombe, Keep Hill, SU89Q: August 1868, E. Chandler (**CGE**). September 1868 (**BM**). ‘On the many of the chalky commons around High Wycombe as on Keep Hill, Green Street, etc.’ (Britten 1872; Druce 1926). August 1908, J. Britten (**BM**). 10 October 1941, H. Wallis (**OXF**). Not refound, 2 September 2001, AM & JC.
- High Wycombe, SU89: 1878, Miss Giles (**OXF**).
- High Wycombe – Lane End, rough chalk slope, SU89G: 30 August 1953, N. Y. Sandwith (**K**).
- Holtspur Bottom/Holtspur Bank, SU99A: 1893, W. H. Summers (Druce 1926). 8 October 1941, H. Wallis (**OXF**). 1968, S. Cowdy. 1969. 20 August 1986, D. Webb. 80–100 plants, 21 August 1998, AM & JC.
- Homefield Wood, SU88D: 22 August 1948, J. E. Lousley (**RNG**). 1950, R. A. H. Graham. 1977, E. Byrne. 18 May 1984, T. Williams (BBONT 1997). 1988, K. R. Stevenson. 1997, N. Smith. 1998. c. 500 plants, 20 August 1998, AM & JC.
- Hughenden Valley, Friars Garden, SU89T: 1971, K. J. Lunnon (Marcan 1972). Not refound, 8 October 2004, AM.
- Ibstone, SU79R: 1967, P. Burrows (Marcan 1972).
- Kits Wood scrub, West Wycombe, SU89H: 1954, F. Ambrose (Hyde 1954). 1973, M. T. Horwood. 1977, B. Marcan. 28 June 1978, T. Marshall. 1986, B. Marcan (BBONT 1997). 1987, D. W. Soden. 19 August 1987, E. Britnell, R. Hatch & B. Marcan. 25 September 1987, D. W. Soden. 1996 (BBONT 1997). 2000–3000 plants, 11 September 1997, A. J. Showler (BBONT 1997). 1999, W. Gray. 1000+ plants, 27 August 2001, B. Laney. c.2000 plants, and second population c. 200 plants, 22 September 2001, AM (**NMW**).
- Kop Hill Quarries, SP80B: 20 August 1985, D. Ferguson. Not refound but hybrids present, 24 August 1998, AM & JC.
- Little Kimble, SP80I: 20 September 1916, M. L. Wedgwood (**MBH**, Wedgwood 1945).
- Lodge Hill, near Bledlow, SP70V: 4 September 1979, A. Colmer. Not refound, only hybrids, 4 September 1998, AM & JC.
- Lower Barn SSSI, SU79L: 9 September 1987, NCC England Field Unit.
- Lydalls Wood, SU79H: 27 August 1981. Not refound, no access, 7 September 1998, AM & JC.
- Manor Farm, SU79L: 27 September 1972, M. T. Horwood (BBONT 1997). Not refound, 18 September 1998, AM & JC.
- Marlow Chalk Pit, SU88N: 1926, Wallis (Druce 1926). Not refound, 26 August 2004, AM & JC.
- New House Farm, SU89P: 1973, M. T. Horwood.
- Newlands Park, Shire Lane, TQ09C: In some profusion, known to me for many years on slope of old grassland among blackthorn and hawthorn bushes, 1950 & 7 September 1957, R. F. Turney (**K**). Not refound, 24 August 2001, AM & JC.
- Old Hill, SU79V: October 1986, B. North. 1000+ plants, 23 August 2004, AM & TR.
- Paradise Wood, by, SU78I: 400 plants in small area of scrub, 30 August 2004, AM & JC (**NMW**).
- Parkwood, Bradenham Bank (Small Dean Lane), SU89I & J: Undated, G. C. Druce (Druce 1926). 26 August 1964, M. Humphrey (Ambrose & Marcan 1964). 1966, A. Wootton. 1967. 18 June 1967, J. Humphrey. 1968, B. Marcan. 15 July 1970, J. Buchanan. 1970–75, C. Hendry. 1981. 27 October 1984, H. J. M. Bowen. 1986, A. Mayled. 1986, B. Marcan & R. Hatch. 1987, M. Young. 29 August 1987, A. J. & J. M. Showler. 1996, M. Young (BBONT 1997). 500–600 large plants, 1997, A. J. Showler (BBONT 1997). c.100 plants, 25 August 2001, AM & JC. 120 plants, 25 August 2004, AM (**NMW**). Second population not refound, 6 August 2004, A. McVeigh & J. Hodgkins.
- Parkwood, SW of, Bradenham, SU89E & J: October 2001, A. J. Showler. c.100 plants, 15 September 2002, AM.
- Penley Wood, SU79S: September 1902 (**BM**). September 1904, G. C. Druce (**BM**, **BRISTM**, **CGE**, **NMW**, **OXF**; Druce 1926). 5 September 1939, H. Wallis (**RNG**). c. 40 plants, 22 September 2001, AM (**NMW**).

- Perks Lane Corner, SU89U: 1973, M. T. Horwood. Not refound, 25 August 2001, AM & JC.
 Piper's Hanging Wood, below, SU89D: 3 July 2004, J. Buchanan. No access 2004.
 Pitstone Hill, SP91M: 27 August 1977, J. A. Colmer. 1980, R. M. Bateman (BBONT 1997). Not refound, 27 August 1998, AM & JC.
 Pound Wood, Cadmore End, SU79W: In chalk scrub, 1966, B. North (AYBY). Both sides of M40, October 1986, B. North (BBONT 1997). Not refound, 2 September 1998, AM & JC.
 Prestwood Picnic Site, SU89U: 6 September 1987, A. J. & J. M. Showler (BBONT 1997). 10 small plants, 11 September 1997, A. J. Showler (BBONT 1997). 25 October 1990, A. J. Showler & R. Maycock. 32 plants, 30 August 1998, AM & JC.
 Richmore Hill Bank, Wormsley, SU79L: 9 September 1987, D. W. Soden & S. J. Leach.
 Sands Bank, SU89G: 1974, E. Britnell. 7 September 1985, B. Marcan. 1986, J. W. G. Gutch. 1986 & 1987, E. Britnell. 1993, A. Idle (BBONT 1997). 121 plants, 1997, A. J. Showler (BBONT 1997). c. 250 plants, 2 September 2001, AM & JC (NMW).
 Seerhill Plantation/Clappins Lane, SU89P: 1971, K. J. Lunnon (Marcan 1972). 1977, E. J. Byrne. Not refound, 2 September 2001, AM & JC.
 Slough Bottom Farm, SU89D: 1973, M. T. Horwood. 1986, (BBONT 1997). Not refound, 25 August 2001, AM & JC.
 Spencers Green, Crong Meadow, SP90E: 30 September 1987, D. W. Soden. 50 plants, 8 September 1998, AM & JC.
 Stokenchurch, SU79N: 1968.
 Swains Wood, SU79G & L: 23 August 1970, M. T. Horwood. 12 August 1979, C. R. Huxley. 1979, T. Williams. 16 July 1987, D. W. Soden. Between 100 and 1000 plants, 1996, R. D' Ayala (BBONT 1997). c. 2000 plants, 18 August 1998, AM & JC.
 The Hale, near, SP80Y: 28 September 1987, D. W. Soden. 27 plants on chalk bank, 25 August 1998, AM & JC.
 Turville Hanging, SU79L: 1979, J. Buchanan & T. Williams. One plant, 23 August 2004, AM & TR.
 Turville Heath, SU79K: 1961, J. A. Cole. Not refound, 17 September 2001, AM & TR.
 Turville Hill, SU79Q: 1963, I. M. Walker (Ambrose 1964). 29 August 1977, J. Roberts. August 1979. 1981 (Marcan 1982). 1982, Hammerton. 1983, A. Beddow. 1984, M. R. Hughes. 30 August 1986, T. H. Fowler. 22 August 1987, J. Roberts. 11 & 14 September 1987, D. W. Soden. 1987 (BBONT 1997). 24 August 1988, L. Adams & G. Yeoman. 1996, R. D' Ayala & N. Snell (BBONT 1997). 100s present in the horse grazed paddock, 1997 (BBONT 1997). 750+ plants, 7 September 1998, AM & JC.
 Vickery's Field/Upper Aston Hill, Aston Clinton, SP80Z: 1967. 30 May 1980, S. Cowdy & M. Richard. Not refound, 25 August 2004, AM.
 Wendover, Steep Hill near (assume Bacombe Hill), SP80: 12 October 1904, A. Wallis (BM).
 West Wycombe, N of, SU89H: 25 September 1987, D. W. Soden. No access, not refound, 30 August 2003, AM & JC.
 West Wycombe, railway line, SU89H: 21 plants, 28 September 2001, A. J. Showler.
 Whiteleaf Cross, S of, SP80H: 20 September 1985, D. Ferguson (BBONT 1997). Not refound, 24 August 1998, AM & JC.
 Winchbottom Bank, SU89Q: 1967. 1971, P. Knipe. 1973, M. T. Horwood. September 1986, B. Marcan. 9 July 1987, R. Hatch & B. Marcan. 1995, M. Young (BBONT 1997). 100s of plants, 1997, A. J. Showler (BBONT 1997). No access, 10 September 2001, AM & JC.
 Windsor Hill, SP80G: 1967, S. Cowdy. 1979 & 1987, M. T. Horwood (BBONT 1997). 1991 (BBONT 1997). 1995, M. Young. Not refound, possible misidentification of *G. amarella* suspected, 30 August 1998, AM & JC.
 Windsor Hill (Risborough Cop North), SP80G: 1973, M. T. Horwood. Not refound, 25 August 2004, AM.
 Yoesden Bank, SU79Y & Z: 1971, J. Buchanan. 1973, M. T. Horwood. 1985–86, D. Ferguson. 18 September 1986, J. Buchanan. 1996, D. Ferguson (BBONT 1997). 11 September 1996, W. Gray. Two populations with 500+ plants and 1000s of plants, 6 September 1998, AM & JC.
 [The Aston Abbots, 1864, A.G. More record in Druce (1926) refers to Tring; see *Thirsk Botanical Exchange Club* 10, 1864. Brimmers Lane Reservoir, SP80G: 5 plants, 16 August 1998, W. Gray. Not refound, probable misidentification, 25 August 1998, AM & JC. Ivinghoe Hills, SP91T: 1973, 1978 & 1987 (BBONT 1997). Not refound, 26 August 1998, AM & JC; almost certainly an error from this very well known site. Lacey Green Churchyard, SU89J: 1987 (BBONT 1997). Not

refound and likely to have been an error, 25 August 2001, AM & JC. Rivenoak Farm, SU79Y: 50 plants, 14 October 1997, W. Gray. Not refound, probable misidentification, 2 September 1998, AM & JC. Upper Wardrobes & Pink Hill, SP80A: 1 plant, 1996, W. Gray. Not refound, probable misidentification, 25 August 1998, AM & JC.]

BEDS (V.C. 30)

Chalton Cross, chalk pit, TL02I: 24 August 1889, J. Saunders (**LTN**; Dony 1953). 20 August 1891 & 5 August 1893, D. M. Higgins (**BM, BRISTM, CGE, DBN**). Old chalk pit, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 15 September 1984, C. R. Boon. 1987, J. G. Dony. 8 plants, 31 August 2003, AM (**NMW**).

Dog Kennel Downs, Dunstable, TL02G: 2004, confirmed G. Bellamy. Not refound, 8 October 2004, AM.

Dyers Hall, TL02P: 100+ plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). c. 750 plants with hybrid, 16 September 2001, AM & JC (**NMW**).

Harlington (including old chalk pit), TL02P: 17 & 19 August 1894, 7 August 1895, 17 August 1901, 6 August 1903, 8 August 1903, 14 August 1906, August 1907, 25 & 30 August 1909 & August 1911, D. M. Higgins (**BIRM, BM, BRISTM, CGE, DBN, E, LTR, K, MANCH, OXF, RNG**). 31 August 1949, J. G. Dony & R. H. Goode (**LTR**). 29 August 1959, D. P. Young (**BM**). 100+ plants, 1970, J. G. Dony (NCC Rare Plant forms). 1985. Not refound, 16 September 2001, AM & JC.

Houghton Regis, chalk pit near, TL02B: 1977–1978, J. G. Dony (C. R. Boon Database). 1986, J. G. Dony. 30 plants, 24 September 2004, AM & JC.

Streatley, TL02U: 1970, J. G. Dony. Not refound but hybrids present, 16 September 2001, AM & JC.

Sundon, near (including old chalk workings), TL02I, N & P: 10 August 1901, D. M. Higgins (**CGE**, as near Luton). 19 August 1905, D. M. Higgins (**E**). 1923, Lady J. C. Davy (**OXF**). September 1941, G. K. Long & J. G. Dony (**LTN**). Locally plentiful in a few old chalk pits near Sundon, 1943, J. G. Dony (**LTN**, Dony 1946, 1953). 1 September 1946, P. Taylor & J. E. Lousley (**K, RNG**). 24 August 1946, J. G. Dony (**BM**). 1968, J. G. Dony. Many thousands of plants extending over a system of spoil heaps, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 18 September 1977, C. R. Boon. 24 July 1982, O. M. Stewart (**E**). 5 August 1986, A. N. Gagg. 1987, J. G. Dony. 430,304 plants, 18 August 1988, J. Plumridge (NCC Rare Plant forms). Population by sewage works not refound, 16 September 2001, AM & JC. Thousands of plants in chalk workings, 17 September 2001, AM & JC. Tetrads TL02I & N, 8 October 2004. AM.

[Ravensden Hill, TL05X: c. 1906, E. M. Langley, rejected by Dony (1953)].

[PEMBROKE (V.C. 45)

Recorded in error in Druce (1932).]

[FLINTS (V.C. 51).

As Wynne (1993) pointed out, the following three records should be viewed with suspicion, and are not accepted in the absence of vouchers: G101, limestone common skirting the road east of, September 1907, T. J. Walshe & A. A. Dallman (Dallman 1908). The Graig, Tremeirchion (Dallman 1910). The Marian, Cwm, Mrs MacDonald (Dallman 1908).]

[DERBY (V.C. 57)

No material has been traced to support the Castleton, Fallgate, c. 1909–1910 record of Drabble & Drabble (1911) and it is rejected.]

[NORTH-WEST YORKS (V.C. 64)

Records for Ripon on the authority of Grisebach (e.g. Luxford 1844, Brown 1844) are based on an ambiguously labelled herbarium sheet in **K** with both *G. amarella* and *G. germanica*; the only clearly labelled plant from Ripon is *G. amarella*.]

[ARGYLL (V.C. 101)

A specimen labelled Kilberry, September 1931, E. M. Macalister-Hall (**E**) is assumed to be a labelling error.]

APPENDIX 2

RECORDS OF *GENTIANELLA* × *PAMPLINII*

[NORTH WILTS (V.C. 7)

Stace *et al.* (2003) in error for v.c. 8 South Wilts.]

SOUTH WILTS (V.C. 8)

Mere Down, ST83G: 8 September 1891, E. F. Linton (**BM**; Grose 1957). 12 September 2001, TR (**NMW**).

Shalbourne, chalk pit, SU36B: October 1910, August & September 1913, C. P. Hurst (**CGE**, **MANCH**, **OXF**; Grose 1957). Not refound – two pits located during search both filled in or in alternative use, 22 August 1999, AM & JC.

NORTH HANTS (V.C. 12)

Ashmansworth, SU45E: 9 September 1914, 15 June & 15 September 1915, 15 September 1918, W. C. Barton (**BIRM**, **BM**, **BRISTM**, **CGE**, **K**, **LTR**, **MANCH**, **OXF**, **RNG**). 30 plants, 24 August 2004, A. R. G. Mundell.

Ashmansworth, chalk quarry, SU45E: On steep slopes of quarry, 4 October 1955, N. M. Pritchard (**ABD**). Site unknown, not investigated.

East Woodhay, in a deep grazed field and on side of road on chalk, 4 October 1955, N. M. Pritchard (**ABD**; Brewis *et al.* 1996). Site unknown, not investigated.

Ecchinswell, chalk pit near, SU55E: 10 & 21 September 1896, 22 September 1897, A. B. Jackson (**BIRM**, **BM**, **CGE**, **OXF**). Not refound, 21 August 1999, AM & JC.

Facombe, south of, SU35Y: Introgressed population of *G. ×pamplinii* and *G. amarella*, 22 August 1999 & 4 September 2001, AM & JC. Second subpopulation not refound 4 September 2001, AM.

Great Litchfield Down, disused railway, SU45S: 1980, R. P. Bowman (Brewis *et al.* 1996). 21 August 1999, AM & JC.

Seven Barrows A34 verge, SU45S: Abundant, 22 August 1999, AM & JC.

Sydmonton, chalk pit (North Sydmonton, Watership chalk pit), SU46W: 21 September 1895, A. B. Jackson (**BM**, **CGE**, **MANCH**, **OXF**; Brewis *et al.* 1996). Not refound, 24 August 2002, AM & JC.

EAST KENT (V.C. 15)

Deal, TR35Q: Dry, grassy, chalk bank, ex herb. N. D. Simpson, 1902 (**BM**). Not refound in general search around Deal, 9 September 2001, AM & JC.

Lyminge, chalk bank, TR14Q: August 1885 (**LTR**). Site unknown, not investigated.

HERTS (V.C. 20)

Aldbury Downs, SP91R: 2 October 1929, C. E. Salmon (**BM**). September 1913, E. J. Salisbury (**K**). 1923, P. Richards (**OXF**). Not refound, 11 September 2001, AM & JC.

Oddy Hill, Wigginton, SP91F: Undated, W. H. Coleman (**BON**). 29 August 1988, M. Demidecki (T. J. James database). 29 August 1998, AM & JC.

MIDDLESEX (V.C. 21)

Harefield, Garrett Wood (including Springwell chalk pit), TQ09L: 1950 (Burton 1983; Kent 2001). Listed as extinct by Kent (2001) and not refound, 13 September 2002, AM.

BERKS (V.C. 22)

Coombe Hill, SU36Q: Undated (Druce 1918). Not refound, area improved, 27 September 2004, AM & TR.

Letcombe Basset, SU38S: In short turf, mostly *Brachypodium*, 19 September 1956, N. M. Pritchard (**OXF**, Bowen 1968). Not refound, 23 August 2001, AM, JC & TR.

Letcombe Castle, SU38X: September 1892, G. C. Druce & B. Taylor (**OXF**; Druce 1893, 1896, 1897). 9 plants with 2 *G. amarella*, 5 September 1998, AM & JC. Ramparts, *G. germanica* with hybrids, 2000, P. Wilson. 3 intermediates, with *G. amarella*, 23 August 2001, AM, JC & TR.

Rivar Copse, base of, SU36L: September 1913, C. P. Hurst (**OXF**; Bowen 1968). Not refound, 7 October 2001, AM & JC.

Streatley, chalky hillside near, SU58K & V: In great quantity, 13 August 1937, H. J. Riddelsdell (**K, MANCH**). Not refound at Lough Down (Lardon Chase) or The Holies, 14 September 2002, AM.

Walbury Hill, SU36Q: 1975, M. Boniface & V. Field (Brewis *et al.* 1996). Not refound, 22 August 1999, AM & JC or 27 September 2004, AM & TR

OXON (V.C. 23)

Bald Hill, SU79H: 1972, A. J. Richards (Killick *et al.* 1998). Not refound 7 September 1998, AM & JC.

Beacon Hill, SU79I: Scrubby long grass, only 3 plants found, 9 September 1956, N. M. Pritchard (**ABD, OXF**; Killick *et al.* 1998). Not refound, 7 September 1999, AM & JC.

Bix Bottom, Nettlebed, SU78J: 19 September 1960, W. S. Catling (**RNG**). Site unknown, not investigated.

Chinnor, SP70Q: Undated, G. C. Druce (**OXF**). 25 September 1889, J. Curtis (**OXF**). 1954, H. J. M. Bowen. A few hundred plants with parents, 21 September 1991, H. J. Killick (Killick *et al.* 1998). Not refound, 4 September 1998, AM & JC.

Crowell Hill, SU79P: 16 August 1913, E. M. Reynolds (**BIRA**). Undated (Druce 1927). September 1927, G. C. Druce (Wedgwood 1945). 12 September 1946, H. W. Pugsley, N. D. Simpson & J. P. M. Brennan (**BM, OXF**). 1946, J. F. G. Chappel (Killick *et al.* 1998). 9 September 1956, N. M. Pritchard (**ABD**; Killick *et al.* 1998). Not refound, 4 September 1998, AM & JC.

Ibstone, SU79L: Undated (Killick *et al.* 1998). Site unknown, not investigated.

Oakley Hill, SU79P: Undated, BBONT (Killick *et al.* 1998). Much introgression, 17 September 2001, AM.

Warburg Reserve – Big Ashes Plantation, SU78E: c. 50 plants introgressed with *G. amarella*, 27 August 2001, AM & JC.

BUCKS (V.C. 24)

Aston Hill, SP81V: Undated (Druce 1926). Site unknown, not investigated.

Chequers, SP80M: September 1997, R. S. R. Fitter (BBONT 1997). No access; not refound, 30 August 2003, AM & JC.

Cock Lane Cemetery, SU89W: Hybrid swarm, c. 250 plants, 2 September 2001, AM & JC.

Eddlesborough, SP91U: September 1917, G. C. Druce (**OXF**). Not refound, 28 August 2004, AM & JC.

Ellesborough, SP80I: in a rough field nearly opposite Ellesborough Church just at the foot of Beacon Hill, 26 August 1913, F. L. Foord-Kelcey (**BM, OXF**; Druce 1926). Not refound, 25 August 1998, AM & JC.

Great Kimble (Kimble), SP80H: September 1904, 1919, G. C. Druce (**BM**; Druce 1926). September 1919, S. Redgrove (**BM**). Site unknown, not investigated.

Kop Hill Quarries, near Princes Risborough, SP80B: Introgressed population, c. 1000+ plants, 24 August 1998, AM & JC (**NMW**).

Lodge Hill, near Bledlow, SP70V: c. 75 plants, 4 September 1998, AM & JC.

Whiteleaf Cross, S of, SP80H: 24 August 1998, AM & JC.

BEDS (V.C. 30)

Dyer's Hall, TL02P: Hybrid with both parents, 16 September 2001, AM & JC.

Harlington, TL02P: 6 August 1903, D. M. Higgins (**MANCH**). Not refound, 16 September 2001, AM & JC.

Houghton Regis, chalk pit near, TL02B: With both parents, 24 September 2004, AM & JC.

Streatley, TL02U: Hybrid swarm, no good *G. germanica* present, 16 September 2001, AM & JC.

Sundon, TL02I, J, N and P: 25 September 1926, T. J. Foggitt (**BM**). 1 September 1946, P. Taylor & J. E. Lousley (**K**). Large chalk working, with both parents, 16 September 2001 and 8 October 2004, AM & JC.

LEICS (V.C. 55)

Clipsham Quarry, SK91S: October 1978, C. A. Stace (**LTR**; det. TR, non C. A. Stace). Not refound 14 September 2003, AM & JC.

