1978

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WESTERN AUSTRALIAN DEPARTMENT OF AGRICULTURE

technical bulletin

No. 43

ISSN 0083–8675
AGDEX 142/06

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Collection site data, preliminary ratings of field characteristics and disease reactions, and measurements of seed protein and oil contents

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Manuscript received June, 1978.

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by J. S. Gladstones and G. B. Crosbie

SUMMARY

Collection site data are listed for lupin wild types entered into the Western Australian Department of Agriculture collection up to 1974. The collection was grown out in 1975, and in the case of *L. angustifolius*, measurements or ratings were made of various morphological and agronomic traits, disease reactions, mean individual seed weights, and whole seed crude protein and oil contents. For other species, measurements were confined to number of days to flowering, individual seed weights, and whole seed crude protein and oil contents. The data are tabulated. Interrelations in *L. angustifolius* among some of the more important plant characters are discussed.

Seed size in *L. angustifolius* showed a bimodal distribution, with a small-seeded (individual seed weight mostly between 50 and 100 mg) group covering the whole geographic range of the species, and a large-seeded (120–200 mg) group confined to inland Iberia and northern Morocco. The large-seeded group, characterised also by coarse, intermediate to tall growth, was typically found on or around arable fields or around olive groves, and appears to have naturalised from previous cultivations. The smaller-seeded, usually finer-growing, shorter and more branching genotypes appear to represent true wild types.

Whole seed crude protein content in *L. angustifolius* was unrelated to individual seed weight, but showed a weak inverse relationship to number of days to flowering. Contents ranged from just under 32 per cent (dry matter basis) to almost 43 per cent, with some indication that subgroups exist among the Mediterranean populations having protein contents up to five per cent higher (absolute basis) than present commercial cultivars. Populations from Morocco, Italy and Israel averaged 2.0 to 2.5 per cent more protein than those from Spain and Portugal.

Seed oil contents in *L. angustifolius* were mostly within the range 4.0 to 5.5 per cent, with indications of small but fairly definite genetically based differences. Lines from the eastern Mediterranean contained on average 1.0 per cent more oil (absolute basis) than those from the western Mediterranean. Oil content was unrelated to seed size or protein content, but there was a possible slight tendency for late-flowering lines to contain more than early-flowering lines.

Within *L. angustifolius*, 67 per cent of the Mediterranean genotypes were rated as resistant, and only 12 per cent as fully susceptible to grey leaf spot (*Stemphylium vesicarium*) under moderately severe natural epidemic. Susceptibility was associated almost exclusively with the large-seeded "cultivated" types of inland Spain and Portugal.

The severity of brown leaf spot (*Pleiochaeta setosa*) in *L. angustifolius* was clearly related to growth habit: erect, vigorously-growing large-seeded genotypes being on average much less affected than short, fine-growing, much-branched "wild" types. A root rot (probably Fusarium) which appeared in mid to late spring tended to affect genotypes from mild coastal districts less than those from colder, drier, inland environments.

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Among the "rough seeded" lupins, mean species per cent protein in the whole seeds was inversely related to seed size: *L. pilosus* having the largest seeds but lowest protein contents and *L. cosentinii* the smallest seeds but highest protein contents. *L. atlanticus* and *L. palaestinus* were intermediate in both respects. All had low whole-seed oil contents, with *L. pilosus* (mean 4.9 per cent) possibly a little higher than the others.

L. micranthus had a relatively high seed oil content (mean 7.5 per cent for 3 genotypes), but only a moderate protein content. *L. hispanicus* ssp. *hispanicus* and ssp. *bicolor* both resembled *L. luteus* in seed composition. All *L. hispanicus* genotypes were late flowering. Both *L. hispanicus* and especially *L. micranthus* were very severely affected by root rot (?Fusarium) under the trial conditions.

L. pilosus and *L. atlanticus* both appear to have good agronomic and yield potential, and could warrant domestication despite their relatively poor seed compositions.

INTRODUCTION AND PROCEDURES

The Western Australian Department of Agriculture now holds a substantial collection of wild lupin genotypes, particularly of *Lupinus angustifolius*. Most originated from collecting expeditions by the senior author in southern Italy (1968) and Morocco, Tunisia, Spain and Portugal (1973). General ecological observations from the two trips have been published previously (Gladstones 1973, 1976). Of the 1973 series of collections, those from Morocco and Tunisia were collected in company with Dr. Ian Forbes of the United States Department of Agriculture. Dr. Forbes contributed an additional small series (the NS collection series, see under Spain in Appendix I), collected independently in central and north-east Spain. All initial seed material from the 1973 expedition was shared equally between the Western Australian Department of Agriculture and the United States Department of Agriculture.

Drs B. J. Quinlivan, C. M. Francis and J. S. Katznelson collected or otherwise obtained some further genotypes in Israel and Turkey, and a few others were acquired by exchange with overseas scientific institutions. Details of origin are given for all lines in Appendix I. Lines introduced after 1974 will be dealt with in a further publication.

Each field collection had an initial collection number, and subsequently a C.P.I. (Commonwealth Plant Introduction) number was assigned by the C.S.I.R.O. Plant Introduction Section, Canberra, upon entry of the main collection details into their computerised records and listing in the (Australian) Plant Introduction Review. Collection and corresponding C.P.I. numbers are included in Appendix I. Lines obtained by exchange have only C.P.I. numbers.

Although some of the lines as introduced were apparently uniform, many field collections consisted of mixtures of genotypes. These were initially sorted into their component pure lines as well as possible on the basis of visible seed characteristics, and subsequently over two years of growing on and re-selection. The task was complicated by a degree of evident natural crossing both before and after introduction, leading to the presence in some mixtures of numerous closely related genotypes. In most cases however, the component lines were clearly distinct and true-breeding.

The final collection was constituted after the second year of field sorting. Different lines under the same C.P.I. accession number were designated A,B,C etc. Every line in the final collection was then allocated a Perth accession (P) number. These are listed alongside the C.P.I. numbers in Tables 1 and 2.

In 1975 (the second sorting year for the 1973 collection series), all wild types were grown as autumn (late May)–sown unreplicated rows at Medina, Western Australia, under as uniform conditions as possible. All lines were sown on the same day and fertilising and watering carried out so as to be non-limiting. The soil carried an ample population of lupin Rhizobia following previous growth of naturalised lupins for many years. Growth was uniformly good, apart from a few exceptions noted in the text, which were mostly associated with incompletely effective nodulation. We are confident that in general the measurements and ratings made are usefully comparable.

Field data obtained for *L. angustifolius* (Table 1) were:—

(1) Number of days to flowering, scored when approximately 40 per cent of the plants in a row had opened their first flowers.

(2) Tallness, rated as 1 (very short) to 6 (very tall) in the seedling stage and again at near maturity. In general the ratings at the two stages showed good agreement, so they were combined to give a single figure.

(3) coarseness, rated on a 1 (very fine) to 5 (very coarse) scale. This was a subjective concept, based principally on stem thickness and leaflet size. The two appeared closely enough correlated (although the correlation was not complete) to be combined into one usefully descriptive term.

(4) "Leaflet width" was scored on a 1 (very narrow) to 5 (very broad) scale, as a separate term. It should be noted that this refers to apparent width, which depends both on the actual width of the leaflet when flattened and the extent to which the opposing leaflet halves are angled vertically to the midrib. In general narrower and/or stiffer leaflets form acuter (more vertical) angles, making them appear narrower than they in fact are. The term could be of significance to canopy light relations.

(5) Branching was rated from 1 (erect growth with little or no basal or mid-stem branch development) to 5 (strong and profuse branch development all up the stem, with basal branches subequal to the main stem).

(6) Pod set, rated 1 to 5, relates chiefly to the proportion of flowers on the primary inflorescence setting pods. It should be noted that results from rows do not necessarily correlate with behaviour in a crop stand. Nevertheless extreme pod set ratings are probably indicative. Lines rating only 1 appeared to have grossly subnormal pod set relative to their vegetative vigour and seed size.

(7) Pod width was rated from 1 (very narrow) to 5 (very broad), according to the depth from the dorsal to the ventral margin. Note that this indicates **potential** for seed size, but not necessarily actual seed size.

(8) Average number of seeds/pod: typical numbers were recorded for fully developed, "normal" pods formed on the primary inflorescences.

(9) Resistance to grey leaf spot (*Stemphylium vesicarium*) was recorded close to the end of the growing season, under conditions of moderately heavy epidemic encouraged by the coastal location and by periodic overhead sprinkler irrigation through the late flowering to ripening period. Because of the ready spread of the disease over considerable distances, and the uniformly good growth of the plants, the ratings could be considered fairly reliable. Recordings made in other years (not presented here) have been in good agreement.

(10) Incidence of brown leaf spot (*Pleiochaeta setosa*) was much less clear-cut than that of grey spot. Infection was mostly fairly light, and greater chance variation within the site might be expected because of the sedentary nature of the disease organism. Nevertheless, variation was present which appeared to be systematically related to plant type. Observations based on leaf lesions and leaf drop were made several times during the early and mid growing season, followed by a final rating close to maturity on the basis of stem and pod lesions. Ratings ranged from 0 (little or no sign of the disease) to 4 (heavy infection leading to considerable leaf drop and some stunting of growth in late winter, followed by large numbers of lesions on the mature stems and pods).

(11) Root rot incidence. Little root rot was evident until October–November, when variable proportions of plants in the rows showed browning of the crowns and lower stems, followed (in the worst cases) by complete rotting of the roots and collapse and death of the plants. Less affected plants wilted and senesced prematurely, and produced variably pinched seeds. The disease organism was not confirmed, but was almost certainly a *Fusarium*. Within *L. angustifolius* the disease was fairly widespread but there did appear to be systematic variation among natural groupings of genotypes. Incidence was rated as 0 (no apparent infection) to 4 according to severity and to the proportion of plants in a row visibly affected.

At maturity, seed samples were harvested from the primary inflorescences only, and the following measurements made.

(12) Mean individual seed weight in mg, determined from the mean of duplicate 40–seed subsamples. Obviously pinched or subnormally–sized seeds were rejected so as to give a better estimate of true "genetic" seed size.

(13) Pure whole-seed samples were ground, subsampled, and analysed for nitrogen content by the Kjeldahl method. Again, pinched or abnormally small seeds were rejected. The results are expressed on a dry matter basis.

(14) Similar subsamples were analysed for oil content using a wide-line NMR analyser. Before analysis, 25 g samples were dried at 103°C for 24 hours. A previous study had shown that the residual moisture content after such drying could be predicted from the initial mean weight of the individual seeds, which for *L. angustifolius* in the present study ranged from 36 to 244 mg and had predicted moisture contents after drying ranging from 1.7 to 2.3 per cent. Results were expressed on a dry matter basis.

For species other than *L. angustifolius*, field observations and measurements were confined to number of days to flowering, individual seed weights, and seed protein and oil contents (Table 2). Some species differences in susceptibility to root rot (Fusarium) are noted in the text below.

Tables 1 and 2 include data (where available) for collection site altitudes and mean annual rainfall, allowing direct comparison with the recorded plant characteristics.

Table 1—Collection site altitude and annual rainfall, and agronomic and seed composition data for *L. angustifolius* accessions.

Perth Accession number	C.P.I. number	Collection site altitude m	Collection site rainfall mm	Days to flowering	Tallness Rating 1–6	Coarseness rating 1–5	Leafiet Width 1–5	Branching rating 1–5	Pod Set rating 1–5	Pod Width rating 1–5	Average Seeds/pod	Individual seed weight mg	Seed protein content %d.b.	Seed oil content %d.b.	Grey spot resistance R, I, S,	Brown spot incidence 0–4	Root rot incidence 0–4
Western Australia—																	
P20639	....	30	800	110	4	3	3	2	3+	4	5	126	39·3	4·0	(R)*	1	1
Israel—																	
P20736	48477	....	....	95	4	3	3	3	3	3	4	129	37·6	4·6	(R)*	2	0
P22660	62261	....	....	95	4	3	4	3	4	3	4–5	103	35·5	5·4	(R)*	2	0
P22661	62278A	....	....	93	4–	3	2	3	3	3	5	128	37·6	4·5	(R)*	2	0
P21625	....	750	700	107	2	2	2	4	2	3	3	112	36·4	6·1	(R)	2	0
Turkey—																	
P21624	69983	....	....	108	4	4	2	3	3+	3+	4	128	35·9	5·6	(R)*	1	0
Italy—																	
P20655	....	....	....	103	4	3	3	3	4	3	5	103	34·6	4·8	R	1	0
P20711	47213	....	80	750	111	3	3	2	3	2–	2	6	100	39·7	5·4	R	0	0
P20712	47214A	....	5	1 100	107	5	4	2	2	3	2	5	94	39·7	4·8	(R)*	1	1
P20713	47214B	....	5	1 100	112	5	3	1	2	2	1	5–6	88	37·2	4·8	R	2	0
P20714	47215A	....	25	900	113	5	3	1	2	3	3–	6	98	37·7	4·8	R	2	0
P20715	47215B	....	25	900	111	5	3	2	1	3	2	5	102	35·2	5·1	R	2	0
P20716	47215D	....	25	900	112	5	4	2	1	3	3	5–6	117	39·1	5·2	R	2	0
P20717	47216	....	100	800	106	3	2	1	4	5–	2	5–6	86	39·9	4·7	R	3	0
P20718	47217	....	10	700	109	5	4	2	1	3	2	5–6	89	35·6	5·0	R	2	0
P20719	47218	....	300	950	114	4	2	1	2	2–3	2–3	Mixed	84	37·6	4·8	R	2–4	0
P20720	47219	....	200	900	111	5	4	2	2	3+	3–	5–6	98	36·8	5·4	I	2	0
P20721	47220	....	200	900	119	4	3	2	3	3	2	4–5	90	39·2	4·8	R	1	0
P20722	47221	....	200	900	115	4	4	2	3	3+	2	5	99	38·0	4·8	R	(0)	0
P20723	47222	....	200	950	113	5	3	1	2	4–	2	6	93	37·1	5·0	R	0	0
P20724	47223	....	100	900	116	4	3	1	3	3	2	5	86	35·5	5·4	R	1	0
P20725	47224	....	100	900	113	5	3	2	2	3	2	5–6	103	37·5	5·0	R	1	0
P20726	47225	....	100	900	108	5	3	2	2	4	2	6	80	38·1	4·3	R	2	(1)
P20727	47226	....	30	900	109	5	3	2+	2	2–	2	5+	88	37·6	5·4	(R)*	3	0
Sicily—																	
P20728	46910	....	....	....	104	3–	2	1	3	2	1	5	64	38·7	5·2	R	3	0
Spain—																	
P22664	67872A	....	900	600	113	2	1	2	3	4	2–	6	54	35·5	5·2	(R)	4	0
P22665	67872B	....	900	600	114	2	2	3	3	4	2	6	51	38·5	4·0	R	4	0
P22666	67873A	....	1 100	600	118	2	2	3	4	3	2	5–6	51	37·3	4·4	I	3	0
P22667	67873B	....	1 100	600	120	2	2	3	4	3	1	5–6	....	....	....	R	3	0
P22663	67873C	....	1 100	600	117	3+	3	3	3	3	2	6–7	67	32·7	4·6	R	1	4
P22669	67874A	....	1 050	600	120	4	4	4	2	3	3	5–6	77	33·6	5·2	R	1	0
P22670	67874B	....	1 050	600	114	4	3	2	2	2	3	5–6	87	35·6	4·7	R	1	0
P22671	67874C	....	1 050	600	114	4	3	3	3	2	2	5–6	73	36·6	3·9	R	2	0
P22672	67874D	....	1 050	600	113	4	3+	3	2	2+	4	5	....	....	....	(R)	1	2
P22673	67874E	....	1 050	600	120	2	2	2–	3	3	1	5	52	36·3	4·2	R	2	0
P22674	67874F	....	1 050	600	114	3	3	4	4	3	3	5	58	35·6	4·7	R	1	0
P22675	67875	....	1 250	800	111	1	1	3	3	3	2	6	54	34·0	5·2	(R)	4	0
P22676	67876	....	1 300	700	110	2	2	3	3	4	2+	5	67	36·6	4·9	R	4	0
P22677	67877	....	900	650	116	1	1	1	5	4	1+	5	50	37·4	4·8	R	3	0
P22678	67878A	....	1 000	700	107	4	4	3	2	3–	4+	4–5	137	35·7	3·8	S	2	3
P22679	67878B	....	1 000	700	109	5	4	2	2	3–	4	4–5	....	....	....	S	2	4
P22680	67879A	....	1 000	700	108	2	1	2	4	3	1	5–6	58	34·5	5·7	I	3	1
P22681	67879B	....	1 000	700	116	2	2	2	3	3	2	5–6	62	35·3	5·3	R	2	1
P22682	67879C	....	1 000	700	122	2	1	2	4	2+	1	5	50	36·2	5·1	(R)	3	0
P22683	67880	....	1 050	700	109	2	1	2	3	3	1	6	59	34·5	5·8	(R)	2	3

* Indicates the presence of small, undeveloped grey spot lesions.

Table I—(*continued*)

Perth Accession number	C.P.I. number	Collection site altitude m	Collection site rainfall mm	Days to flowering	Tallness Rating 1–6	Coarseness rating 1–5	Leafiet Width 1–5	Branching rating 1–5	Pod Set rating 1–5	Pod Width rating 1–5	Average Seeds/pod	Individual seed weight mg	Seed protein content % d.b.	Seed oil content % d.b.	Grey spot resistance R, I, S,	Brown spot incidence 0–4	Root rot incidence 0–4
Spain (*continued*)—																	
P22684	67881	1300	800	110	2	2	3	3	5	1	6	53	32·6	5·5	R	3	1
P22685	67882A	1 100	500	113	1	1	1	5	5	1	6	50	34·5	5·5	R	3	2
P22686	67882B	1 100	500	116	1	1	1	3	2+	1	5+	48	34·5	4·8	R	4	3
P22687	67883	1 150	600	114	2	3	3	2	4	2	5	....	....	....	R	3	0
P22687A	67884	1 200	600	115	2	3	3–4	3	4	2	5–6	62	39·8	4·8	R	3	1
P22688	67885	1 000	500	118	5	5	3	2	3	4	5	....	....	....	R	2	0
P22689	67886A	700	500	117	5	4	3	3	2	5	5	140	33·8	5·1	(R)	(1)	0
P22690	67886B	700	500	109	5	4	2	2	2	5	5	134	35·3	4·6	R	2	0
P22691	67886C	700	500	117	5	4	3	3	2	5	5	130	34·1	4·3	R	1	1
P22692	67886D	700	500	114	4	3	3	2	2	4	4–5	113	37·0	4·3	(R)	2	0
P22693	67887A	400	800	107	5	4	4	2	1+	4	4–5	158	37·8	5·1	R	1	3
P22694	67887B	400	800	105	5	3+	3	2	1	4	4–5	174	33·6	5·5	S	1	2
P22695	67888A	450	1 000	101	4	4	3	3	3+	5	4–5	188	34·8	5·3	R	1	3
P22696	67888B	450	1 000	110	5	5	3+	3	4–	4	4–5	169	34·1	4·1	R	2	2
P22697	67888C	450	1 000	110	5–	5	3	3	4	4	5	150	35·2	4·5	R	1	2
P22698	67888D	450	1 000	111	5	4	3	2	3+	4–	4	144	33·6	5·3	R	2	2
P22699	67889A	500	1 100	103	5	4	4	2	3	4	4	156	35·9	4·4	S	1	3
P22700	67889B	500	1 100	106	4	3	3	3	3	2	6	83	36·3	4·5	R	3	3
P22701	67889C	500	1 100	103	3+	3	3	3+	3	3	5	89	36·0	4·1	R	3	2
P22702	67889D	500	1 100	102	5	5	4	2	2	5	4–5	185	36·8	5·0	R	1	2
P22703	67889E	500	1 100	107	5	4	4	2	3	4	4–5	163	34·3	4·9	S	2	1
P22704	67890	500	1 000	108	3	2	2	3+	3	2	4–5	76	35·7	4·3	(R)	2	3
P22705	67891A	500	1 000	104	3	2	3	3	5	2	4–5	55	32·8	4·4	S	2	2
P22706	67891B	500	1 000	113	2	2	2	3	4	1	5	49	34·2	5·2	R	3	2
P22707	67892	400	600	109	2	1	1	4	4	1	5	49	33·6	5·3	(R)	3	2
P22708	67893A	450	600	111	5	5	5	2	2	5	4–5	137	35·4	4·4	S	1	0
P22709	67893B	450	600	109	5	4	3+	3	3+	4	5+	....	....	....	S	2	1
P22710	67893C	450	600	108	4	5	5	4	3	4+	5	133	33·6	4·2	R	2	3
P22711	67893D	450	600	110	3	3	3	3+	3	4	4–5	114	36·6	4·0	R	1	2
P22712	67894	700	800	110	4	4	3	3	2	4+	4–5	143	35·0	4·6	R	1	2
P22713	67895	800	850	116	5	4	3	2	2+	5	4–5	173	35·9	5·0	R	1	2
P22714	67896	900	900	111	5	4	3	2	2+	4	5	156	33·2	5·0	R	1	2
P22715	67897	850	900	110	5	4	3	2	2	4	4	181	32·9	5·2	R	3	3
P22716	67898A	500	650	99	5	5	4	2+	3	5	4–5	150	34·7	4·7	(R)	2	3
P22717	67898B	500	650	98	4	3+	3+	3	2	4	4–5	149	36·4	4·2	R	2	3
P22718	67899A	500	650	109	4	3	2	3	3	4	4–5	153	36·9	4·9	R	2	1
P22719	67899B	500	650	106	4+	4	3	2	2	4	4	149	35·4	4·8	R	2	2
P22720	67899C	500	650	107	5	4	3	2	1	4	4	162	36·5	4·7	R	1	2
P22721	67900	450	600	108	4	4	3	2	3+	5–	5–6	168	34·2	5·6	(R)	1	1
P22722	67901	300	550	104	4	3	3	3	4	4	4–5	137	35·9	3·9	R	(1)	2
P22723	67902	600	700	107	5	3	3	1	3	3	4–5	158	34·2	4·9	R	2	1
P22724	67903	600	700	102	5	4	3	3	2	4	4–5	147	34·8	4·8	R	1	1
P22725	67904	800	800	110	5	4	4	1	2+	4	4–5	128	35·4	4·4	S	2	3
P22726	67905A	900	850	104	4	4	4	3	4	5	4–5	135	35·0	4·1	(R)	1	1
P22727	67905B	900	850	106	5	4	3	2	3	5	4–5	140	32·3	4·7	S	1	3
P22728	67906	900	850	109	5	4	3	1	2	5	4–5	157	36·3	5·0	R	2	4
P22729	67907	550	550	103	5	3	2+	3	1	4	4	142	36·0	4·2	1*	2	2
P22730	67908	700	600	103	4	3	3	2	2	4	4–5	156	35·0	4·6	1*	2	1
P22731	67909A	800	600	100	4	3	3	3	3	4	4–5	148	35·6	3·8	1*	2	1
P22732A	67909B	800	600	100	4	3	3	2	3	4	4–5	143	35·2	3·7	1*	1	1
P22732B	67909C	800	600	102	5	3	3	2+	3–	4	4–5	....	....	....	1*	(1)	(1)
P22732C	67909D	800	600	101	4	4	4	2	2+	4	4	....	....	....	1*–R	2	1
P22733	67909E	800	600	102	4	3	2	3	3–	4	4	133	36·9	3·6	1*	1	2
P22734	67910	300	500	101	5	3	3	1	2	4	4–5	146	35·0	4·3	S	0	1
P22735	67911	450	550	103	5	4	3	2	2	5	5	197	33·1	4·8	R	2	2

* Indicates the presence of small, undeveloped grey spot lesions.

Table 1—(*continued*)

Perth Accession number	C.P.I. number	Collection site altitude m	Collection site rainfall mm	Days to flowering	Tallness Rating 1–6	Coarseness rating 1–5	Leafiet Width 1–5	Branching rating 1–5	Pod Set rating 1–5	Pod Width rating 1–5	Average Seeds/pod	Individual seed weight mg	Seed protein content % d.b.	Seed oil content % d.b.	Grey spot resistance R, I, S,	Brown spot incidence 0–4	Root rot incidence 0–4
Spain (*continued*)—																	
P22736	67912	350	500	104	5	3+	....	1	3	4	4	148	36·4	3·5	S	1	2+
P22737	67913	600	500	97	4	4	....	2	3	4	5	125	36·1	4·1	S	1	2
P22738	67914A	550	500	99	4	4	....	3	3–	5	5–6	154	36·2	4·0	S	(1)	2
P22739	67914B	550	500	105	5	3	3	1	3–	5–	5	134	33·4	4·5	S	(0)	2
P22740	67915	600	500	101	4	4	3	2+	3	5	4–5	164	33·6	5·3	Mixed	(1)	3
P22741	67916A	650	500	109	4	3	2	3	2	4–	4	....	....	....	(R)	2	0
P22742	67916B	650	500	106	5	4	3	2	1	5	4–5	158	37·3	4·4	(R)	1	1
P22743	67916C	650	500	99	4	4	3	2	4	4	5	130	39·4	3·4	S	2	1
P22744	67916D	650	500	101	4	3	3	2	4	5–	5	139	40·5	3·7	I*	1	(0)
P22745	67917A	500	550	105	4	4	3	3	4	4	5	140	37·1	4·1	R	(0)	1
P22746	67917B	500	550	103	4	4	4	2	4	5	5	244	39·7	5·4	R	2	3
P22747	67918	250	600	94	3	2	....	2	4	2	5	77	38·1	3·5	I	(1)	3
P22748	67919	600	750	110	3	3–	3	2	3+	3	5	91	35·5	4·3	(R)	1	2
P22749	67920	830	700	111	2	1	....	3	4–	1	5	....	....	....	R	3	2
P22750	67921	770	650	108	4	3	2	3	3–	5	5	148	34·3	3·5	(S)	(1)	1
P22751	67922	250	600	108	3	3–	2	2	3+	3	5+	114	39·6	3·7	R	3	1+
P22752	67923A	50	900	109	1	1	1	3	5	1	5–6	47	33·5	4·2	R	3	2
P22753	67923B	50	900	109	1	1	1	3	5	1	5–6	....	....	....	R	3	2
P22754	67924	10	850	111	3	2	1	2	3	2	4	77	37·3	4·6	R	3	(0)
P22755	67925	250	800	100	1	1	1	4	4	1–	5	37	33·2	4·5	R	4	2
P22756	67926A	400	900	98	4	5	4	3+	3+	4+	4–5	171	37·3	4·2	R	2	1
P22757	67926B	400	900	103	5	3	2	2	1	4	4	162	33·4	4·1	R	1	0
P22758	67926C	400	900	102	5	4	3+	3	2	4+	4–5	154	36·1	4·7	(R)	(0)	1
P22759	67927	400	900	109	5	5	5	2	3	4	5	127	34·3	4·6	(R)	(0)	(1)
P22760	67928	450	1 000	108	5	4	4	3	3	4	4–5	....	....	....	S	(3)	1
P22761	67929A	450	1 000	107	4	3	3	2	2	3+	4–5	116	37·9	4·3	R	2	3
P22762	67929B	450	1 000	110	3	3	3	3	2–3	3+	4	90	36·3	3·0	I*–S	1	2
P22763	67930A	600	950	107	5	4	4–	2	2	4	4–5	144	32·6	5·0	R	1	2
P22764	67930B	600	950	107	5	3	3	2	2	4	5	135	40·4	4·0	I*	1	1
P22765	67931A	450	700	109	5	4	4	2+	3	5	5	138	35·7	5·2	I*–R	2	2
P22766	67931B	450	700	101	5	4	4	3	2+	4	4–5	132	35·8	4·2	S	1	2
P22767	67932A	300	650	98	3	3	3	4	2+	3	4–5	124	33·0	4·4	I*	2	3+
P22768	67932B	300	650	105	4	4	4	2	3	4	5	148	36·8	4·0	R	2	1
P22769	67933	400	800	110	5	3	3	2	1	2+	4–5	93	35·0	4·4	R	2	1
P22770	67934	450	800	110	4	3+	4	3	2+	3	5+	97	33·8	5·5	R	2	1
P22771	67935	400	800	112	5	4	4	2	4	3	5–6	85	34·5	4·2	Mixed	(1)	(0)
P22772	67936	600	1 200	114	5	4	3	2	3	2+	5–6	82	32·5	3·7	S	1	2
P22773	67937	500	1 200	120	4	3	2	2	3	2	5	79	34·1	3·2	I	2	(1)
P22774	67938	300	1 000	114	4	3	3	3	3	2	5–6	74	33·3	4·0	R	2	1
P22775	67939	150	900	120	4	2+	2	2	3	2	5–6	65	32·6	4·6	R	2	3
P22776	67940	150	900	121	5	3	3	2	3	3	6	73	32·0	4·2	R	2–	2
P22777	67941	150	900	123	4	3	3	3	3	3	5–6	66	35·2	4·3	R	2+	(0)
P22778	67942A	150	900	114	5	3	3	2	4	3	5–6	94	33·3	3·7	R	1	1
P22779	67942B	150	900	111	4	3	2	3	4	3	5	85	34·2	3·8	(R)	1	2–
P22780	67943A	550	1 100	113	4	3+	3	2	4	3	5	85	33·8	4·2	R	1	3–
P22781	67943B	550	1 100	110	5	3	3	2	4	3	5	97	34·0	4·3	(R)	1	1
P22782	67943C	550	1 100	111	4	2+	2	2	5	2	6	78	33·1	4·2	I*	1	2
P22783	67944A	400	800	117	5	3+	3	2	4	3	5	95	32·3	4·4	Mixed	1	4
P22784	67944B	400	800	112	4	3	2	3	2	3	4–5	90	35·6	5·2	R	1+	2+
P22785	67944C	400	800	113	4	3	3	2	3	3	5	95	35·0	4·6	R	2	4
P22786	67944D	400	800	113	4	3	3	1	3	3	5	95	33·0	5·2	I*	2	4
P22787	67944E	400	800	110	4	2	3	3	2+	3	4–5	100	32·9	5·0	R	1	3
P22788	67944F	400	800	114	5	3	3	1	3	3	5–6	85	32·0	5·7	I*	2	3
P22789	67944G	400	800	112	4	2	2	3	2+	3	5	90	34·1	5·3	(R)	2	2
P22790	67945A	400	800	112	4+	3	2	3	2+	4	5–6	122	34·7	5·0	(R)	2	3

* Indicates the presence of small, undeveloped grey spot lesions.

Table I—(*continued*)

Perth Accession number	C.P.I. number	Collection site altitude m	Collection site rainfall mm	Days to flowering	Tallness Rating 1–6	Coarseness rating 1–5	Leaflet Width 1–5	Branching rating 1–5	Pod Set rating 1–5	Pod Width rating 1–5	Average Seeds/pod	Individual seed weight mg	Seed protein content % d.b.	Seed oil content % d.b.	Grey spot resistance R, I, S,	Brown spot incidence 0–4	Root rot incidence 0–4
Spain (*continued*)—																	
P22791	67945B	400	800	114	4	3	3	2	3+	4	5–6	102	33·1	5·1	(R)	1	4
P22792	67945C	400	800	110	5	3	3	2	4	3+	5	111	33·0	5·0	(R)	1	3
P22793	67945D	400	800	109	4+	3	2	2	3	3+	5	138	34·6	5·4	R	2	(1)
P22794	67945E	400	800	110	4	3	2	2	4	3	5–6	....	....	....	I*–R	1	2
P22795	67945F	400	800	111	5	4	3	2	4–	4	5–6	101	32·6	4·8	R	1	1
P22796	67945G	400	800	111	5	4	3	2	4	4–	5–6	107	33·1	5·0	R	1	2
P22797	67945H	400	800	114	5	3	2	2	3	3	5	99	35·6	4·5	R	1	1
P22798	67946	500	850	117	4	2	1	3	2	2	5–6	91	34·9	4·2	R	1	2
P22799	67947A	....	....	117	4	2	2	4	4	2	5–6	74	37·8	3·5	R	1	2
P22800	67947B	....	....	117	4	2	2+	2	4	3	5–6	64	36·7	4·2	R	1	3
P22801	65105	....	....	105	4	4	4	3	3	5	4	186	34·0	4·6	I	(1)	2
P22802	65106A	....	....	105	5	5	4	2	2	5–	4–5	181	32·6	4·5	I	(1)	1
P22803	65106B	....	....	102	5	3	4	1	2	4	5	137	34·0	5·0	S	2	3
P22804	65107	....	....	111	2	1	1	3	4	1	5–6	....	....	....	S	2	1
P22805	65109A	....	....	107	6	5	4	1	2–	5	4–5	168	36·7	5·3	R	1	(1)
P22806	65109B	....	....	107	6	5	4	1	1	5	5	179	35·8	5·2	R	1	3
P22807	65110	....	....	112	6	3	3	1	2	3+	5+	127	34·6	4·1	I*	1+	2
P22809	65112	....	....	104	6	5	4	1	2	5	4–5	185	33·8	4·6	I*	(1)	4
P22810	65113A	....	....	111	5	3	2	2	2	3	4–5	124	32·2	5·0	(R)	1	3
P22811	65113B	....	....	111	6	3	3	2	3–	4	4–5	123	33·1	4·8	I	1	3
P22812	65116A	....	....	104	6	4	3	2	3	4–	5	126	32·4	4·7	I	2	3+
P22813	65116B	....	....	105	5	3	3	2	4–	3	6	....	....	....	(R)	2	4
P22814	65116C	....	....	105	5	4	4	2	4	4–	5–6	111	33·6	2·8	I	1	4
P22815	65117	....	....	110	5	3	3	3	2	4	5	137	37·2	3·9	I*	1	(1)
P22816	65118A	....	....	110	6	4	4	2	4–	4–	5	113	33·1	4·3	I*–R	1	2
P22817	65118B	....	....	110	5	3	3	2	3	3	5–6	86	31·8	4·1	I*	1	1
P22818	65121	....	....	101	6	4	4	2	2	5	4–5	167	35·8	4·3	I	1	2
Portugal—																	
P20648	....	....	....	107	5	4	4	2	3	4	5	151	35·6	4·8	S	1	(1)
P20650	....	....	....	107	4+	4	3	2	4	4	5–6	140	35·6	4·5	(S)	1	(1)
P20651	....	....	....	103	5	5	4	1	3	5	4–5	123	36·3	4·1	S	1	0
P20652	....	....	....	111	....	....	....	....	....	....	....	140	37·3	4·3	S	....	....
P20653	....	....	....	107	4	4	4	2	4–	5	5	157	38·3	4·6	S	1	0
P22819	68054A	200	600	105	6	4	2	1	2–	5–	4	176	35·3	3·9	R	1	0
P22820	68054B	200	600	107	5	4	3	2	2	4	4–5	140	34·1	3·9	I	2	1
P22821	68054C	200	600	109	5	4	3	2	2	5	4–5	148	31·8	4·8	I	2–	2
P22822	68055A	250	650	102	5	4	3	2	3	4–	4–5	118	35·6	3·5	I	2	2
P22823	68055B	250	650	108	5	4	3	3	2	5	4–5	153	33·6	4·5	I	1	3
P22824	68056A	250	600	102	5	4	3	1	2+	5	5	152	34·8	4·8	S	2	3
P22825	68056B	250	600	102	4	4	3	3	3	4	5	147	34·0	4·2	R	2	1+
P22826	68057A	300	550	108	5	4	3	2	3	5	5	147	35·9	4·2	(R)	2	3
P22827	68057B	300	550	101	5	4–	3	3	2	4	5	174	34·0	4·8	R	1	1
P22828	68058	300	575	104	5	3	2	3	3–	3	4–5	109	36·6	4·4	I	1	1
P22829	68059	500	850	109	4	3	3	2	3	4	5	109	35·4	4·0	R	2+	2+
P22830	68060	500	850	109	4	3	3	2	4	4–	4–5	....	....	....	(R)	3	1
P22831	68061	350	1 000	110	5	4–	3+	2	4+	3	5–6	82	35·9	3·7	R	2+	2
P22832	68062	250	600	109	5	3+	3	1	1	3	4–5	122	33·0	4·6	R	2	1
P22833	68063	500	1 500	111	5	3	3	1	2+	3	6–7	81	32·8	4·1	I	1	1
P22834	68064	200	900	111	6	3+	2+	2	3	3	5–6	....	....	....	R	1	2
P22835	68065	600	800	113	6	4	3	1	3–	3	6	76	33·5	4·0	I	(1)	1
P22836	68066	400	1 000	114	5	3	2	2	4–	3	5–6	76	34·9	3·8	I	1	2
P22837	68067A	450	1 000	117	4–	2	3–	4	4	2+	5–6	64	34·1	4·2	S	1+	2
P22838	68067B	450	1 000	117	3	2	2	4	4	2	5–6	....	....	....	S	3	3

* Indicates the presence of small, undeveloped grey spot lesions.

Table I—(*continued*)

Perth Accession number	C.P.I. number	Collection site altitude m	Collection site rainfall mm	Days to flowering	Tallness Rating 1–6	Coarseness rating 1–5	Leafiet Width 1–5	Branching rating 1–5	Pod Set rating 1–5	Pod Width rating 1–5	Average Seeds/pod	Individual seed weight mg	Seed protein content %d.b.	Seed oil content %d.b.	Grey spot resistance R, I, S,	Brown spot incidence 0–4	Root rot incidence 0–4
Portugal—*continued*																	
P22839	68068A	500	1 050	117	4	3	3	3	3	3	5–6	....	....	....	R	2	2
P22840	68068B	500	1 050	115	5	3	3	2	2	3	5–6	89	32·0	4·6	(R)	3	2
P22841	68069	100	400	108	3	4	2	3	3	4	4	14·3	40·1	4·3	R	1	0
Morocco—																	
P22842	65197	50	500	96	2+	2	1	5	3	2	4	72	37·4	3·5	R	2	0
P22843	65198A	50	550	93	2	2	1	4	2	2	4	68	37·2	3·1	R	3	0
P22844	65198B	50	550	95	3–	2+	2	4	2	3–	5	....	....	....	(R)	3	0
P22845	65199A	100	525	96	1	1	1	4	2	1	4–5	54	33·0	4·7	R	4	(1)
P22846	65199B	100	525	95	2	1	1	5	3	1	4	62	33·9	4·8	R	4	0
P22847	65200A	50	525	94	2	2	1	4	4	2	4–5	64	38·3	3·8	R	2	0
P22848	65200B	50	525	97	2	2	1	4	3	1	4	69	37·5	4·2	R	2	0
P22849	65201A	100	550	97	2	2	1	4	4	2	5	79	36·0	4·2	R	2	(1)
P22850	65201B	100	550	97	2	2–	2	4	4	2	5	....	....	....	R	3	2
P22851	65202	150	525	95	2	1	2	5	3–	2	4	69	37·5	4·0	R	4	0
P22852	65203	150	525	101	1	1	1	5	2	2	3–4	58	40·1	4·4	R	2	0
P22853	65204A	200	525	96	1	1	1	5	1	1	3	....	....	....	(R)	4	0
P22854	65204B	200	525	99	1	1	1	5	1	2	3	....	....	....	R	4	0
P22855	65204C	200	525	96	1	1	1	5	1	2	3–4	74	41·7	4·2	R	3	0
P22856	65204D	200	525	96	2	1	1	4	1	2	3	77	42·8	3·4	R	3	(1)
P22857	65204E	200	525	97	1	1	1	5	2	2	4	94	40·5	4·7	R	2	0
P22858	65204F	200	525	94	1	1	2	5	2–	2	4	63	42·2	4·0	R	2	0
P22859	65205	100	500	100	2	1	1	5	2	2	4	71	37·6	4·2	R	3	0
P22860	65206A	100	500	96	3	2	1	5	1	2	4	82	38·9	4·5	R	2–	0
P22861	65206B	100	500	94	3	2	2	5	3	2	4–5	69	37·7	4·4	R	2	0
P22862	65206C	100	500	102	2	2	2	5	3	2	4	67	38·7	4·4	R	2	0
P22863	65207	1 200	375	96	1	2	2	5	5	2	5+	66	40·0	5·0	I	3	(1)
P22864	65208	1 000	200	93	1	2	2	4	4	2	5	62	37·4	4·3	I	1+	0
P22865	65209A	1 000	200	93	2	2	2	4	5	2	5	65	37·8	4·2	I	2	0
P22866	65209B	1 000	200	95	2	2	2	4	4	2	5	66	37·2	4·4	I	2	0
P22867	65209C	1 000	200	94	1	2	2	5	4	2	5	57	34·2	4·5	(R)	2	0
P22868	65210A	1 000	700	96	3	4	4	4	3	5	4–5	173	37·8	5·6	I	2	0
P22869	65210B	1 000	700	98	3	3	3	4	2	4	4–5	136	38·2	5·0	I	1	(2)
P22870	65210C	1 000	700	97	3	5	5	4	3	5	4–5	146	35·2	5·4	I	2	(1)
P22871	65210D	1 000	700	103	3	4	3	4–	2	4	4–5	140	37·2	5·8	(R)	1	0
P22872	65211A	330	600	95	4	4	3	3	2	5	4	181	33·8	5·2	(R)	2	(3)
P22873	65211B	330	600	94	4	4	3	4	2	5	4	207	36·6	4·9	(R)	2	0
P22874	65211C	330	600	96	4	4	3	3	3	5	4–5	200	36·5	4·7	(R)	1	(3)
P22875	65211D	330	600	95	4	4	3	4	2	4	5	198	37·1	4·4	(R)	2	0
P22876	65211E	330	600	94	3	3	4–	4	3+	5	4–5	182	35·3	4·9	R	1	(3)
P22877	65211F	330	600	94	4	3	3	4	2	5	4–5	174	37·7	4·1	(R)	2	2
P22878	65212	900	1 150	109	4	4–	3	4	2+	5	4	194	34·5	5·6	R	0	1
P22879	65213A	920	1 150	114	3	4–	4	4	3–	5	4	142	35·9	4·8	I	1	3
P22880	65213B	920	1 150	111	3	4	4–	4	3+	5	4	156	37·3	1·8	(R)	1	3
P22881	65213C	920	1 150	110	3	3+	3	4	3+	5	4	155	38·0	5·4	(R)	1	2
P22882	65213D	920	1 150	109	....	....	....	....	....	....	....	159	34·4	5·6	I	1	2
P22883	65214	910	1 150	111	4	4	4	3	3+	5	4–5	168	35·7	5·3	(R)	(0)	(2)
P22884	65215	650	900	118	4	4	4	2	3	5	4	183	39·0	5·3	R	(1)	1
P22885	65216	520	900	105	3	3	4	3	4	4	4–5	149	37·2	4·4	I–R	2	(3)
P22886	65218A	100	700	114	2	2	2	4	1	3	4	160	37·0	5·0	R	1	0
P22887	65218B	100	700	108	2	3	3	4	2–	3	4	129	33·5	4·7	I	2	0
P22888	65219	40	680	96	2	2	3	3	2	2	4–5	72	38·4	4·1	I	3	(1)
Control—																	
Cv. N.Z. Blue	....	....	....	102	5	4	4	2	3	5	4–5	....	....	....	S	(0)	(2)

* Indicates the presence of small, undeveloped grey spot lesions.

Table 2—Numbers of lines resistant to grey spot (*Stemphylium* spp.) by region of origin.

Region of Origin	Resistant	Intermediate or mixed	Susceptible
Western Australia*	1	0	0
Israel	4	0	0
Turkey	1	0	0
Italy and Sicily	18	1	0
Spain and Portugal	113	42	30
Morocco	35	12	0
Total	172	55	30

* Naturalised wild type.

DISCUSSION OF RESULTS

L. angustifolius

(1) Number of **days to flowering** showed the expected relationships to latitude, altitude, and mean annual rainfall at the sites of origin, although the range (approximately 90 to 120 days) was relatively small. For comparison, commercial varieties range from about 75 days to flowering for Unicrop to 102 days for cvs. New Zealand Blue, Uniharvest and Marri. Accessions from low altitude coastal areas of Israel and Morocco, and from the Anti Atlas mountain region of southern Morocco, formed a distinct early-flowering group flowering at 90–95 days. The Anti Atlas group (CPI 65207–65209) is of particular interest because of the short and relatively dry, yet cold growing season of its natural enviroment, a combination of enviromental factors different from those of all other *L. angustifolius* introductions.

(2) **Tallness, coarseness,** and **leaflet width** were positively correlated amongst themselves and with **seed size.** There were nevertheless some exceptions. Many of the lines from Portugal and north-west Spain, and to some extent from Italy, had fairly small seeds and narrow leaflets, yet grew quite tall. See further discussion below under individual seed weights.

(3) **Branching** was inversely related to tallness. Among the Iberian collections there was a broad distinction between medium to tall, medium to sparsely branching lines of the middle to lower latitudes on the one hand, and the short, strongly branching, early-rosetted types mainly from high altitudes. Most typically, though not invariably, the latter group were fine-textured and small-seeded: a distinctive group of "alpine" wild types. A further distinctive group consisted of short, profusely branching, fine, small-seeded yet early flowering types from the sandy Moroccan lowlands and the Anti Atlas Mountains, together with later-flowering but otherwise similar lines from two sandy coastal sites in the extreme south west of Spain (C.P.I. 67923 and 67924).

(4) **Pod set,** as rated, showed only partial relationships to other factors. As might be expected, lines with the highest pod numbers tended to be those with small pods and seeds, but small pods and seeds gave no guarantee of prolific pod set. At the other extreme, however, large-seeded genotypes all had relatively few pods.

(5) **Pod width rating** was fairly closely, but nevertheless incompletely, correlated with individual seed weight. Whereas there were clearly limits to how far large seeds could be fitted into small pods, some large or medium pods had only medium or small seeds, and appeared less completely filled than others. The observations suggested that selection for "pod fill" could be a means of improving harvest index of the fruits, and thereby perhaps of the whole plants.

(6) **Seed number per pod** varied from four to between six and seven, with a clear tendency for large numbers to be associated with small seeds. Some genotypes with small seeds but relatively few seeds per pod had very high pod numbers, and from observation it appeared that in such cases the low seed numbers were often due to ovule abortion. Despite the overall trend, occasional genotypes combined quite large seeds with as many as 5–6 seeds per pod, clearly exceeding the 4–5 in existing commercial varieties. This suggests another possible avenue for improving fruit and perhaps whole plant harvest index.

(7) **Individual seed weight** in *L. angustifolius* varied over the extremely wide range of 37 to 244 mg. The histogram for the whole population of *L. angustifolius* wild types (Figure 1) shows a clearly bimodal distribution, with genotypes about equally divided between a small-seeded group (mostly 50–100 mg) and a medium to large-seeded group (mostly 120–160 mg, with a skewed tail up to about 200 mg). The individual seed weights of comparable commercial varieties, e.g. cv. New Zealand Blue, average about 160–180 mg. One genotype, C.P.I. 67917B from southern Spain, had the extraordinarily high average individual seed weight of 244 mg and could represent a distinct genetic type.

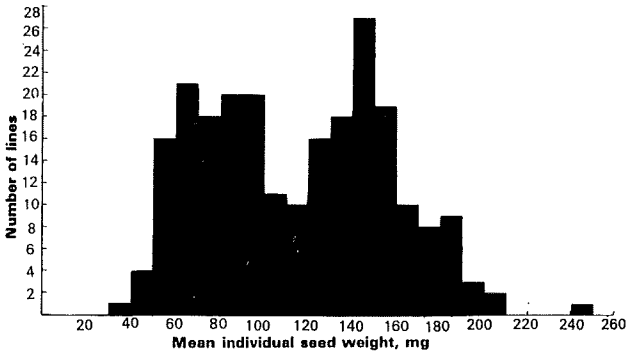

Figure 1—Frequency distribution of mean individual seed weights (mg, air-dry) among Mediterranean *L. angustifolius* collections.

The geographical distribution of seed size was not random. True large-seeded types (> 130 mg) were found only in two regions; Iberia and Morocco. In Iberia they are confined, with very minor exceptions, to altitudes less than 900 m and to inland areas. The Moroccan large-seeded populations come exclusively from northern inland areas at altitudes between 300 and 1 000 m. In both regions the large-seeded genotypes show strong associations with loamy soils and with present or recent cultivation, mostly around olive groves or in cultivated fields. As argued elsewhere (Gladstones 1974), these are probably escaped "cultivated" types, perhaps the products of past selection for seed and plant size.

In contrast the true small-seeded "wild" types are found over the species' entire range. They extend from sea level to about 1 300 m altitude. Some were found as apparent weeds, volunteering in or around cultivated fields, but many were found isolated from cultivation, often on rocky mountain soils or coastal sands.

The smallest-seeded "wild" types were from the central Spanish highlands, the sandy coastal lowlands of Morocco and southern Spain, and the Anti Atlas highlands of southern Morocco. Herbarium specimens seen from about 1 200 m in the Atlas foothills of southern Morocco resembled the last type. As already discussed under plant type, these are all fine, low-growing, much-branched plants irrespective of their flowering times. Slightly larger-seeded "wild" types from Israel, Turkey and Italy, together with some from Iberia, tended to be intermediate in all respects. The question of their possible past selection must remain open, but observation in Italy (Gladstones 1973) and subsequently in Corsica and southern France (Gladstones, unpublished) suggests that some of these intermediate plant types have been used for green manuring and perhaps other purposes, even though they have not attained the seed and plant dimensions of the true cultivated strains of Iberia and Morocco.

(8) **Grey leaf spot resistance.** Numbers of lines showing resistant, intermediate or mixed, and susceptible reations are shown in Table 2. Overall, 67 per cent of lines were more or less fully resistant, and only 12 per cent were classified as susceptible. These proportions and the reactions of individual lines (as far as they can be compared) agree with those recorded previously by Forbes, Gladstones and Wells (1975) for the same material tested in the U.S.A. The American tests were with the still largely unsorted accessions, which explains the relatively high number of mixed and uncertain reactions recorded.

Lines classified as susceptible were exclusively from Spain and Portugal. Among them, a strong relationship was apparent to seed size and plant type. Of the 25 susceptible lines for which individual seed weights were obtained, 22 were large-seeded (> 120 mg, mean 143 mg)

and only three were small-seeded (mean 67 mg). Clearly, susceptiblity is associated primarily with the large-seeded, "cultivated" Iberian strains of *L. angustifolius*. A small number of susceptible "wild" types found in the collection can be adequately explained by natural crossing, as evidenced by the segregation for various characters noted in some of the accessions when grown out in Australia.

The reason why so many (though by no means all) of the "cultivated" types are susceptible to grey leaf spot, a characteristic shared by all of the modern northern European cultivars so far included in the collection, remains obscure. It can be noted, however, that all were from inland areas where relative humidities are fairly low and where, from Western Australian experiences, grey leaf spot might not be expected to be a significant problem. With the exception of one or two intermediate types, all accessions of coastal or near-coastal origin were recorded as resistant. The possibility that susceptibility, or some character associated with it, might be advantageous for cultivated types under certain dry environmental conditions should be kept in mind in future work.

In the intermediate or mixed reaction category, only a few lines were mixed, and these can be accounted for by natural crossing—either in the original environment or in the early year(s) of growing on in Australia. The great majority in the category were "intermediate", and comprised two types: (1) those with sparse but normal-sized lesions, and (2) those with fairly numerous but small, undeveloped lesions. The latter were by far the more common. These differences, which have been confirmed in other years, suggest the presence in the Mediterranean populations of diverse resistance genes, resulting in different levels and perhaps different kinds of resistance to grey leaf spot.

(9) **Brown leaf spot incidence.** No line was completely free from brown spot, a result which agrees with American observations (I. Forbes, private communication). Wide differences were nevertheless apparent in the severity of symptoms, which showed a clear relationship to plant growth habit. Short, rosetted genotypes were on average much worse affected than tall, erect-growing genotypes. This result is consistent with the known biology of the brown spot organism, which is slimy and moves upwards from the soil surface only with difficulty (I. Forbes, P. M. Wood, personal communications). After due allowance for growth habit, although there was no indication of complete resistance in any line or group of lines, one group did impress as being less affected than most with comparable growth habit. These were certain of the large-seeded "cultivated" lines of inland northern Morocco (C.P.I. 65212–65215). The differences seem large enough to warrant further investigation.

(10) **Incidence of root rots** (probably Fusarium). Large differences were apparent in the incidence and severity of root rot symptoms towards maturity, assumed to have been due to *Fusarium* spp. Owing to lack of replication and possible immediate site effects, they cannot be accepted as being of definite genetic origin. The pattern of variation among genetic groups nevertheless suggested that some of the differences could have been genetically based. The coastal Moroccan wild types as a group stood out as being very little affected, as did all lines from southern Italy and Israel. These three groups have in common the fact that all came from coastal or near coastal lowlands, having mild and moderately humid growing seasons. Inland and high altitude genotypes were on average more severely affected, although there were some exceptions, e.g. the highland wild populations from southern Morocco and possibly some of those from central Spain. The pattern shows a broad parallel to that for grey leaf spot resistance, except that the association of susceptibility with "cultivated" growth habit is less apparent in this case. The observations suggest that degrees of resistance may in fact exist, and that the most likely sources of resistance will be found among coastal lowland wild types.

(11) **Seed crude protein contents** (N x 6.25) ranged from just under 32 per cent, dry matter basis to almost 43 per cent (Figure 2). The majority of lines fell between 33 and 38 per cent. Distribution below the mean was essentially normal, but the upper end of the range appeared skewed, with evidence of secondary peaks (sub-populations) at 37–38 and 39–41 per cent. An outlying group of three genotypes between 41.5 and 43.0 per cent all came from a single collecting site in coastal Morocco. The results strongly suggest that populations exist among the wild Mediterranean races of *L. angustifolius* with higher crude protein contents than the commercial cultivars, which typically contain about 33–35 per cent.

Table 3—*L. angustifolius*: whole seed crude protein and oil contents on a dry matter basis, by region of origin.

Region of Origin	No. of lines	Mean protein %*	Mean oil %
Western Australia†	1	39·3	4·00
Israel	4	36·8	5·15
Turkey	1	35·9	5·60
Italy and Sicily	19	37·6	4·98
Spain and Portugal	166	35·0	4·50
Morocco	43	37·3	4·53
Spain and Portugal Only—			
GLS–resistant	102	35·1	4·64
Intermediate or mixed	39	34·7	4·25
GLS–susceptible	25	35·2	4·32

* Nitrogen x 6·25. † Naturalised.

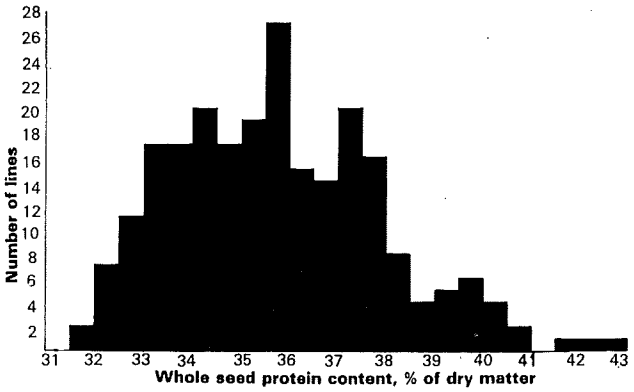

Figure 2—Frequency distribution of whole seed crude protein contents (per cent N x 6.25, dry matter basis) among Mediterranean *L. angustifolius* collections.

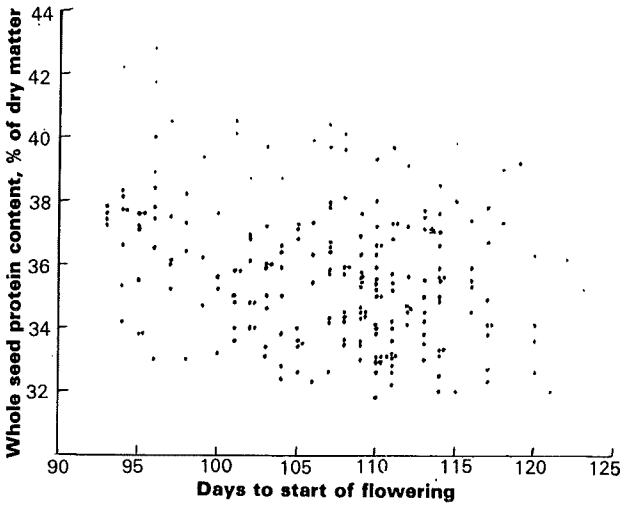

Figure 3—Relationship of whole seed crude protein contents (per cent N x 6.25, dry matter basis) to numbers of days to flowering among Mediterranean *L. angustifolius* collections.

Examination of the data by region of origin (summarised in Table 3) shows that accessions from Italy and Morocco had consistently the highest protein contents, while those from the eastern Mediterranean were moderately high. Lines from Spain and Portugal had on average the lowest contents. The naturalised Western Australian wild type P20639 was within the higher range of protein contents, a result which confirms previous findings of Hill and Gladstones (unpublished) and of Perry and Crosbie (unpublished). Crude protein content showed a slight, but fairly definite, inverse relationship to number of days to flowering (Figure 3). This agrees with independent data from a more restricted range of cultivated and wild genotypes grown at a different site in a different year (Hill and Gladstones, unpublished). There was no apparent overall relationship between crude protein content and individual seed weight (Figure 4), or with differences in grey leaf spot susceptibility (Table 3).

(12) Seed oil contents (Figure 5) ranged mainly between 4.0 and 5.5 per cent on a whole seed, dry matter basis, with a fairly normal distribution of values. We have no clear evidence as to how far this relatively narrow range of variation was genetically based, but there did appear to be a trend from the highest values in lines from the eastern Mediterranean, through intermediate values in those from southern Italy, to lowest values in lines from Iberia and Morocco (Table 3). The difference between eastern and western Mediterranean approached 1.0 per

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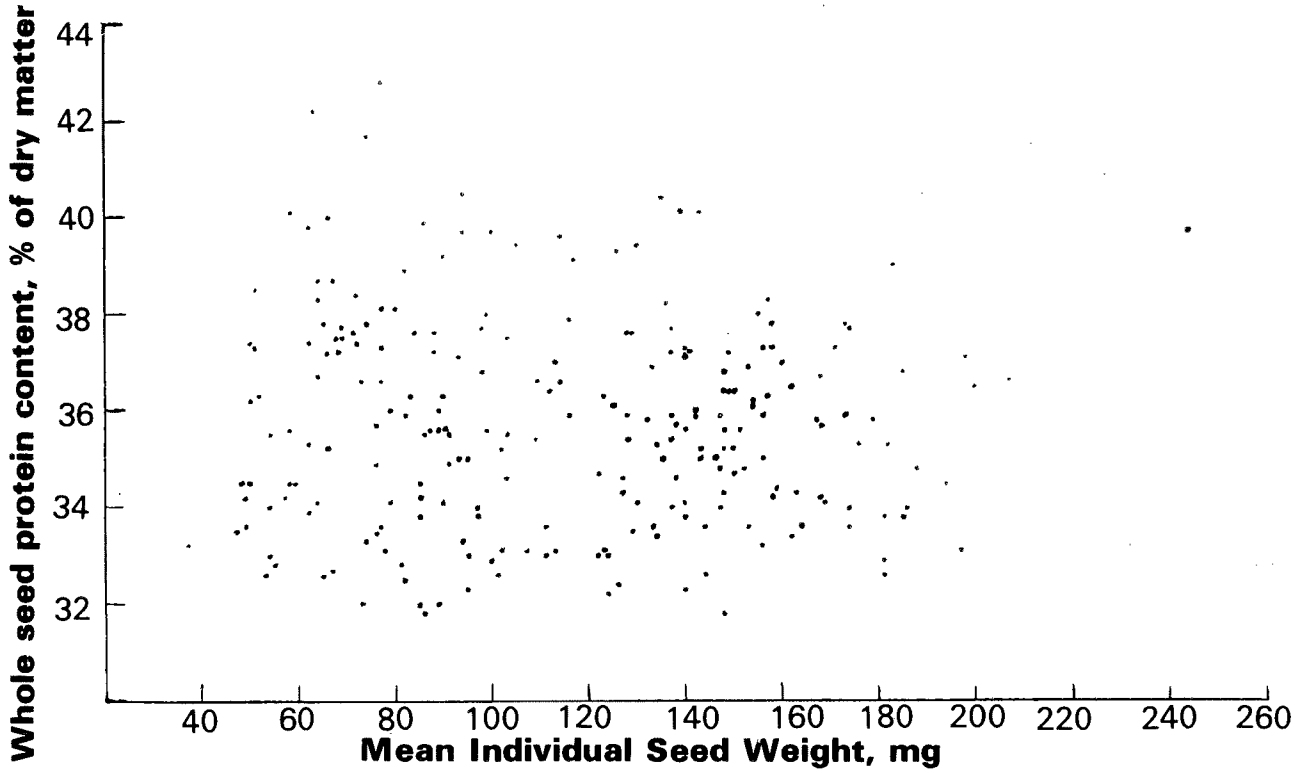

Figure 4—Relationship of whole seed crude protein contents (per cent N x 6.25, dry matter basis) to mean individual seed weights (mg, air dry) among Mediterranean *L. angustifolius* collections.

cent, but is subject to error because of the small number of lines in the eastern group. A second relationship was that among Iberian lines, those with resistance to grey leaf spot had on average slightly higher oil contents than susceptible lines (Table 3). This can reasonably be explained by their greater photosynthetic capacity during seed maturation, due to better leaf retention at the end of the season.

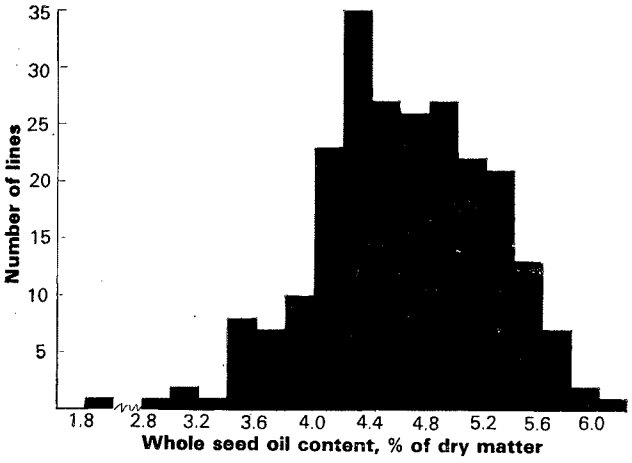

Figure 5—Frequency distribution of whole seed oil contents (per cent, dry matter basis) among Mediterranean *L. angustifolius* collections.

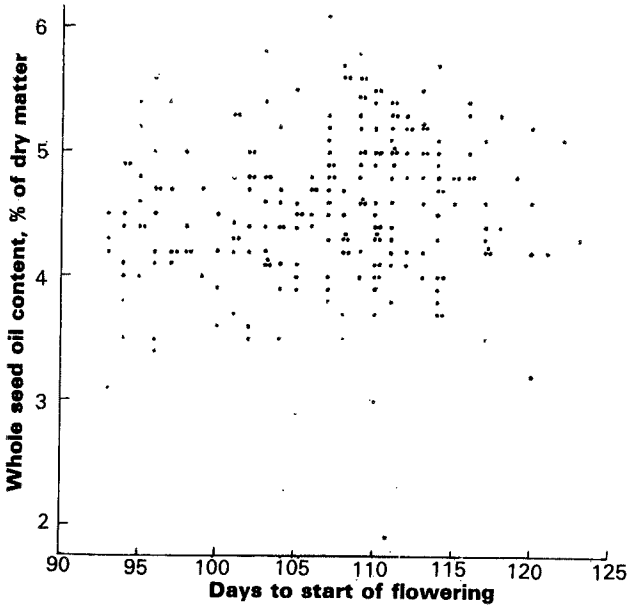

Figure 6—Relationship of whole seed oil contents (per cent, dry matter basis) to numbers of days to flowering among Mediterranean *L. angustifolius* collections.

Oil content was substantially unrelated to number of days to flowering (Figure 6). If any weak relationship was present, it was positive. There was no indication of any relationship with individual seed weight (Figure 7) or with seed crude protein content (Figure 8).

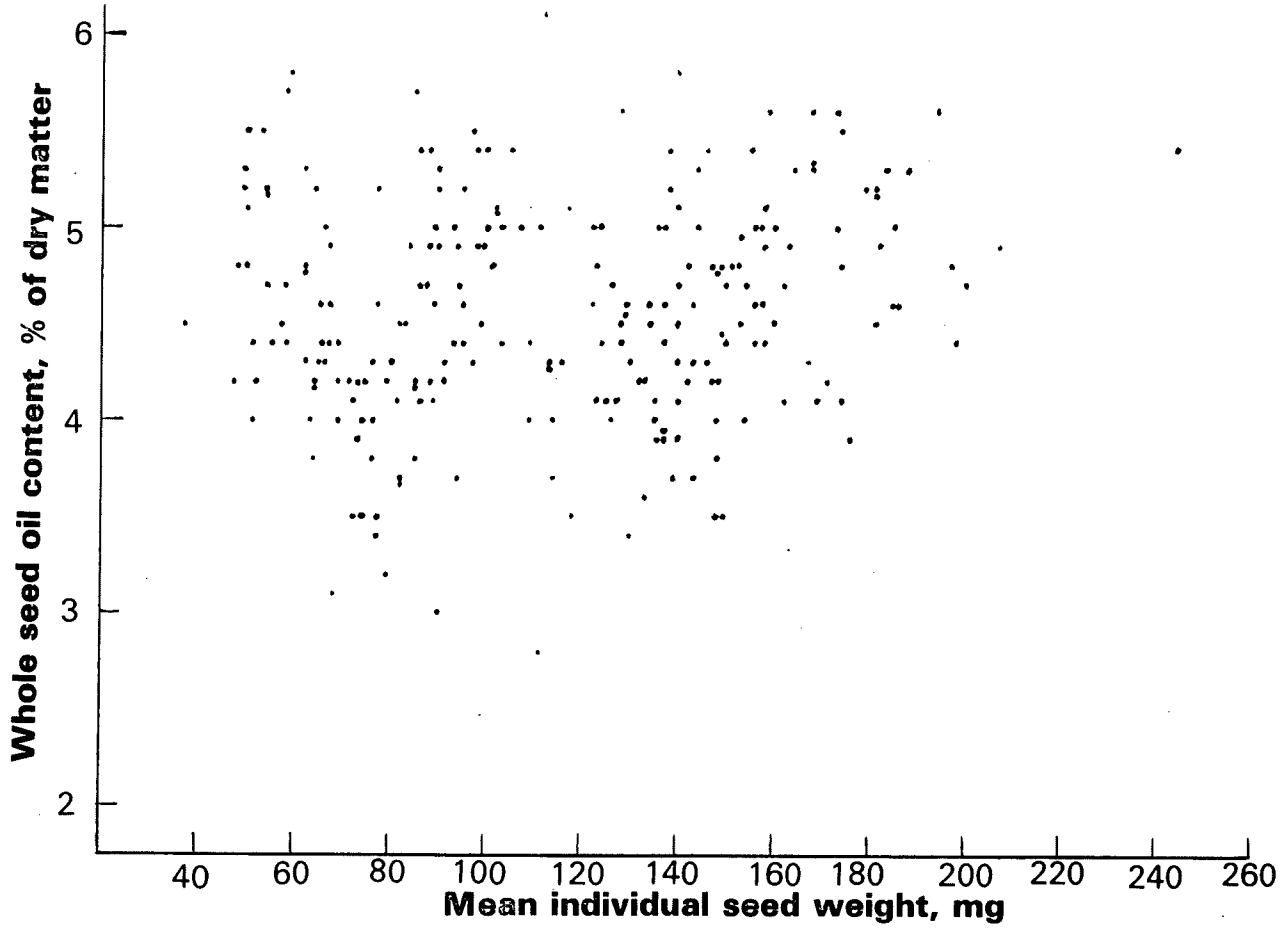

Figure 7—Relationship of whole seed oil contents (per cent, dry matter basis) to mean individual seed weights (mg, air dry) among *L. angustifolius* Mediterranean collections.

Species other than *L. angustifolius*

The data collected included only number of days to flowering, mean individual seed weight, and whole seed crude protein and oil contents (Table 4). Species means for these characteristics are summarised in Table 5. Some additional observations on root rots (*Fusarium*?) are referred to under the individual species.

(1) *L. cosentinii.* Maturities varied only within narrow limits, a reflection perhaps of the species' very restricted and essentially uniform natural environment which is the sandy coastal plains of the Western Mediterranean and the adjacent Atlantic coasts (see Gladstones 1974). With the exception of one small-seeded strain P 20791, whose small seed size has been confirmed over several growing seasons, all lines produced seeds between 140 and 230 mg. P 20791 had the highest seed protein content, but otherwise there was no obvious relationship between seed size and either protein or oil content. Oil contents were low, averaging 3 to 4 per cent.

(2) *L. atlanticus.* The seeds of this species, ranging between 200 and 350 mg, were intermediate in size between those of *L. cosentinii* and *L. pilosus*, which are the species' apparently nearest relatives amongst those studied. Protein and oil contents were also intermediate. Days to flowering varied within a fairly narrow range, with an average similar to those of *L. angustifolius* and *L. cosentinii.* Despite its quite restricted natural range (as so far discovered) in the Anti Atlas and in the Atlas foothills, the collections of *L. atlanticus* showed a fair range of variation in growth habit and seed characteristics. Some of the lines showed a distinct tendency towards determinate bearing habit, with most impressive pod and seed set on the primary inflorescence. This is held on a long stout peduncle above the level of the main leaf canopy.

From a visual assessment, the species would seem to have good cropping possibilities if the wild characteristics of shattering pods, hard-seededness and high alkaloid content could be eliminated as has been done in other lupin

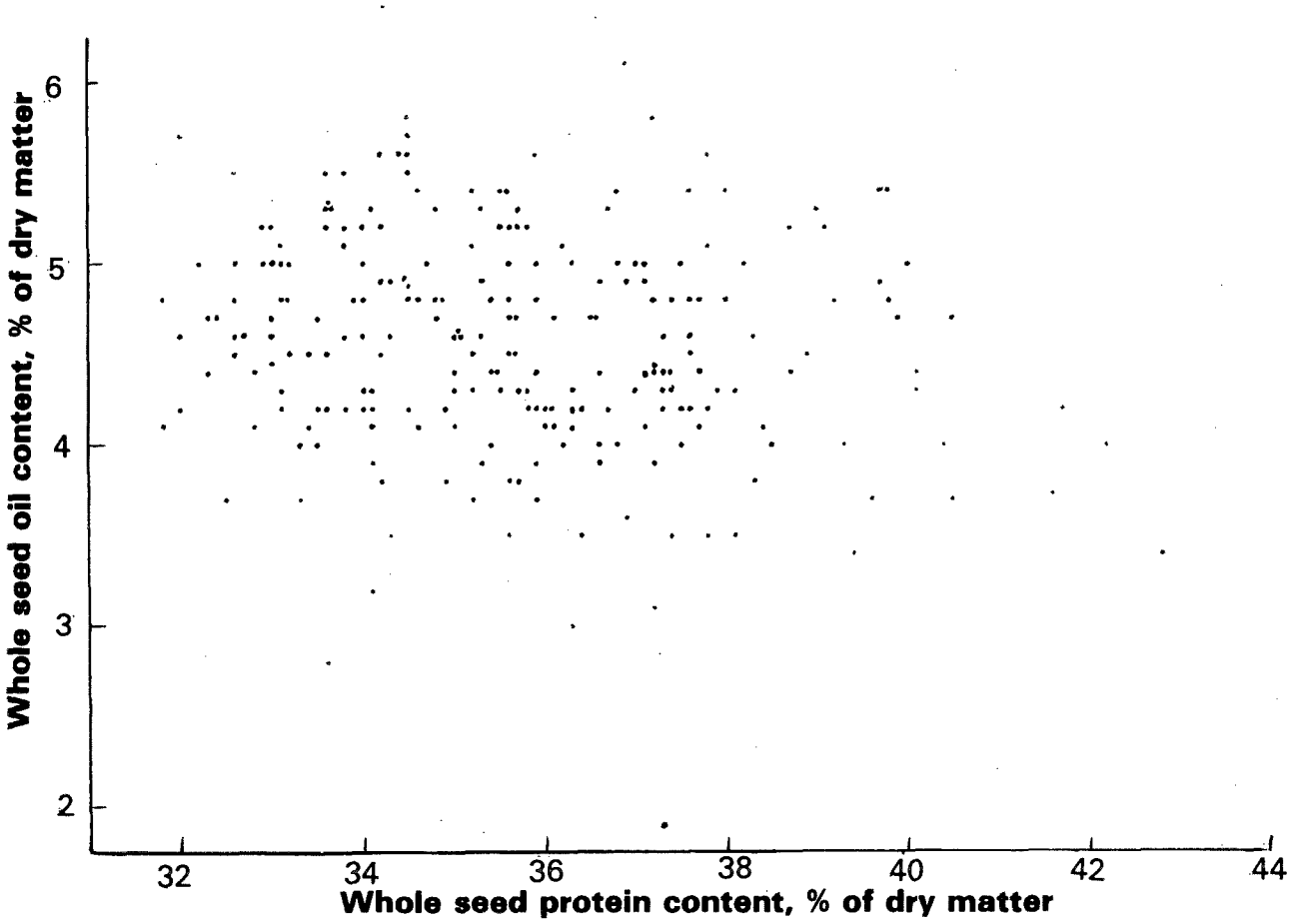

Figure 8—Relationship of whole seed oil contents (per cent, dry matter basis) to whole seed crude protein contents (per cent N x 6.25, dry matter basis) among *L. angustifolius* Mediterranean collections.

species. The positive attributes of cold resistance (particularly in contrast to *L. cosentinii*) and probably also drought resistance are implicit in its natural range: see site details in Appendix 1.

(3) *L. pilosus.* Number of days to flowering varied widely, depending on origin. Lines from the coastal plain of Israel flowered a little earlier than *L. angustifolius* or *L. luteus* from the same environment, but maturity was if anything later because of slower seed maturation. One group of coastal strains failed to nodulate effectively, whereas the nodulation of other strains appeared good. As noted previously (Gladstones 1974), this difference was correlated with certain morphological distinctions which suggest that the poorly-nodulating group may differ taxonomically from "typical" *L. pilosus.* It should be noted, however, that even the effectively nodulated lines had very low crude protein contents. Other data of Hill and Gladstones (unpublished) confirm this, and indicate that the low seed protein of content *L. pilosus* is partly (but only partly) due to a very thick testa, which constitutes approximately one third of the seed weight.

Despite its low seed protein content, observation in rows of the better *L. pilosus* genotypes suggests a real potential for development as a crop plant if the present wild characteristics of the species can be overcome. Some lines have extremely impressive pod and seed set, considering their large seed size, and appear to have a good harvest index. Their erect, semi determinate habit should be well suited to cropping.

(4) *L. palaestinus.* The data for seed size and especially seed composition are somewhat suspect, because nodulation of all lines of the species appeared to be, to varying degrees, incompletely effective. Pod set was generally poor. These observations have been repeated when *L. palaestinus* has been grown in other years.

(5) *L. micranthus.* The number of genotypes in the collection is extremely small. Despite

Table 4—Collection site data, days to flowering, individual seed weights, and whole seed crude protein and oil contents of wild types of Mediterranean lupin species.

Species and Origin	Perth Accession Number	C.P.I. Number	Collection site altitude m	Collection site rainfall mm	Days to flowering	Individual seed weight mg	Seed protein content % d.b.	Seed oil content % d.b.
L. cosentinii								
Morocco	P20791	....	....	....	101	99	39·3	2·6
,,	P22889	65226	30	475	102	216	32·4	3·7
,,	P22890	65227A	20	500	107	227	37·3	5·2
,,	P22891	65227B	20	500	99	203	31·3	4·4
,,	P22892	65228	50	500	104	190	32·6	3·4
,,	P22893	65229	50	500	97	146	33·9	2·6
,,	P22894	65230A	20	500	102	146	31·2	3·4
,,	P22895	65230B	20	500	102	193	34·2	3·1
,,	P22896	65231A	50	600	100	164	35·1	2·5
,,	P22897	65231B	50	600	103	170	33·9	2·6
,,	P22898	65232	75	550	101	160	30·0	3·4
,,	P22900	65234A	50	525	101	153	29·6	3·7
,,	P22902	65235	100	550	102	173	33·0	3·0
,,	P22903	65236A	50	500	99	193	37·1	3·4
,,	P22904	65236B	50	500	103	186	36·0	3·0
,,	P22905	65237A	100	500	106	216	35·9	2·3
,,	P22906	65237B	100	500	100	142	33·6	2·9
,,	P22907	65237C	100	500	103	170	35·3	2·6
,,	P22909	65238	10	400	100	192	32·0	3·8
,,	P22910	65239	20	350	99	193	34·1	3·3
Algeria	P20747	10650	....	....	99	202	32·1	4·2
Tunisia	P22911	65138	20	400	101	155	38·3	3·1
,,	P22913	65140	35	400	103	154	31·8	3·6
,,	P22914	65141	10	400	103	178	36·5	3·6
,,	P22915	65142	20	300	103	155	35·7	3·2
Spain	P22916	67948	10	700	105	149	36·1	2·5
L. atlanticus								
Morocco	P22917	65220A	1 200	375	103	288	30·1	3·7
,,	P22918	65220B	1 200	375	98	348	31·8	3·9
,,	P22919	65221	1 000	200	101	278	33·4	3·7
,,	P22920	65222	1 200	400	....	199	28·2	4·6
,,	P22921	65223A	1 000	490	107	265	33·2	2·6
,,	P22922	65223B	1 000	490	103	272	33·2	2·7
,,	P22923	65223C	1 000	490	101	287	32·8	2·6
,,	P22924	65223D	1 000	490	104	284	32·6	3·2
,,	P22925	65223E	1 000	490	108	311	28·0	3·8
,,	P22926	65223F	1 000	490	105	316	32·9	3·2
,,	P22927	65223G	1 000	490	99	258	28·6	3·0
,,	P22928	65223H	1 000	490	105	291	32·3	3·6
,,	P22929	65223I	1 000	490	105	271	33·6	3·2
,,	P22930	65224	1 100	500	....	247	28·7	4·8
,,	P22931	65225	460	300	109	304	33·7	4·2
L. pilosus								
Israel	P20957	....	100	....	95	587	23·0	5·0
,,	P22935	62286	....	....	84	423	21·5*	5·7
,,	P22936	62287	....	....	84	536	22·1*	6·0
,,	P22937	62288	....	....	84	731	26·0	5·6
Turkey	P21626	69994	....	....	120	298	28·2	4·1
L. palaestinus								
Israel	P22939	62281A	....	....	91	265	32·5	3·9
,,	P22941	62281C	....	....	96	190	31·8	3·4
,,	P22943	62282	....	....	90	201	28·3	4·0
L. micranthus								
Morocco	P22944	65240	600	525	114	130	30·1	8·1
Israel	P22945	62280A	....	....	97	94	35·1	6·8
,,	P22946	62280B	....	....	99	77	33·6	7·6

* Plants appeared to be ineffectively nodulated.

Table 4—(*continued*)

Species and Origin	Perth Accession Number	C.P.I. Number	Collection site altitude m	Collection site rainfall mm	Days to flowering	Individual seed weight mg	Seed protein content % d.b.	Seed oil content % d.b.
L. luteus								
Spain	P22948	67974	400	800	140	72	40·7	5·6
,, ...	P22949	67975A	400	800	144	83	41·8	5·3
,, ...	P22950	67975B	400	800	144	66	40·4	5·0
Portugal	P22951	68081A	100	1 100	129	71	43·2	4·7
,, ...	P22952	68081B	100	1 100	132	94	47·1	4·8
,, ...	P22953	68082	350	1 000	135	77	41·9	5·4
,, ...	P22954	68083	500	1 000	139	72	42·6	5·2
,, ...	P22955	68073B	500	1 500	147	68	38·4	5·5
,, ...	P22956	68084	100	400	129	68	42·7	4·5
Israel	P22957	62278B	....	....	105	153	47·0	5·1
,, ...	P22958	62283	....	....	107	150	41·4	5·7
L. hispanicus ssp. *hispanicus*								
Spain	P23007	67951	1 250	800	131	94	45·0	4·5
,, ...	P23008	67952	900	650	139	88	43·3	4·3
,, ...	P23009	67953	900	650	152	72	45·1	4·3
,, ...	P23010	67954	1 000	700	152	63	42·2	4·1
,, ...	P23011	67958A	1 000	500	137	87	41·3	4·5
,, ...	P23012	67963A	700	800	134	134	40·5	4·8
,, ...	P23013	67963B	700	800	136	119	39·4	5·2
,, ...	P23014	67964	800	850	134	121	40·4	5·2
,, ...	P23015	67965	900	900	141	86	42·0	2·8
,, ...	P23016	67966	900	850	137	94	38·3	5·7
,, ...	P23017	67967	550	550	132	111	42·5	4·5
,, ...	P23018	67970	450	1 000	137	111	38·6	5·4
,, ...	P23019	65123	1 200	....	150	85	43·9	3·8
L. hispanicus ssp. *bicolor*								
Spain	P22971	67949	1 100	600	154	46	44·2	4·1
,, ...	P22972	67950	1 250	800	156	36	43·5	4·8
,, ...	P22973	67955	1 100	500	150	45	40·7	0·3
,, ...	P22975	67957	1 200	600	155	40	45·7	2·9
,, ...	P22976	67958B	1 000	500	157	48	43·8	3·4
,, ...	P22977	67958C	1 000	500	157	60	43·5	4·8
,, ...	P22978	67959A	1 000	500	141	50	42·8	4·2
,, ...	P22979	67959B	1 000	500	148	48	40·3	4·5
,, ...	P22980	67960	900	500	134	....	42·0	....
,, ...	P22981	67961	700	500	146	67	43·3	2·6
,, ...	P22982	67962	500	1 000	130	75	37·9	5·3
,, ...	P22984	67969	800	700	150	53	40·9	5·8
,, ...	P22985	67971	400	800	142	59	39·2	4·7
,, ...	P22986	67972	200	900	146	48	38·7	1·5
,, ...	P22987	67973	400	800	141	57	36·7	5·1
,, ...	P22988	65122	1 100	....	148	48	44·8	4·7
,, ...	P22989	65124A	1 200	....	136	56	41·8	5·0
,, ...	P22990	65124B	1 200	....	153	40	44·1	4·7
Portugal	P22991	68070A	500	1 000	141	....	41·0	....
,, ...	P22992	68070B	500	1 000	153	57	45·3	3·5
,, ...	P22993	68071	600	1 000	150	40	40·9	3·3
,, ...	P22994	68073A	500	1 500	146	48	41·1	5·0
,, ...	P22995	68074	250	900	148	55	40·1	4·4
,, ...	P22996	68075	200	900	152	48	44·4	4·4
,, ...	P22997	68076	500	1 000	150	....	40·3	....
,, ...	P22998	68077	600	800	144	41	39·5	5·1
,, ...	P22999	68078A	600	800	136	44	42·9	4·4
,, ...	P23000	68078B	600	800	146	....	44·4	....
,, ...	P23001	68078C	600	800	139	40	45·2	3·7
,, ...	P23002	68078D	600	800	140	....	39·7	....
,, ...	P23003	68078E	600	800	146	58	40·0	5·3
,, ...	P23004	68079A	400	600	146	58	41·6	4·7
,, ...	P23006	68080	400	1 000	146	45	40·4	4·2

its being, with *L. angustifolius*, one of the two most widespread lupin species in the Mediterranean region, the present senior author when collecting has seen and collected only one plant. The reason for this probably lies in an anomalous (for lupins) adaptation largely to alkaline soils, which were avoided during collecting. See Gladstones (1974) for further discussion on this point.

The seed oil content of *L. micranthus* was higher than that of other Mediterranean lupins, apart from *L. albus*. On the other hand its protein content was only average. When grown on sandy soils in Western Australia, nodulation has been satisfactory but growth has always been poor; and towards maturity the plants have almost invariably succumbed to Fusarium root rots.

(6) *L. luteus*. Of the 11 *L. luteus* genotypes, eight were from high rainfall districts of northern Portugal and north-west Spain, and are both late maturing and relatively small-seeded. These probably approach the true "wild" type of *L. luteus*, even though most came from situations which suggested that they had escaped from cultivation. Other *L. luteus* seen, but not collected, in central Portugal were always either in cultivated stands or fairly clearly related to recently cultivated stands. These appeared in general to be of a somewhat larger-seeded and earlier-maturing type, resembling the cultivated bitter *L. luteus* of northern Germany from which the present sweet cultivars were derived.

The two *L. luteus* lines from Israel differed from the Portuguese collections in being moderately early flowering and in having substantially larger seeds. Although not documented in detail, it was also noted that their number of seeds per pod was consistently lower.

(7) *L. hispanicus*. Both subspecies are notably late-flowering, ssp. *bicolor* particularly so, consistent with its more northerly distribution and predominantly high altitude and/or wet natural habitats. The characteristic seed size difference between the two subspecies is well illustrated by their individual seed weights, although these also show that considerable variation exists within each subspecies; there was even a slight overlap between the two. The seed composition of both resembled that of *L. luteus*, to which *L. hispanicus* is closely related (see Gladstones 1974).

L. hispanicus was conspicuous, as it has been when grown in other years, for its susceptibility to Fusarium root rots in late spring. Susceptibility appeared to be worse than that of *L. luteus*, and of the two subspecies ssp. *bicolor* appeared on average to be the worse affected with some rows succumbing almost completely before maturity.

Table 5—Mean days to flowering*, individual seed weights, and whole seed crude protein and oil contents of wild types of Mediterranean lupin species.

Species	No. of lines	Days to flowering	Individual weight seed mg.	Seed protein % of d.m.	Seed oil % of d.m.
L. angustifolius	234	107	115	35·7	4·6
L. cosentinii	26	102	174	34·2	3·3
L. atlanticus	15	104	281	31·5	3·5
L. pilosus	5	93	515	25·7†	4·9†
L. palaestinus	3	93	219	30·9	3·8
L. micranthus	3	103	100	32·9	7·5
L. luteus	11	132	89	42·5	5·2
L. hispanicus ssp. hispanicus	13	139	97	41·7	4·6
L. hispanicus ssp. bicolor	33	146	50	41·8	4·2

* At Medina, Western Australia, with autumn (late May) sowing.

† Three effectively nodulated lines only. Two ineffectively nodulated lines not included.

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APPENDIX 1

ORIGINS AND COLLECTION SITE DATA

L. angustifolius

Site No.	C.P.I. and collection No.	Site data
		Western Australia
....	....	(P 20639). Naturalised wild type, fairly common in Perth metropolitan area and at Gingin. University of Western Australia Accession No.=N 2791.
		Israel
....	48477	(P 20736). Received from Dr J. Hackbarth, W. Germany, 1969. Apparently identical with P 20654 (University of W.A. Accession N 3739) received 1963 from the United States Department of Agriculture. No site data available, probably from coastal plain.
....	62260 (Q 030)	17/7/73. Obtained by Dr B. J. Quinlivan. Reported origin Tel Aviv. Lat. 32°.
....	62261 (Q 031)	17/7/73. Obtained by Dr B. J. Quinlivan. Reported origin Petah Tiqua. Lat. 32°.
....	....	(P 21625). Collected by Drs C. M. Francis and J. S. Katznelson, Golan Heights. Lat. 32°. Alt. 750 m, annual rainfall 700 mm.
		Turkey
....	69983	27/6/74. Collected by Drs C. M. Francis and J. S. Katznelson, near Marmaris. Lat. 37°. Alt. 50 m, annual rainfall 850 mm.
		Italy
....	....	(P 20655). Received from United States Department of Agriculture 1963. No site data available.
3	47213 (G 51)	4/6/68. Villa S. Giovanni, 10 km N of Reggio, 1 km from sea. Lat. 38°. Alt. 80 m, annual rainfall 750 mm. Brown, gritty loamy sand, pH 6·5. Parent rock granite.
2	47214 (G 47)	3/6/68, 25 km from Catanzaro on E coast road to Reggio. Lat. 39°. Alt. 5 m, annual rainfall 1 100 mm. Coarse, gritty sandy loam with schist inclusions. Parent material schistose detritus. Weed in barley field.
5	47215 (G 65).	6/6/68, 12 km NE from Palmi, 1 km N of Gioia Tauro, on Autostrada. Lat. 38°. Alt. 25 m, annual rainfall 900 mm. Deep, coarse, fluvial yellow sand, pH 6·4. On road cutting, very free drainage. Associated legumes *L. luteus*, *Ornithopus compressus*, *O. pinnatus*.
4	47216 (G 57)	4/6/68 near Scilla, c. 1 km inland on feeder road to Autostrada. Lat. 38°. Alt. 100 m, annual rainfall 800 mm. Rocky, brown gritty sandy loam, pH 6·7. On steep, rocky road embankment.
1	47217 (G 38)	30/5/68, 15 km from Catanzaro on road to Crotone. Lat. 39°. Alt. 10 m, annual rainfall 700 mm. Light brown, gritty sandy loam, pH 6·8 (on soil dump, atypical of area).

Site No.	C.P.I. and collection No.	Site data
11	47218 (G 112)	12/6/68, S lower slope of Mt. Vesuvius. Lat. 41°. Alt. 300 m, annual rainfall 950 mm. Dark grey, very rubbly, gritty sand, pH c. 7·2. Parent rock pumice. Moderate slope, very free drainage. In orchard.
10	47219 (G 111)	12/6/68, S lower slope of Mt. Vesuvius. Lat. 41°. Alt. 200 m, annual rainfall 900 mm. Gritty sand, pH c. 7·0. Parent rock pumice. Moderate slope, very free drainage. In vineyard.
9	47220 (G 110)	12/6/68, E lower slope of Mt Vesuvius. Lat. 41°. Alt. 200 m, annual rainfall 900 mm. Brownish grey, rubbly, very gritty sand, pH c. 7·3. Parent rock pumice. Flat, drainage free, run-on. Waste land.
9	47221 (G 109)	Site details as 47220.
8	47222 (G 107)	12/6/68, W lower slope of Mt. Vesuvius. Lat. 41°. Alt. 200 m, annual rainfall 950 mm. Fine loamy sand, pH c. 7·0. Parent rock pumice. Slight slope, free drainage. Waste land.
7	47223 (G 104)	12/6/68, W lower slope of Mt. Vesuvius. Lat. 41°. Alt. 100 m, annual rainfall 900 mm. Grey-brown, rubbly, loose coarse sand, pH 7·0. Parent rock pumice. Moderate slope, very free drainage. Among houses.
7	47224 (G 103)	Site details as 47223.
7	47225 (G 102)	Site details as 47223.
6	47226 (G 77)	7/6/68, 11 km SSW from Nicastro on Autostrada, c 8 km N of S. Eufémia. Lat. 39°. Alt. 30 m, annual rainfall 900 mm. Deep, brownish, coarse fluvial sand with gneissic inclusions, pH 6·7. On top of Autostrada embankment, dry, very free drainage. Associated legumes *Trifolium subterraneum*, *O. compressus*, *O. pinnatus*.
		Sicily
....	46910	Received from the Botanic Institute of the University of Catania. No site details available.
		Spain
1	67872 (GS 001)	8/6/73, 25 km NNW of Madrid. Lat. 41°. Alt. 990 m, annual rainfall 600 mm. Light brown gritty sandy loam, pH 5·5. Parent rock granite. Slope 10 to 15 per cent, free run-off drainage. Woodland margin, associated legumes *Trifolium subterraneum*, *T. cherleri*, *Ornithopus compressus*.
2	67873 (GS 005)	8/6/73, 10 km S of Segovia. Lat. 41°. Alt. 1 100 m, annual rainfall 600 mm. Light brown gritty sandy loam, acid. Parent rock granite. Roadside verge. Associated legumes *Lupinus hispanicus* ssp. *bicolor*, *T. cherleri*, *O. compressus*.
3	67874 (GS 008)	8/6/73, 5 km S of Segovia. Lat. 41°. Alt. 1 050 m, annual rainfall 600 mm. Light brown gritty sandy loam, acid. Parent rock granite. Level, free run-off drainage. Roadside verge and fallow, associated legumes *T. cherleri*, *O. compressus*.

Site No.	C.P.I. and collection No.	Site data
4	67875 (GS 015)	9/6/73, 15 km E from Villacastin on N VI. Lat. 41°. Alt. 1 250 m, annual rainfall 800 mm. Very gritty loamy sand among rock outcrops, pH 6·5. Parent rock granite. Undulating, free run-off drainage. Range grazing among pine, associated legumes *T. campestre*, *O. compressus*, *O. perpusillus*.
5	67876 (GS 017)	9/6/73, near Villacastin, 30 km NE from Avila on N VI to Madrid. Lat. 41°. Alt. 1 300 m, annual rainfall 700 mm. Light brown very gritty loamy sand among numerous rock outcrops, pH 5·7. Parent rock granite. Among stunted pines, associated legumes *L. hispanicus* ssp. *bicolor*, *O. compressus*.
6	67877 (GS 021)	9/6/73, S bank above Embalse de Burguillo on N 403, c. 42 km SSE from Avila. Lat. 40°. Alt. 900 m, annual rainfall 650 mm. Light brown loamy sand, fairly deep, pH 6·0. Parent rock granite. Free run-off drainage. On waste land between vineyard and road, associated legume *O. compressus*.
7	67878 (GS 027)	9/6/73, 19 km SSW from El Escorial on road to Navas del Rey, at turn-off to Cebreros. Lat. 40°. Alt. 1 000 m, annual rainfall 700 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Flat, free draining. Edge of fallow paddock, associated legumes *L. hispanicus* ssp. *hispanicus*, *O. compressus*.
8	67879 (GS 029)	9/6/73, 12 km SSW from El Escorial on road to Navas del Rey. Lat. 41°. Alt. 1 000 m, annual rainfall 700 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Moderate slope, free draining. Roadside, associated legumes *L. hispanicus* ssp. *hispanicus*, *O. compressus*.
9	67880 (GS 031)	9/6/73, 10 km SSW from El Escorial on road to Navas del Rey. Lat. 41°. Alt. 1 050 m, annual rainfall 700 mm. Light brown gritty loamy sand among rocks, acid. Parent rock granite. Moderate slope, free draining. Rough grazing among pines, associated legumes *L. hispanicus* ssp. *bicolor*, *O. compressus*.
10	67881 (GS 033)	10/6/73, c. 2 km E from Villacastin, 32 km NE from Avila on N VI to Madrid. Lat. 41°. Alt. 1 300 m, annual rainfall 800 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Flat, free draining. Rough grazing among pines, associated legume *O. compressus*.
11	67882 (GS 034)	10/6/73, 9 km WSW from Avila on N 110 to El Barco. Lat. 41°. Alt. 1 100 m, rainfall 500 mm. Light brown, very gritty loamy sand, fairly deep, pH 6·0. Parent rock granite. Flat, free draining. Weed at uncultivated edge of rye crop. Associated legume *L. hispanicus* ssp. *bicolor*.
12	67883 (GS 037)	10/6/73, 45 km WSW from Avila on N 110 to El Barco. Lat. 41°. Alt. 1 150 m, annual rainfall 600 mm. Light brown, very gritty loamy sand, acid. Parent rock granite. Steep slope on roadside embankment, associated legumes *T. hirtum*, *O. compressus*.
13	67884 (GS 043)	10/6/73, 60 km WSW from Avila on N 110 to El Barco. Lat. 40°. Alt. 1 200 m, annual rainfall 600 mm. Light brown, very gritty loamy sand, acid. Parent rock granite. Free draining. Woodland margin, associated legumes *L. hispanicus* ssp. *bicolor*, *O. compressus*.

Site No.	C.P.I. and collection No.	Site data
14	67885 (GS 049)	10/6/73, 11 km NW from Béjar on road to Sequeros. Lat. 40°. Alt. 1 000 m, annual rainfall 500 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Flat, fallow land, associated legumes *L. hispanicus* ssp. *bicolor*, *O. compressus*.
15	67886 (GS 055)	11/6/73, 8 km S from Ciudad Rodrigo on road to Coria. Lat. 41° Alt. 700 m, annual rainfall 500 mm. Brown, stony loamy sand to sandy loam, pH 5·7. Parent rocks granite and schist? Roadside, flat, associated legumes *L. hispanicus* ssp. *bicolor*, *O. compressus*.
16	67887 (GS 061)	11/6/73, 12 km E from the Ciudad Rodrigo—Caceres road along route 512 from Hoyos to Villanueva. Lat. 40°. Alt. 400 m, annual rainfall 800 mm. Rubbly brown silty sand, pH 5·7. Parent material alluvium with schistose detritus. Flat, free draining. In fallow paddock following cereal, associated legumes *O. compressus*, *O. pinnatus*, *O. perpusillus*.
17	67888 (GS 067)	11/6/73, Plasencia. Lat. 40°. Alt. 450 m, annual rainfall 1 100 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Roadside.
18	67889 (GS 068)	11/6/73, 4 km E from Plasencia on road to Jarandilla de la Vera. Lat. 40°. Alt. 500 m, annual rainfall 1 100 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Roadside.
19	67890 (GS 069)	11/6/73, 21 km E from Plasencia on road to Jarandilla de la Vera. Lat. 40°. Alt. 500 m, annual rainfall 1 000 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Roadside, associated legumes *O. compressus*, *O. pinnatus*.
20	67891 (GS 070)	11/6/73, 24 km E from Plasencia on road to Jarandilla de la Vera. Lat. 40°. Alt. 500 m, annual rainfall 1 000 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Roadside, associated legumes *L. hispanicus* ssp. *bicolor*, *O. compressus*.
21	67892 (GS 077)	12/6/73, 5 km S from Navalmoral on road to Guadalupe. Lat. 40°. Alt. 400 m, annual rainfall 600 mm. Brownish grey, very gritty loamy sand, pH 5·8. Parent rock granite. Slope 15%, free run-off drainage. Edge of fallow, associated legumes *O. compressus*, *O. pinnatus*.
22	67893 (GS 078)	12/6/73, 20 km SSE from Navalmoral on road to Guadalupe. Lat. 40°. Alt. 450 m, annual rainfall 600 mm. Brown, rubbly, very gritty loam. Parent rock schist. On roadside embankment.
23	67894 (GS 081)	12/6/73, Sierra de Guadalupe, 48 km SSE from Navalmoral on road to Guadalupe. Lat. 40°. Alt, 700 m. annual rainfall 800 mm. Flaky brown loam, acid. Parent rock schist. Roadside, free run-off drainage.
24	67895 (GS 082)	12/6/73, Sierra de Guadalupe, 54 km SSE from Navalmoral on road to Guadalupe. Lat. 40°. Alt. 800 m, annual rainfall 850 mm. Flaky brown loam, acid. Parent rock schist. Roadside, associated legumes *L. hispanicus* ssp. *hispanicus*, *O. compressus*.
25	67896 (GS 085)	12/6/73, Sierra de Guadalupe, 3 km N from Guadalupe on road to Navalmoral. Lat. 39°. Alt. 900 m, annual rainfall 900 mm. Flaky brown loam, acid. Parent rock schist. Roadside, associated legume *L. hispanicus* ssp. *hispanicus*.

Site No.	C.P.I. and collection No.	Site data
26	67897 (GS 086)	12/6/73, Sierra de Guadalupe, 1 km N from Guadalupe on road to Navalmoral. Lat. 39°. Alt. 850 m, annual rainfall 900 mm. Flaky brown loam, acid. Parent rock schist. Roadside, associated legume *O. compressus*.
27	67898 (GS 090)	13/6/73, 13 km WSW from Zafra on C 4311 to Jerez de los Caballeros. Lat. 38°. Alt. 500 m, annual rainfall 650 mm. Grey brown sandy loam, pH 7·5. Parent rock metamorphosed granite. Flat, drainage free, run-on. Roadside and among adjacent olive trees, associated legumes *T. cherleri*, *Astragalus hamosus*.
28	67899 (GS 091)	13/6/73, 12 km SW from Zafra on N 435 to Fregenal de la Sierra. Lat. 38°. Alt. 500 m, annual rainfall 650 mm. Light brown, stony, loamy sand, pH 6·0. Parent rock metamorphosed granite. Flat, drainage free, run-off. At edge of cultivated field and among rocks in field, associated legumes *Trifolium* spp., *O. compressus*.
29	67900 (GS 093)	13/6/73, 16 km SW from Zafra on N 435 to Fregenal de la Sierra. Lat. 38°. Alt. 450 m, annual rainfall 600 mm. Light brown, stony, loamy sand, pH 7·5. Parent rock metamorphosed granite. Drainage free, run-off. Roadside.
30	67901 (GS 094)	13/6/73, 22 km SW from Zafra on N 435 to Fregenal de la Sierra. Lat. 38°. Alt. 300 m, annual rainfall 550 mm. Friable light sandy loam, pH 7·0. Parent rock schist. Drainage free, run-off. Roadside.
31	67902 (GS 095)	13/6/73, 29 km SW from Zafra on N 435 to Frenegal de la Sierra. Lat. 38°. Alt. 600 m, annual rainfall 700 mm. Friable light sandy loam, neutral. Parent rock schist. Drainage free, run-off. Roadside.
32	67903 (GS 096)	13/6/73, 33 km SW from Zafra on N 435 to Frenegal de la Sierra. Lat. 38°. Alt. 600 m, annual rainfall 700 mm. Stony, brown light sandy loam, pH 5·8. Parent rock metamorphosed granite. Among rocks and cork oaks, associated legume *O. compressus*.
34	67904 (GS 098)	13/6/73, 16 km SE from Frenegal de la Sierra on C 434 to Cala. Lat. 38°. Alt. 800 m, annual rainfall 800 mm. Brown, flaky clay loam, pH 6·7. Parent rock slate. Slope 10%, drainage free fun-off. On waste land near road, associated legume *O. compressus*.
35	67905 (GS 099)	13/6/73, 35 km SE from Frenegal de la Sierra on C 434 to Cala. Lat. 38°. Alt. 900 m, annual rainfall 850 mm. Brown, flaky clay loam, pH 5·5. Parent rock slate. Drainage free, run-off. Roadside in cork oak country, associated legumes *L. hispanicus* ssp. *hispanicus*, *T. subterraneum*, *O. compressus*.
36	67906 (GS 103)	13/6/73, 43 km SE from Fregenal de la Sierra on C 434 to Cala. Lat. 38°. Alt. 900 m, annual rainfall 850 mm. Growing at edge of road among rubble, mainly road foundation.
37	67907 (GS 104)	13/6/73, 4 km N from Santa Olalla de Cala on N 630 to Merida. Lat. 38°. Alt. 550 m, annual rainfall 550 mm. Brown, gritty sandy loam, pH 6·0. Parent rock metamorphosed granite. Level, drainage free, run-on. Roadside, associated legumes *T. subterraneum*, *O. compressus*.

Site No.	C.P.I. and collection No.	Site data
38	67908 (GS 106)	13/6/73, 19 km N from Santa Olalla de Cala on N 630 to Merida. Lat. 38°. Alt. 700 m, annual rainfall 600 mm. Brown, gritty sandy loam, pH 7·0. Parent rock granite. On roadside bank, associated legumes *T. subterraneum*, *O. compressus*.
39	67909 (GS 107)	13/6/73, 27 km N from Santa Olalla de Cala on N 630 to Merida. Lat. 38°. Alt. 800 m, annual rainfall 600 mm. Very rocky, gritty, light brown loamy sand, pH 5·8. Parent rock granite. Slope 10%, drainage free, run-off. On (?) roughly fallowed waste land, associated legume *O. compressus*.
40	67910 (GS 111)	14/6/73, 20 km N from Merida on N 630 to Caceres. Lat. 39°. Alt. 300 m, annual rainfall 500 mm. Light brown, very gritty clay loam, pH 7·0. Parent rock granite. Drainage free, run-off. In fallow among rocks.
41	67911 (GS 112)	14/6/73, 26 km N from Merida on N 630 to Caceres. Lat. 39°. Alt. 450 m, rainfall 550 mm. Light brown sandy loam, acid. Parent rock schist. Drainage free, run-on. Edge of cork oak woodland, associated legumes *O. compressus*, *O. pinnatus*.
42	67912 (GS 115)	14/6/73, 55 km N from Merida on N 630 to Caceres. Lat. 39°. Alt. 350 m, annual rainfall 500 mm. Edge of road, soil type indeterminate. Associated legume *O. compressus*.
43	67913 (GS 119)	15/6/73, 47 km SE from Zafra on N 432 to Cordoba. Lat. 38°. Alt. 600 m, annual rainfall 500 mm. Light brown gritty sandy loam, pH 6·4. Parent rock granite. Drainage free, run-off. Among rocks at edge of fallow, associated legume *O. compressus*.
44	67914 (GS 121)	15/6/73, 2 km NE from Azuaga, 72 km ESE from Zafra on N 432 to Cordoba. Lat. 38°. Alt. 550 m, annual rainfall 500 mm. Brown sandy loam, slightly self-mulching, pH 7·0. Parent rock (?) metamorphosed granite. On ditch embankment.
45	67915 (GS 122)	15/6/73, 21 km ENE from Penarroya on C 421 to Pozoblanco. Lat. 38°. Alt. 600 m, annual rainfall 500 mm. Flaky brown loam, pH 7·2. Parent rock slate. On steep side of road cutting.
46	67916 (GS 123)	15/6/73, 21 km S from Alcaracejos on C 411 to Espiel. Lat. 38°. Alt. 650 m, annual rainfall 500 mm. Friable flaky brown loam, pH 7·0. Parent rock slate. Drainage free, run-off. White-seeded type, very common along roadside and in adjacent fields, probably cultivated. Associated legume *O. compressus*.
47	67917 (GS 124)	15/6/73, 43 km NW from Cordoba on N 432 to Espiel. Lat. 38°. Alt. 500 m, annual rainfall 550 mm. Stony brown sandy loam, pH 7·0. Parent rock schist. Common along roadside
48	67918 (GS 127)	17/6/73, 14 km N from Montoro on N 420 to Ciudad Real. Lat. 38°. Alt. 250 m, annual rainfall 600 mm. Gritty brown sandy loam, pH 6·7. Parent rock metamorphosed granite. On steep roadside embankment, associated legume *O. compressus*.
49	67919 (GS 129)	17/6/73, 27 km N from Montoro on N 420 to Ciudad Real. Lat. 38°. Alt. 600 m, annual rainfall 750 mm. Grey-brown gritty sand, pH 6·0. Parent rock granite. Flat, free run-off drainage. Roadside, associated legume *O. compressus*.

Site No.	C.P.I. and collection No.	Site data
50	67920 (GS 132)	17/6/73, 87 km N from Montoro on N 420 to Ciudad Real. Lat. 38°. Alt. 830 m, annual rainfall 700 mm. Rocky brown sandy loam, pH 6·7. Parent rock schist. Free drainage. Roadside, associated legume *O. compressus*. Close to highest point on road.
51	67921 (GS 134)	17/6/73, 89 km N from Montoro on N 420 to Ciudad Real. Lat. 38°. Alt. 770 m, annual rainfall 650 mm. Brown silty sandy loam, pH 7·2. Parent rock schist. Free drainage. Roadside at edge of olive grove, associated legumes *T. subterraneum*, *O. compressus*. Seeds rather flattened.
52	67922 (GS 136)	18/6/73, 6 km N from Marbella on road to Coin. Lat. 37°. Alt. 250 m, annual rainfall 600 mm. Brown sandy loam, pH 7·2. Parent rock micaceous schist. Drainage free, run-off. Roadside.
53	67923 (GS 137)	18/6/73, 24 km N from Algeciras on road to Jimena de la Frontera. Lat. 36°. Alt. 50m, annual rainfall 900 mm. Yellow-brown loamy sand, pH 6·8. Parent rock granite. Free drainage. Growing among cork oaks.
54	67924 (GS 138)	18/6/73, 6 km N from Algeciras on road to Malaga. Lat. 36°. Alt. 10 m, annual rainfall 850 mm. Brown loamy sand, sublittoral, pH 7·0. Flat, free drainage. Vacant land near road, associated legume *Medicago tornata*.
55	67925 (GS 141)	20/6/73, 8 km SE from Valverde del Camino on road to La Palma (c. 35 km NNE of Huelva). Lat. 38°. Alt. 250 m, annual rainfall 800 mm. Light brown, gritty sand, pH 5·7. Parent rock granite. Moderate-steep slope, free run-off drainage. At edge of Eucalyptus plantation, associated legumes *O. compressus*, *O. pinnatus*.
56	67926 (GS 144)	20/6/73, at Zalamea la Real, 20 km NE from Valverde del Camino on N 435 to Fregenal de la Sierra. Lat. 38°. Alt. 400 m, annual rainfall 900 mm. Brown sandy loam, pH 5·6. Parent rock schist. Slope 10%, free run-off drainage. At edge of Eucalyptus plantation, perhaps originally cultivated. Associated legume *O. compressus*.
57	67927 (GS 146)	20/6/73, 26 km N from Valverde del Camino on N 435 to Fregenal de la Sierra. Lat. 38°. Alt. 400 m, annual rainfall 900 mm. Rocky brown sandy loam, pH 5·6. Parent rock schist. On roadside embankment, associated legume *O. compressus*.
58	67928 (GS 147)	20/6/73, 44 km N from Valverde del Camino on N 435 to Fregenal de la Sierra. Lat. 38°. Alt. 450 m, annual rainfall 1 000 mm. Very stony brown loamy sand, pH 7·0. Parent rock schist. On steep roadside embankment.
59	67929 (GS 148)	20/6/73, 45 km N from Valverde del Camino on N 435 to Fregenal de la Sierra. Lat. 38°. Alt. 450 m, annual rainfall 1 000 mm. Gritty brown loamy sand, pH 6·3. Parent rock granite. Free drainage. Roadside, associated legume *L. hispanicus* ssp. *hispanicus*.
60	67930 (GS 150)	20/6/73, 23 km W from Aracena on N 433 to Portuguese border. Lat. 38°. Alt. 600 m, annual rainfall 950 mm. Light brown, gritty loamy sand, pH 6·5. Parent rock granite. Roadside.

Site No.	C.P.I. and collection No.	Site data
61	67931 (GS 152)	20/6/73, 34 km E from Portuguese border on N 433 to Aracena. Lat. 38°. Alt. 450 m, annual rainfall 700 mm. Light brown loamy sand, pH 6·8. Parent rock granite. Roadside and semi-cultivated among cork oaks. Associated legume *O. compressus*.
62	67932 (GS 153)	20/6/73, 21 km E from Portuguese border on N 433 to Aracena. Lat. 38°. Alt. 300 m, annual rainfall 650 mm. Grey brown, gritty loamy sand, pH 6·5. Parent rock granite. Drainage free, run-off. Among granite rocks near road, associated legume *O. compressus*.
63	67933 (GS 155)	26/6/73, 5 km N from Portuguese border on road to Verin. Lat. 42°. Alt. 400 m, annual rainfall 800 mm. Grey-brown sandy loam, acid, alluvium ex granite. Roadside, associated legumes *L. hispanicus* ssp. *bicolor*, *O. compressus*.
64	67934 (GS 156)	27/6/73. Verin, below parador. Lat. 42°. Alt. 450 m, annual rainfall 800 mm. Grey brown, very gritty loamy sand, acid. Parent rock granite. Roadside, on steep slope, associated legume *O. compressus*. Probably wild.
65	67935 (GS 157)	27/6/73, Verin. 1 km below parador on road to turn-off. Lat. 42°. Alt. 400 m, annual rainfall 800 mm. Stony brown sandy loam, acid, alluvium ex granite. Flat, free drainage. Roadside, adjacent vineyards. Associated legumes *L. luteus L. hispanicus* ssp. *bicolor*, *O. compressus*.
66	67936 (GS 160)	27/6/73, 25 km NW from Verin on N 525 to Orense. Lat. 42°. Alt. 600 m, annual rainfall 1 200 mm. Gritty loamy sand, acid. Parent rock granite. Moderate slope, free run-off drainage. Roadside, associated legume *L. luteus*.
67	67937 (GS 161)	27/6/73, 13 km SE from Orense on N 525 to Verin. Lat. 42°. Alt. 500 m, annual rainfall 1 200 mm. Grey-brown, gritty loamy sand, acid. Parent rock granite. Roadside, associated legumes *T. subterraneum*, *O. compressus*.
68	67938 (GS 164)	27/6/73, 5 km SSE from Orense on N 525 to Verin. Lat. 42°. Alt. 300 m, annual rainfall 1 000 mm. Grey-brown, gritty loamy sand, acid. Parent rock granite. Roadside, associated legume *O. compressus*.
69	67939 (GS 165)	28/6/73. Orense, on N 120. Lat. 42°. Alt. 150 m, annual rainfall 900 mm. Light brown, gritty loamy sand. Parent rock granite. On steep, new road embankment.
70	67940 (GS 166)	28/6/73. Site as 67939, different plant type.
71	67941 (GS 167)	28/6/73. Orense, on C 546. Lat. 42°. Alt. 150 m, annual rainfall 900 mm. Brown loamy sand, acid. Parent rock granite. Drainage free, run-on. At edge of road, associated legumes *T. subterraneum*, *O. compressus*.
72	67942 (GS 170)	28/6/73, 4 km NE from Orense on C 546 to Monforte. Lat. 42°. Alt. 150 m, annual rainfall 900 mm. Brown loamy sand, acid. Parent rock granite. Roadside.
73	67943 (GS 172)	28/6/73, 10 km NE from Allariz on connecting road to N 120. Lat. 42°. Alt. 550 m, annual rainfall 1 100 mm. Brown loamy sand, acid. Parent rock granite. In grazed fallow, relict of farmer planting?

Site No.	C.P.I. and collection No.	Site data
74	67944 (GS 173)	28/6/73, below parador, Verin. Lat. 42°. Alt. 400 m, annual rainfall 800 mm. Light brown, gritty loamy sand and sandy loam alluvium, acid. Parent rock granite. Composite of *L. angustifolius* types along 2 km of road between parador and turn-off: types should include 67934 and 67935. Associated legumes *L. luteus*, *L. hispanicus* ssp. *bicolor*, *O. compressus*.
75	67945 (GS 178)	29/6/73. Verin, E outskirts of town. Lat. 42°. Alt. 400 m, annual rainfall 800 mm. Grey-brown, gritty sandy loam, acid, alluvium ex granite. Flat, free drainage. In vacant town block, associated legumes *L. luteus*, *L. hispanicus* ssp. *bicolor*, *O. compressus*.
76	67946 (GS 179)	29/6/73, 5 km E from Verin on N 525 to Puebla de Sanabria. Lat. 42°. Alt. 500 m, annual rainfall 850 mm. Grey-brown, gritty sandy loam, acid. Parent rock schist. Free run-off drainage. Roadside, associated legume *O. compressus*.
77	67947 (GS 181)	10/6/73, somewhere between Avila and Ciudad Rodrigo. Further details not recorded.
78	65105 (NS 001)*	13/6/73, 17 km NW from Barcelona on N 2. Lat. 42°. Alt. 180 m.
79	65106 (NS 002)	14/6/73, 31 km N from Barcelona on N 152. Lat. 42°. Alt. 500 m.
80	65107 (NS 003)	14/6/73, 12 km N from Ripoll on N 152. Lat. 42°. Alt. 950 m.
81	65109 (NS 005)	14/6/73, 3 km E from Seo de Urgel on C 1313 to Puigcerda. Lat. 42°. Alt. 750 m.
82	65110 (NS 006)	15/6/73, 8 km S from Seo de Urgel on C 1313 to Artesa de Segre. Lat. 42°. Alt. 650 m. On waste land.
83	65112 (NS 008)	15/6/73. Lerida, near Rio Segre on C 1313. Lat. 42°. Alt. 150 m.
84	65113 (NS 009)	16/6/73. Zaragoza, on waste land along River Ebro. Lat. 42°. Alt. 200 m.
85	65116 (NS 021)	19/6/73, 1 km S from El Burgo de Osma, about 60 km WSW from Soria. Lat. 42°. Alt. 900 m. Roadside near Duero River.
86	65117 (NS 027)	20/6/73, 28 km N from Pamplona on N 121. Lat. 43°. Alt. 750 m.
87	65118 (NS 028)	20/6/73. Elizondo, on N 121 N from Pamplona, 23 km S from French border. Lat. 43°. Alt. 300 m.
88	65121 (NS 032)	22/6/73, 25 km E from Ponferrada on N VI to Astorga. Lat. 43°. Alt. 850 m. Brownish loam. Waste area along roadway.

* NS series collected by Dr I. Forbes, United States Department of Agriculture, in north and north-east Spain.

Portugal

1	68053 (GP 001)	21/6/73, 8 km N from Beja on N 18 to Evora. Lat. 38°. Alt. 150 m, annual rainfall 600 mm. Light brown, sandy loam, pH 6·8. Parent rock granite. Flat, drainage free, run-off. Uncultivated land near road, associated legume *Ornithopus compressus*.

Site No.	C.P.I. and collection No.	Site data
2	68054 (GP 003)	21/6/73, 17 km N from Portel on N 18 to Evora. Lat. 38°. Alt. 200 m, annual rainfall 600 mm. Light brown, gritty loamy sand, pH 6·0. Parent rock granite. Among cork oaks and rocks near road, may originally have been planted. Associated legumes *O. compressus. O. pinnatus.*
3	68055 (GP 004)	21/6/73. Evora, outskirts of town on N 254 to Vila Vicosa. Lat. 39°. Alt. 250 m, annual rainfall 650 mm. Light brown, gritty loamy sand, pH 6·6. Parent rock granite. Drainage free, run-off. On road verge.
4	68056 (GP 005)	21/6/73, 4 km past S. Miguel de Machete, c. 22 km NE from Evora on N 254 to Vila Vicosa. Lat. 39°. Alt. 250 mm, annual rainfall 600 mm. Light brown, gritty loamy sand, acid. Parent rock granite. Roadside, associated legume *O. compressus.*
5	68057 (GP 006)	21/6/73, Elvas. Lat. 39°. Alt. 300 m, annual rainfall 550 mm. Brown, gritty loamy sand, pH 7·0. Parent rock granite. Drainage free, run-off. At edge of olive grove, perhaps cultivated. Associated legumes *L. luteus* (cultivated?), *O. compressus.*
6	68058 (GP 010)	22/6/73, 41 km NNE from Estremoz on N 18 to Portalegre. Lat. 39°. Alt. 300 m, annual rainfall 575 mm. Growing at edge of road in rubble of road foundations. Associated legume *O. compressus.*
7	68059 (GP 012)	22/6/73, 3 km N from Portalegre on road to Castelo de Vide. Lat. 39°. Alt. 550 m, annual rainfall 850 mm. Light brown, loamy sand, acid. Parent rock granite. Drainage free, run-on. Roadside, associated legumes *T. subterraneum, O. compressus.*
8	68060 (GP 015)	22/6/73, 4 km NNW from Castelo de Vide on road to Montalvao. Lat. 39°. Alt. 500 m, annual rainfall 850 mm. Grey brown, loamy sand, acid. Parent rock granite. Roadside, associated legumes *T. subterraneum, O. compressus.*
9	68061 (GP 021)	24/6/73, Vila Real. Lat. 41°. Alt. 350 m, annual rainfall 1 000 mm. Brown, gritty sandy loam, pH 5·5. Parent rock granite. Moderate slope, free run-off drainage. Volunteering (originally cultivated?) among fruit trees, associated legumes *L. luteus* (cultivated?), *O. compressus, O. pinnatus.*
10	68062 (GP 026)	24/6/73, Mirandela. Lat. 41°. Alt. 250 m, annual rainfall 600 mm. Flaky brown loam, pH 5·8. Parent rock schist. Moderate-steep slope, free run-off drainage. Volunteering at edge of olives and on railway embankment below, probably originally cultivated. Associated legume *O. compressus.*
11	68063 (GP 028)	25/6/73, 25 km N from Viseu on N 2 to Vila Real. Lat. 41°. Alt. 500 m, annual rainfall 1 500 mm. Grey, very gritty loamy sand, pH 5·6. Parent rock granite. On roadside embankment, associated legumes *L. hispanicus* ssp. *bicolor, O. compressus, O. pinnatus.*
12	68064 (GP 033)	25/6/73, 17 km S from Viseu on road to Nelas. Lat. 41°. Alt. 200 m, annual rainfall 900 mm. Grey, very gritty loamy sand, acid. Parent rock granite. Edge of road. Associated legumes *L. hispanicus* ssp. *bicolor, O. compressus, O. pinnatus, O. perpusillus.*
13	68065 (GP 041)	25/6/73, 16 km NW from Trancoso on N 229 to Lamego. Lat. 41°. Alt. 600 m, annual rainfall 800 mm. Gritty grey sand, pH 5·8. Parent rock granite. Roadside, isolated plant. Associated legumes *L. hispanicus* ssp. *bicolor, O. compressus.*

Site No.	C.P.I. and collection No.	Site data
14	68066 (GP 048)	26/6/73, 2 km S from Vidago, 21 km SW from Chaves, on N 2 to Vila Real. Lat. 42°. Alt. 400 m, annual rainfall 1 000 mm. Grey, very gritty sand, pH 6·5. Parent rock granite. Moderate slope, free run-off drainage. On bank below road in forest country, associated legumes *L. hispanicus* ssp. *bicolor*, *O. compressus*.
15	68067 (GP 050)	29/6/73, 3 km S from Vidago, 22 km SW from Chaves, on N 2 to Vila Real. Lat. 42°. Alt. 450 m, annual rainfall 1 000 mm. Grey, coarse sand, acid. Parent rock granite. Forest margin, associated legume *O. compressus*.
16	68068 (GP 051)	29/6/73, 4 km S from Vidago, 23 km SW from Chaves, on N 2 to Vila Real. Lat. 42°. Alt. 500 m, annual rainfall 1 050 mm. Grey, coarse sand, acid. Parent rock granite. Roadside.
17	68069 (GP 052)	1/7/73, 10 km S from Colares on N 247 to Cascais, c. 0·5 km from sea. Lat. 39°. Alt. 100 m, annual rainfall 400 mm. Brown gritty sandy loam, pH 6·8. Parent rock granite. Slope about 20%, aspect south overlooking sea, free run-off drainage. Growing among low coastal scrub, apparently wild. Associated legumes *L. luteus*, *O. compressus*.
		Morocco
1	65197 (GM 006)	1/5/73, 20 km NNE from Rabat on road to Kenitra. Lat. 34°. Alt. 50 m, annual rainfall 500 mm. Deep, red-brown fine loamy sand, pH c. 7·3. Parent rock coastal limestone. Flat, free drainage. Roadside, associated legume *L. cosentinii*.
2	65198 (GM 011)	2/5/73, 7 km E from Kenitra on road to Fes. Lat. 34°. Alt. 50 m, annual rainfall 550 mm. Deep, red-brown fine loamy sand, pH 6·5. Alluvium ex coastal limestone. Slight slope, free drainage. Fallow, associated legumes *L. luteus*, *L. cosentinii*, *Ornithopus compressus*, *O. isthmocarpus*, *Medicago tornata*.
3	65199 (GM 022)	2/5/73, 57 km E from Kenitra on road to Fes. Lat. 34°. Alt. 100 m, annual rainfall 525 mm. Deep, brownish fine sand, pH 6·3. Parent rock coastal limestone. Flat, free drainage. In Ecualyptus plantation, associated legume *O. isthmocarpus*.
4	65200 (GM 027)	3/5/73, 6 km E from Rabat on road to Meknes. Lat. 34°. Alt. 50 m, annual rainfall 525 mm. Deep, brown fine loamy sand, pH 7·2, alluvium ex coastal limestone. Flat, free drainage. Fallow/rough pasture, associated legumes *L. cosentinii*, *T. subterraneum*, *O. isthmocarpus*, *M. tornata*.
5	65201 (GM 032)	3/5/73, 17 km E from Rabat on road to Meknes. Lat. 34°. Alt. 100 m, annual rainfall 550 mm. Deep, reddish brown, fine loamy sand, pH 6·8. Parent rock coastal limestone. Slight slope, very free drainage. Fallow, associated legumes *L. cosentinii*, *T. subterraneum*, *O. compressus*, *O. pinnatus*, *O. perpusillus*, *M. tornata*.
6	65202 (GM 039)	3/5/73, 27 km E from Rabat on road to Meknes. Lat. 34°. Alt. 150 m, annual rainfall 525 mm. Deep, pale brown silty sand, pH 6·5. Parent rock coastal limestone. Slight slope, free run-on drainage. Roadside, associated legumes *T. subterraneum*, *O. compressus*.

Site No.	C.P.I. and collection No.	Site data
7	65203 (GM 042)	3/5/73, 38 km E from Rabat on road to Meknes. Lat. 34°. Alt. 150 m, annual rainfall 525 mm. Deep, pale brown loamy sand, pH 6·5. Parent rock coastal limestone. Flat, free drainage. Roadside.
8	65204 (GM 044)	3/5/73, 65 km E from Rabat on road to Meknes. Lat. 34°. Alt. 200 m, annual rainfall 525 mm. Deep, light pinkish brown fine sand, pH 6·0. Parent rock coastal limestone. Flat, very free drainage. Fallow adjacent vineyards.
9	65205 (GM 046)	5/5/73, 11 km S from Rabat on road to Rommani. Lat. 34°. Alt. 100 m, annual rainfall 500 mm. Deep, brown silty sand, pH 6·5. Parent rock coastal limestone. Flat, free drainage. Roadside at edge of cork oak woodland, associated legumes *T. cherleri*, *O. compressus*, *O. isthmocarpus*.
10	65206 (GM 049)	5/5/73, 18 km S from Rabat on road to Rommani. Lat. 34°. Alt. 100 m, annual rainfall 500 mm. Deep, brown silty sand, pH 6·0, alluvium ex coastal limestone. Flat, free drainage. Fallow/rough pasture, associated legumes *L. cosentinii*, *O. compressus*, *O. isthmocarpus*.
11	65207 (GM 075)	8/5/73, Kerdous Plateau (Anti Atlas Mountains), 64 km E from Tisnit on road to Tafraoute. Lat. 30°. Alt. 1 200 m, annual rainfall 375 mm. Brown rocky loam, pH 7·5. Parent rock schist. Moderate slope, free run-off drainage. Weed in barley field, associated legumes *L. atlanticus*, *Medicago* spp.
12	65208 (GM 077)	8/5/73, Anti Atlas, 14 km W from Tafraoute on road to Tisnit. Lat. 30°. Alt. 1 000 m, annual rainfall 200 mm. Light brown gritty sandy loam, pH 7·2. Parent rock granite. Moderate slope, free drainage. Around granite outcrop in almond grove: would receive run-off from rocks. Associated legume *L. atlanticus*.
13	65209 (GM 078)	8/5/73, Anti Atlas, 5 km W from Trafaoute on road to Tisnit. Lat. 30°. Alt. 1 000 m, annual rainfall 200 mm. Pale brown, coarse sand, pH c. 7·0. Parent rock granite. Free drainage. Roadside, with considerable run-on from road and adjacent granite rocks.
14	65210 (GM 108)	15/5/73, 8 km SE from Oulmes on road to Khenifra. Lat. 33°. Alt. 1 000 m, annual rainfall 700 mm. Brown flaky loam, pH 6·5. Parent rock schist. At edge of wheat crop on top of steep embankment. Associated legumes *O. compressus*, *Scorpiurus muricatus*.
15	65211 (GM 120)	17/5/73, 40 km W from Taza on road to Fes. Lat. 34°. Alt. 330 m, annual rainfall 600 mm. Deep, red-brown, gritty friable clay loam (terra rossa), pH 8·0. Parent rock limestone. Slight slope, free run-off drainage. Volunteering by road and in crop fallow, common, probably originally cultivated. Not present on adjacent grey-brown clays. Associated legumes *Vicia* spp., *Cicer arietinum*, *Medicago* spp., *Scorpiurus muricatus*.
16	65212 (GM 124)	19/5/73, 30 km ESE from Chechaouen (Xauen) on road to A1 Hoceima. Lat. 35°. Alt. 900 m, annual rainfall 1 150 mm. Friable flaky clay, pH 7·0. Parent rock shale. Moderate–steep slope, free run-off drainage. Growing among olive and fig trees and as a weed in surrounding wheat crops: probably originally sown for green manure.

Site No.	C.P.I. and collection No.	Site data
17	65213 (GM 125)	19/5/73, 25 km ESE from Chechaouen (Xauen) on road to A1 Hoceima, just E of Bab Taza. Lat. 35°. Alt. 920 m, annual rainfall 1 150 mm. Friable flaky clay, pH 7·0. Parent rock shale. Steep slope, free run-off drainage. Volunteering around olive grove, probably originally sown for green manure. Common all around Bab Taza.
18	65214 (GM 126)	19/5/73, 23 km ESE from Chechaouen (Xauen) on road to A1 Hoceima, just W of Bab Taza. Site details as for 65213.
19	65215 (GM 128)	19/5/73, just S of Chechaouen (Xauen) on road to A1 Hoceima. Lat. 35°. Alt. 650 m, annual rainfall 900 mm. Deep, light brown, friable flaky loam, pH 5·7. Parent rock shale. Steep slope, free run-off drainage. Volunteering at edge of barley crop, associated legume *O. compressus*.
20	65216 (GM 130)	19/5/73, 3 km N from Chechaouen (Xauen) on road to Tetouan. Lat. 35°. Alt. 520 m, annual rainfall 900 mm. Deep, brown, flaky clay loam, pH 7·6. Parent rock shale. Steep slope, free run-off drainage. Roadside, associated legumes *Medicago* spp., *Scorpiurus muricatus*. Heavy Phomopsis infection showing on previous year's stems.
21	65217 (GM 132)	20/5/73, 10 km SE from Tangier on road to Tetouan. Lat. 36°. Alt. 150 m, annual rainfall 775 mm. Deep, yellow-grey, flaky clay, pH 7·0. Parent rock shale. Moderate slope, free run-off drainage. Rough grazing and roadside, dense stand.
22	65218 (GM 136)	20/5/73, 73 km S from Tangier on main inland route to Larache. Lat. 36°. Alt. 100 m, annual rainfall 700 mm. Deep, light brown friable clay loam, pH 7·0. Parent rock shale. Moderate–steep slope, free run-off drainage. Road cutting.
23	65219 (GM 139)	21/5/73, 10 km SE from Larache on road to Meknes. Lat. 35°. Alt. 40 m, annual rainfall 680 mm. Deep, red brown loamy sand, pH 7·0, alluvium ex coastal limestone. Flat, free drainage. Roadside verge.
		L. luteus
		Spain
1	67974 (GS 158)	27/6/73. Verin, 1 km below parador on road to turn-off. Lat. 42°. Alt. 400 m, annual rainfall 800 mm. Stony, brown sandy loam, acid, alluvium ex granite. Flat, free drainage. Roadside, adjacent vineyards. Associated legumes *L. angustifolius, Ornithopus compressus*.
2	67975 (GS 174)	28/6/73. Verin, below parador, along 2 km to turn-off. Lat. 42°. Alt. 400 m, annual rainfall 800 mm. Gritty loamy sands and sandy loams, acid, alluvium ex granite. Flat, free drainage. Edge of vineyard. Composite of *L. luteus* types along road, should include 67974. Associated legumes *L. angustifolius, L. hispanicus* spp. *bicolor, O. compressus*.
		Portugal
1	68081 (GP 018)	23/6/73. Vila Nova de Famalicao, 32 km NNE from Porto on N 14 to Braga. Lat. 41°. Alt. 100 m, annual rainfall 1 100 mm. Grey-brown, very gritty loamy sand, pH 5·5. Parent rock granite. Slight slope, free run-off drainage. In vacant block adjacent vineyard: probably escaped green manure crop, common in vicinity. Associated legumes *O. compressus, O. pinnatus*.

Site No.	C.P.I. and collection No.	Site data
2	68082 (GP 022)	24/6/73. Vila Real. Lat. 41°. Alt. 350 m, annual rainfall 1 000 mm. Brown, gritty sandy loam, pH 5·5. Parent rock granite. Moderate slope, free run-off drainage. Volunteering (originally cultivated?) among fruit trees, associated legumes *L. angustifolius* (cultivated?), *O. compressus*, *O. pinnatus*.
3	68083 (GP 024)	24/6/73, 38 km ENE from Vila Real on N 15 to Mirandela. Lat. 41°. Alt. 500 m, annual rainfall 1 000 mm. Grey, gritty loamy sand, pH 6·2. Parent rock granite. Drainage free, run-on plus some seepage. At edge of meadow, perhaps previously cultivated there. Associated legumes *L. hispanicus* spp. *bicolor*, *T. repens*, *O. compressus*, *O. perpusillus*. Plant types suggested possible natural crossing with *L. hispanicus*.
4	68073B (GP 030·2)	25/6/73, 25 km N from Viseu on N 2 to Vila Real. Lat. 41°. Alt. 500 m, annual rainfall 1 500 mm. Grey, very gritty loamy sand, pH 5·6. Parent rock granite. On roadside embankment, associated legumes *L. angustifolius*, *L. hispanicus* spp. *bicolor*, *O. compressus*, *O. pinnatus*.
5	68084 (GP 053)	1/7/73, 10 km S from Colares on N 247 to Cascais, c. 0·5 km from the sea. Lat. 39°. Alt. 100 m, annual rainfall 400 mm. Brown, gritty sandy loam, pH 6·8. Parent rock granite. Slope about 20%, aspect south overlooking sea, free run-off drainage. Growing among low coastal scrub, apparently wild. Associated legumes *L. angustifolius*, *O. compressus*.
		Italy
....	47227 (G 66)	6/6/68, 12 km NE from Palmi, Calabria, on Autostrada. Lat. 38°. Alt. 25 m, annual rainfall 900 mm. Deep, yellow coarse sand, spillway deposit, pH 6·4. Moderate slope, very free drainage. Roadside waste land. Associated legumes *L. angustifolius*, *Ornithopus compressus*, *O. pinnatus*.
		Israel
....	62278B (Q 048·2)	23/7/73. Obtained by Dr. B. J. Quinlivan. Reported origin Tel Aviv.
....	62283 (Q 053)	23/7/73. Obtained by Dr. B. J. Quinlivan. Received as "*L. palaestinus*", of reported origin Petah Tiqua.
		L. hispanicus spp. *hispanicus* **(Spain only)**
1	67951 (GS 013)	9/6/73, 16 km E from Villacastin, 67 km NW from Madrid, on N VI. Lat. 41°. Alt. 1 250 m, annual rainfall 800 mm. Grey-brown, very gritty loamy sand among rocks, pH 6·5. Parent rock granite. Slight slope, free run-off drainage. Rough grazing, pine country. Associated legumes *L. hispanicus* spp. *bicolor*, *Ornithopus compressus*, *O. perpusillus*, *Trifolium campestre*.
2	67952 (GS 023)	9/6/73, 48 km SSE from Avila on N 403 to San Martin, a little past El Tiemblo. Lat. 40°. Alt. 900 m, annual rainfall 650 mm. Light brown, gritty loamy sand, pH 5·7. Parent rock granite. Free run-off drainage. Roadside.

Site No.	C.P.I. and collection No.	Site data
13	67971 (GS 159)	27/6/73. Verin, 1 km below parador, on road to turn-off. Lat. 42°. Alt. 400 m, annual rainfall 800 mm. Brown, stony sandy loam, acid, alluvium ex granite. Flat, free drainage. Roadside, adjacent vineyards. Associated legumes *L. angustifolius*, *L. luteus*, *O. compressus*.
14	67972 (GS 171)	28/6/73, 7 km NE from Orense on C 546 to Monforte. Lat. 42°. Alt. 200 m, annual rainfall 900 mm. Brown, gritty loamy sand, acid. Parent rock granite. Flat, free drainage. Waste land by road, associated legume *O. compressus*.
15	67973 (GS 175)	28/6/73, below parador, Verin. Lat. 42°. Alt. 400 m, annual rainfall 800 mm. Light brown, gritty loamy sand and sandy loam alluvium, acid. Parent rock granite. Composite of *L. hispanicus* types along 2 km of road between parador and turn-off: types should include CPI 67971. Associated legumes *L. angustifolius*, *L. luteus*, *O. compressus*.
16	65122 (NS 015)*	19/6/73, 5 km NE from Segovia on N 110 to Riaza. Lat. 41°. Alt. 1 100 m.
17	65124 (NS 020)	19/6/73, 10 km SW from Riaza on N 110 to Segovia. Lat. 41°. Alt. 1 200 m.

* NS series collected by Dr I. Forbes, United States Department of Agriculture, in north and north-east Spain.

Portugal

1	68070 (GP 025)	24/6/73, 38 km ENE from Vila Real on N 15 to Mirandela. Lat. 41°. Alt. 500 m, annual rainfall 1 000 mm. Grey, gritty loamy sand, pH 6·2. Parent rock granite. Drainage free, run-on plus some seepage. At edge of meadow, where *L. luteus* probably recently cultivated. Associated legumes *L. luteus*, *Trifolium repens*, *Ornithopus compressus*, *O. perpusillus*. Plant types suggested possible natural crossing with *L. luteus*.
2	68071 (GP 027)	24/6/73, 12 km ENE from Vila Real on N 15 to Mirandela. Lat. 41°. Alt. 600 m, annual rainfall 1 000 mm. Grey, gritty loamy sand, pH 5·8. Parent rock granite. Drainage free, run-on. Edge of road, associated legumes *O. compressus*, *O. perpusillus*.
3	68073A (GP 030·1)	25/6/73, 25 km N from Viseu on N 2 to Vila Real. Lat. 41°. Alt. 500 m, annual rainfall 1 500 mm. Grey, very gritty loamy sand, pH 5·6. Parent rock granite. On roadside embankment, associated legumes *L. angustifolius*, *L. luteus*, *O. compressus*, *O. pinnatus*.
4	68074 (GP 032)	25/6/73, 9 km S from Viseu on road to Nelas. Lat. 41°. Alt. 250 m, annual rainfall 900 mm. Grey, very gritty loamy sand, pH 6·0. Parent rock granite. Drainage free, run-on. Roadside, on bank adjacent vineyard. Associated legumes *O. compressus*, *O. pinnatus*.
5	68075 (GP 034)	25/6/73, 17 km S from Viseu on road to Nelas. Lat. 41°. Alt. 200 m, annual rainfall 900 mm. Grey, very gritty loamy sand, acid. Parent rock granite. Edge of road. Associated legumes *L. angustifolius*, *O. compressus*, *O. pinnatus*, *O. perpusillus*.

Site No.	C.P.I. and collection No.	Site data
6	68076 (GP 035)	25/6/73, 2 km SW from Mangualde on road to Nelas. Lat. 41°. Alt. 500 m, annual rainfall 1 000 mm. Very gritty grey sand, pH 5·3. Parent rock granite. Slight slope, free run-off drainage. Roadside in pine forest country, associated legumes *O. compressus*, *O. pinnatus*.
7	68077 (GP 039)	25/6/73, 16 km NW from Trancoso on N 229 to Lamego. Lat. 41°. Alt. 600 m, annual rainfall 800 mm. Gritty grey sand, pH 5·8. Parent rock granite. Roadside, very common. Associated legume *O. compressus*.
8	68078 (GP 043)	25/6/73, 39 km NW from Trancoso on N 229 to Lamego. Lat. 41°. Alt. 600 m, annual rainfall 800 mm. Grey, gritty loamy sand, pH 5·7. Parent rock granite. Flat, run-on, possibly restricted drainage and seepage. Associated legumes *L. luteus* (growing as mixture), *O. compressus*.
9	68079 (GP 046)	26/6/73, 12km NNW from Mirandela on road to Chaves. Lat. 42°. Alt. 400 m, annual rainfall 600 mm. Grey gritty sand, pH 6·5. Parent rock granite. Drainage free, run-off. Roadside, close to river. Associated legume *O. compressus*.
10	68080 (GP 049)	26/6/73, 2 km S from Vidago, 21 km SW from Chaves, on N 2 to Vila Real. Lat. 42°. Alt. 400 m, annual rainfall 1 000 mm. Grey, very gritty sand, pH 6·5. Parent rock granite. Moderate slope, free run-off drainage. On bank below road in forest country, associated legumes *L. angustifolius*, *O. compressus*.
		L. micranthus
		Morocco
1	62540 (GM 067)	6/5/73, 35 km N from Khouribga on road to El Khatouat (c. 40 km NW of Oued Zem). Lat. 33°. Alt. 600 m, annual rainfall 525 mm. Gritty brown clay, pH 7·5. Parent rock schist. Slight slope, free run-off drainage. Fallow/natural pasture, associated legumes *Medicago truncatula* and other *M.* spp.
		Israel
1	62280 (Q 050)	Obtained by Dr. B. J. Quinlivan 23/7/73. Origin reported as Purdy Hana. Received as *L. luteus*.
		L. cosentinii
		Morocco
1	65226 (GM 001)	30/4/73, 25 km SW from Rabat on coast road to Casablanca, c. 1 km from sea. Lat. 34°. Alt. 30 m, annual rainfall 475 mm. Dark brown loam (rhendzina), pH 8·0. Parent rock coastal limestone. Flat, free drainage. Roadside, associated legumes *Trifolium subterraneum* ssp. *brachycalycinum*, *Medicago* spp., *Astragalus hamosus*, *Scorpiurus muricatus*.
2	65227 (GM 002)	30/4/73, 12 km SW from Rabat on coast road to Casablanca. Lat. 34°. Alt. 20 m, annual rainfall 500 mm. Dark brown loam (rhendzina), pH 8·0. Parent rock coastal limestone. Flat, free drainage. Along roadside and extending into Eucalyptus plantation, common.

Site No.	C.P.I. and collection No.	Site data
3	65228 (GM 003)	1/5/73, 13 km NNE from Rabat on road to Kenitra. Lat. 34°. Alt. 50 m, annual rainfall 500 mm. Deep, red-brown fine loamy sand, pH 7·3. Parent rock coastal limestone. Flat, free drainage. Roadside, associated legumes *Trifolium* spp., *M. polymorpha.*
4	65229 (GM 005)	1/5/73, 20 km NNE from Rabat on road to Kenitra. Lat. 34°. Alt. 50 m, annual rainfall 500 mm. Deep, red-brown fine loamy sand, pH 7·3. Parent rock coastal limestone. Flat, fee drainage. Roadside, associated legume *L. angustifolius.*
5	65230 (GM 007)	1/5/73, 6 km W from Kenitra, c. 4 km from coast. Lat. 34°. Alt. 20 m, annual rainfall 500 mm. Brown loamy sand with limestone inclusions, pH 7·6. Parent rock coastal limestone. Slight slope, free run-off drainage. Roadside, associated legumes *L. luteus, Ornithopus isthmocarpus, M. tornata.*
6	65231 (GM 009)	1/5/73, Kenitra, S outskirts of town on road to Rabat. Lat. 34°. Alt. 50 m, annual rainfall 600 mm. Deep, red-brown fine loamy sand, pH 7·3. Parent rock coastal limestone. Moderate slope, free drainage. Roadside.
7	65232 (GM 010)	1/5/73, 6 km SSW from Kenitra on road to Rabat. Lat. 34°. Alt. 75 m, annual rainfall 550 m. Deep, red-brown fine loamy sand, pH 7·3. Parent rock coastal limestone. Flat, free drainage. Roadside, associated legumes *M. tornata, M. polymorpha.*
8	65233 (GM 012)	2/5/73, 7 km E from Kenitra on road to Fes. Lat. 34°. Alt. 50 m, annual rainfall 550 mm. Deep, red-brown fine loamy sand, pH 6·5, alluvium ex coastal limestone. Slight slope, free drainage. Fallow, associated legumes *L. angustifolius, L. luteus, M. tornata, O. compressus, O. isthmocarpus.*
9	65234 (GM 028)	3/5/73, 6 km E from Rabat on road to Meknes. Lat. 34°. Alt. 50 m, annual rainfall 525 mm. Deep, brown fine loamy sand, pH 7·2, alluvium ex coastal limestone. Flat, free drainage. Fallow/rough grazing, associated legumes *L. angustifolius, T. subterraneum, M. tornata, O. isthmocarpus.*
10	65235 (GM 036)	3/5/73, 17 km E from Rabat on road to Meknes. Lat. 34°. Alt. 100 m, annual rainfall 550 mm. Deep, reddish brown fine loamy sand, pH 6·8. Parent rock coastal limestone. Slight slope, very free drainage. Fallow, associated legumes *L. angustifolius, T. subterraneum, O. compressus, O. isthmocarpus, O. perpusillus, M. tornata.*
11	65236 (GM 045)	5/5/73, 6 km S from Rabat on road to Rommani. Lat. 34°. Alt. 50 m, annual rainfall 500 mm. Rich, deep, brown loamy sand, pH 7·0, recent alluvium ex coastal limestone. Flat, free drainage. Roadside, associated legume *Astragalus hamosus.*
12	65237 (GM 048)	5/5/73, 13 km S from Rabat on road to Rommani. Lat. 34°. Alt. 100m, annual rainfall 500 mm. Deep, brown silty sand, pH 6·2. Parent rock coastal limestone. Moderate slope, very free drainage. Edge of cork oak woodland, associated legumes *O. isthmocarpus, A. hamosus.*

Site No.	C.P.I. and collection No.	Site data
13	65238 (GM 070)	7/5/73, 12 km WSW from Casablanca on coast road S 130 to Azzemour, c. 0·5 km from sea. Lat. 34°. Alt. 10 m, annual rainfall 400 mm. Black loamy sand with limestone inclusions, pH 8·0. Parent rock coastal limestone. Slight slope, free run-off drainage. Roadside.
14	65239 (GM 071)	7/5/73, 46 km WSW from Casablanca on coast road S 130 to Azzemour. Lat. 33°. Alt. 20 m, annual rainfall 350 mm. Brown loamy sand, pH 7·8. Parent rock coastal limestone. Flat, free drainage. Roadside.
		Tunisia
1	65138 (GT 001)	28/5/73. N Cap Bon Peninsula, 12 km ENE—NE of Soliman, 20 km NE of Grombalia. Lat. 37°. Alt. 20 m, annual rainfall 400 mm. Deep, reddish loamy sand, pH 7·0. Parent rock limestone. Drainage free, run-on. At edge of vineyard.
2	65139 (GT 002)	28/5/73, N Cap Bon Peninsula, 8 km NNE of Soliman, 18 km NNE—N of Grombalia. Lat. 37°. Alt. 20 m, annual rainfall 400 mm. Deep, brown loamy sand, pH 7·3. Parent rock limestone. Flat, drainage free run-off. At edge of barley crop.
3	65140 (GT 003)	28/5/73, N Cap Bon Peninsula. 34 km NNE of Grombalia, on MC 42 and MC 46 to Haouaria. Lat. 37°. Alt. 35 m, annual rainfall 400 mm. Deep, brown loamy sand, pH 7·0. Parent rock limestone. Drainage free, run-off. Roadside.
4	65141 (GT 004)	29/5/73, S. Cap Bon Peninsula, 8 km WSW from Nabeul on MC 28 to Hammamet. Lat. 36°. Alt. 10 m, annual rainfall 400 mm. Grey-brown sandy loam, pH 7·7. Parent rock limestone. Flat, drainage free, run-on. Roadside, associated legumes *Medicago tornata, M. littoralis, Astragalus hamosus.*
5	65142 (GT 007)	29/5/73, 2 km N of Sousse. Lat. 36°. Alt. 20 m, annual rainfall 300 mm. Deep, yellow, coastal dune sand, pH 7·5. Undulating, very free drainage. Rough grazing and olive trees.
		Spain
1	67948 (GS 140)	18/6/73, 32 km SW from Algeciras on N 340 to Cadiz. Lat. 36°. Alt. 10 m, annual rainfall 700 mm. Grey-white littoral sand, pH c. 7·0. Slightly undulating, surface drainage free, fairly close water table. Rough grazing.
		L. atlanticus
		Morocco only
1	65220 (GM 074)	8/5/73, Kerdous Plateau, Anti Atlas Range; 64 km E from Tisnit, 46 km W from Tafraoute, on Tisnit–Tafraoute road. Lat. 30°. Alt. 1 200 m, annual rainfall 375 mm. Brown rocky loam, pH 7·5. Parent rock schist. Moderate slope, free run-off drainage. Weed in barley crop, associated legumes *L. angustifolius, Medicago* spp.

Site No.	C.P.I. and collection No.	Site data
2	65221 (GM 076)	8/5/73, Anti Atlas, 14 km W from Tafraoute on road to Tisnit. Lat. 30°. Alt. 1 000 m, annual rainfall 200 mm. Light brown, gritty sandy loam, pH 7·2. Parent rock granite. Moderate slope, free drainage. Around granite outcrop in almond grove: would receive run-off from rocks. Associated legume *L. angustifolius*.
3	65222 (GM 081)	10/5/73, Atlas foothills, 87 km S from Marrakech on road to Taroudant. Lat. 31°. Alt. 1 200 m, annual rainfall 400 mm. Rubbly brown clay loam, pH 7·6. Parent rock schist. Steep slope, free run-off drainage. Growing among the rubble of a roadside embankment.
4	65223 (GM 083)	11/5/73, Atlas foothills, c. 0·5 km SW of Amizmiz, 60 km SSW of Marrakech. Lat. 31°. Alt. 1 000 m, annual rainfall 490 mm. Very rubbly loam, pH 7·6. Parent rock schist. Steep slope, free run-off drainage. Weed in wheat crop and in fallow.
5	65224 (GM 087)	11/5/73, Atlas foothills, 1 km S of Amizmiz, 60 km SSW of Marrakech. Lat. 31°. Alt. 1 100 m, annual rainfall 500 mm. Rubbly brown loam, pH c. 7·5. Parent rock schist. Moderately steep slope, free run-off drainage. Weed in barley crop.
6	65225 (GM 090)	12/5/73, 29 km N from Marrakech on road to Casablanca. Lat. 32°. Alt. 460 mm, annual rainfall 300 mm. Stony clay loam, pH c. 7·8. Parent rock schist. Slight slope, free run-off drainage. Edge of and weed in wheat crop, associated legumes *M. truncatula*, *M. minima*.
		L. pilosus
		Israel
1	....	(P20957). Collected by Dr. J. S. Katznelson 1964, Karey Deshe, Lower Galilee. Lat. 33°. Alt. 100 m. Heavy basaltic clay. Received as *L. montanus*.
2	62284 (Q 054)	Obtained by Dr. B. J. Quinlivan 17/7/73. Origin reported as Wadi Milk.
3	62285 (Q 055)	As 62284.
4	62286 (Q 056)	As 62284.
5	62287 (Q 057)	As 62284.
6	62288 (Q 058)	Obtained by Dr. B. J. Quinlivan 23/7/73. Origin reported as Hula Plain.
7	62289 (Q 059)	Obtained by Dr. B. J. Quinlivan 23/7/73. Origin reported as Tiberias.
		Turkey
1	69994	Collected by Dr. C. M. Francis and Dr. J. S. Katznelson 1/7/74, Dortyol, 300 m from townsite. Lat. 37°. Alt. 50 m, annual rainfall 2 000 mm. Soil pH 7·5.

Site No.	C.P.I. and collection No.	Site data
		L. palaestinus
		Israel only
1	14862	Collected by Miles and Donald, Ben Yamina, annual rainfall 600 mm. Coarse red sand.
2	62281 (Q 051)	Obtained by Dr. B. J. Quinlivan 23/7/73. Origin reported as Tel Aviv.
3	62282 (Q 052)	Obtained by Dr. B. J. Quinlivan 23/7/73. Origin reported as Givat Olga.

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