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NITROGEN CONTENT OF SOILS, *CALLUNA VULGARIS*, AND SOME NATIVE PLANTS IN TONGARIRO NATIONAL PARK, (1992-1993).

(Short Answers in Conservation Science)

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NITROGEN CONTENT OF SOILS, *CALLUNA VULGARIS.* AND SOME NATIVE PLANTS IN TONGARIRO NATIONAL PARK. (1992-1993)

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Abstract

Nitrogen levels in soils, shoots of *Calluna vulgaris,* and a few native plants were measured from areas in Tongariro National Park (T.N.P.). The *Calluna* was measured in winter and in summer. Associations between soil nitrogen level and plant nitrogen are weak. Comparisons between native plant and *Calluna* nitrogen levels indicate *Calluna* is high in nitrogen. Abundance of Phytophagous insects, and insect diversities are positively correlated with nitrogen levels in *Calluna* but not with soil level.

INTRODUCTION.

Nitrogen plays a vital role in all protein based living systems; nitrogen containing compounds are essential components of diets of most heterotrophic organisms. Invertebrates are no exception; for herbivorous invertebrates nitrogen is a vital governing factor ruling their growth rates, ultimate size, fecundity, productivity and hence population size and success (Brunsting & Heil 1985, McNeil & Southwood 1978). Correlations between insect abundance or diversity and food plant nitrogen levels have been shown by researchers (McNeil & Prestidge 1982, Prestidge & McNeil 1981, van Der Meijden et al. 1984). These studies, though, considers ' host' plant nitrogen levels affecting insects geared for feeding on those plants and not general insect abundance and diversity in a habitat that may contain much nitrogen, but not, of necessity, many ' host' plants! The approach to studing nitrogen influences in a community may be on a micro or macro scale, depending on the resolution required. Ofen a single plant (single bush effect) and the immediate concentration of nutrients and minerals in the adjacent soil influencing its individual nitrogen content, has a very different bearing on the community (structure and operation) than an ecosystem approach where the total nitrogen of an area or a plant species is held responsible for particular communitity structures (ecosystem effect). I believe that in Tongariro National Park where *Calluna* has invaded extensively areas of native vegetation (eg. tussock/herb fields around Pukeonake to Chateau region) the ecosystem may still contain much nitrogen but little as host plant sources, and that single bush characteristics play a more important role, and predict a different structure than the ecosystems.

The information gained is compared to English (European) heath systems, with special reference to the effects nitrogen levels have on population growth of *Lochmaea suturalis*, the proposed bio-control agent and principle defoliator of *Calluna.*

METHOD

An investigation into the nitrogen levels in some native plants plausible as food for native insects, and the *Calluna* in areas with different recency of invasion around the park, was done, both in the winter of 1992 and the following summer 1992-93. Soils from areas sampled for plants were also taken for nitrogen content analysis in order to establish any correlations between nitrogen levels in soil and that in the plants *(Calluna).* From sites 1, 3, 8, 10 and 11 the top 10 cm of foliage (ca. 10 grams wet weight) of 5 separate (tagged) *Calluna* plants were taken, ie. 5 replicates per site per plant type. The samples were freeze dried, ground to powder, and analysed by the Kjeldhal method by the Soil Science Department, Massey University.

The data obtained were measured in mg/g dry weight of sample. This is a good measure of single bush nitrogen levels (semi-micro resolution). Transformation of the data to mg/100g dry weight allowed comparisons with values obtained from the literature. Using biomass (average biomass of sites, and acknowledging possible different wood/foliage ratios) and % cover of *Calluna* data for each site, a measure of nitrogen in *Calluna* on an ecosystem level (macro resolution) was attainable.

The abundance and diversity measures of phytophagous insects attained from on-going independent sampling were graphed and correlated with *Calluna* nitrogen levels (single bush approach) and with the total nitrogen availible in *Calluna* vegetation in the sampling area (ecosystem approach).

Location of sample sites.

Grid ref.	place	Veg. sampled	site
6205000N 2745000E	Moawhango Ecol. area	*Calluna*	1
6205000N 2745000E	Moawhango Ecol. area	tussock	2
6213500N 2746000E	Eastern T.N.P.	*Dracophyllum* ,*Calluna* & *Gaultheria*	3
6224000N 2726000E	Western T.N.P.	*Calluna*	11
6222000N 2727000E	Western T.N.P.	*Calluna*	8
6222000N 2718500E	Western T.N.P.	flax & *Calluna*	10

Also see map (figure 1).

ORIGINAL AREA AND SPREAD OF *CALLUNA* IN EIGHTY YEARS.

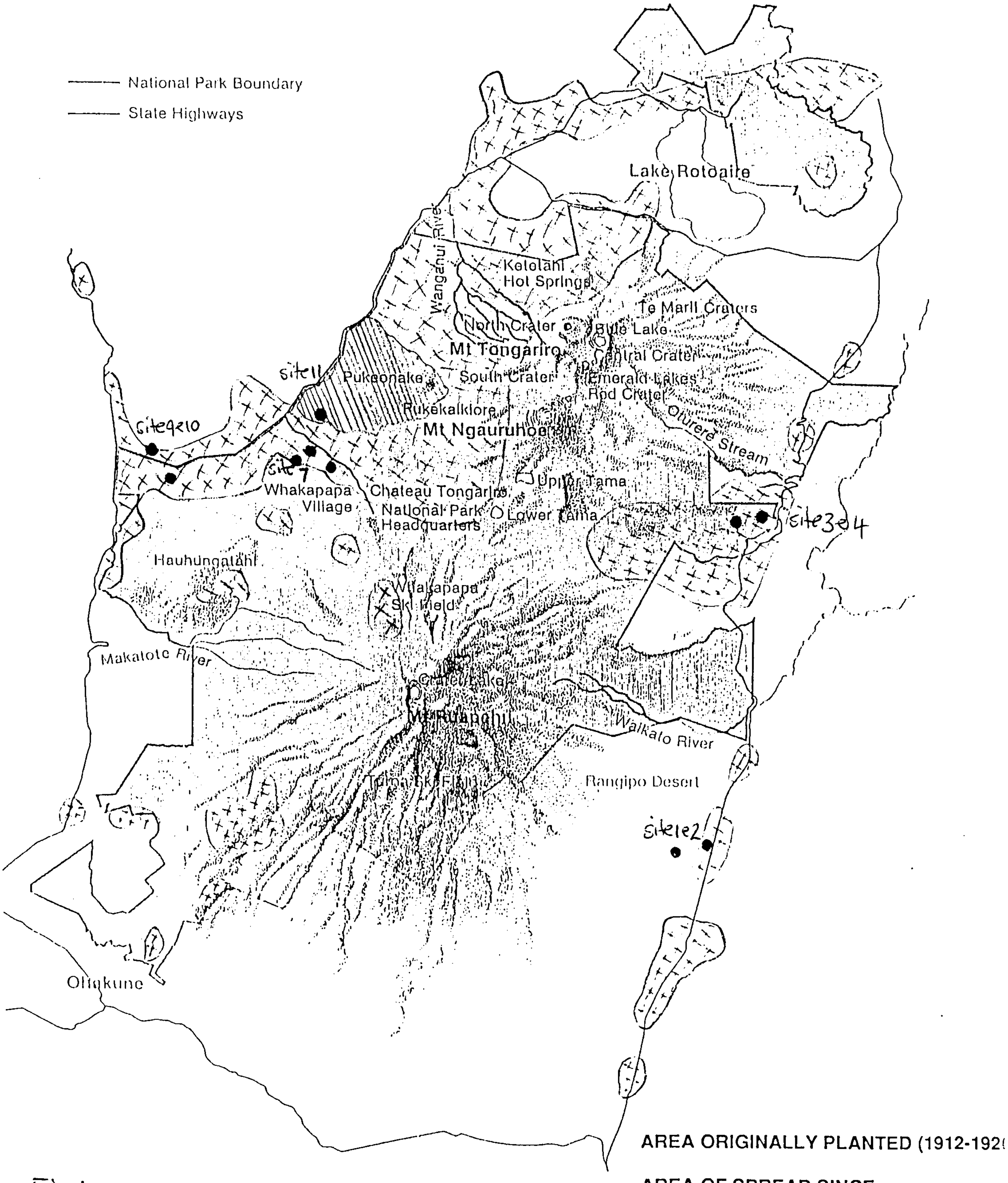

Fig 1

RESULTS

Results of plant nitrogen analysis show that flax has the highest nitrogen content, with *Calluna* and *Gaultheria* having similar but lower values and *Dracophyllum* and tussock having the lowest shoot nitrogen values (Figure 2, Table 2).

Table 2. NITROGEN VALUES, from Kjeldahl assays (mg/g SAMPLE) from TONGARIRO NATIONAL PARK.

Means followed by the same letter are not significantly different at the 5% level (T-test).

plant	winter mean	summer mean	mean N_2
Calluna	9.23x	7.92	8.58
tussock	4.18	3.2	3.69
Dracophyllum	5.71y		
Gaultheria	7.44xy		
flax	12.2		
glasshouse *Calluna*		8.64	

Soil analysis (Table 3) shows site 8, *Calluna* invaded manuka swamp, with a deep organic layer, to be the richest in nitrogen; site 11, about 2 km west, is the next richest, followed by the eastern sites, 1 and 2 and then 3 (refer to map, Figure 1).

Plant nitrogen levels from different communities around T.N.P.

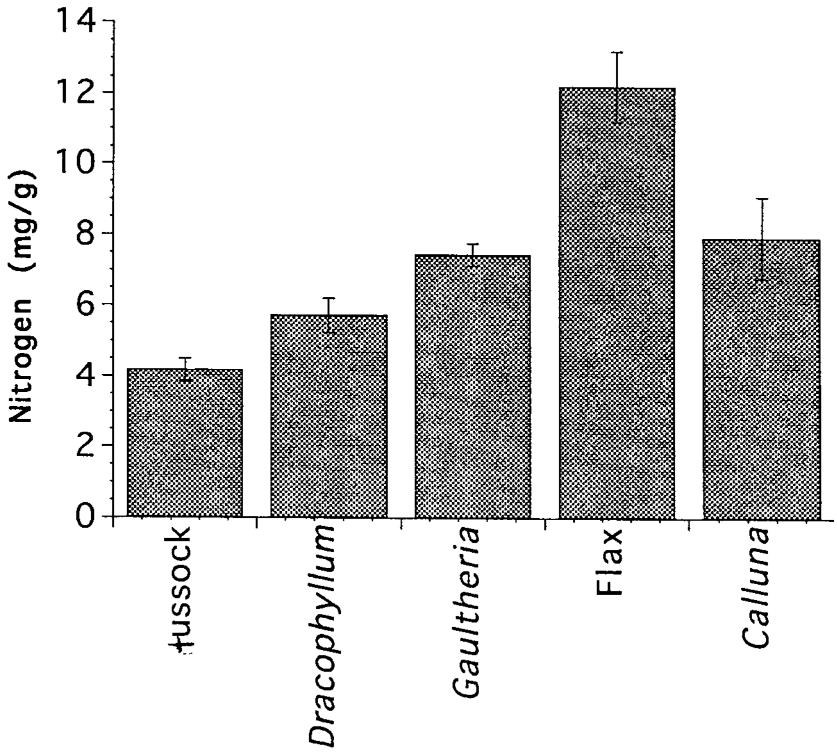

Fig2

Table 3 SOIL NITOGEN LEVEL (mg/g sample)

site	Soil N_2
1	2.52 a
2	2.78 ab
3	1.93 abc
8	5.2
10	2.94 ac
11	3.3 a

Soil nitrogen levels and *Calluna* nitrogen levels in winter-collected shoots are not correlated (r=0.195, P >0.05 from Pearson Correlation Co-efficient), while summer collected *Calluna* shoot levels are somewhat more strongly, though not significantly, negatively correlated (r=-0.796, P>0.05). The trend is for higher nitrogen levels in the summer, dropping fractionally in winter (Figure 3).

It is interesting to note that the nitrogen values of tussock (site 2) are similar to the soil levels while flax (site 10) is five times as much (Figure 3). *Calluna* tends to maintain a constant level (seasonally) some-what independent of the soil level (Figure 3); values for summer are about 7-9 mg/100g, while the soils vary from 2-5 mg/100g.

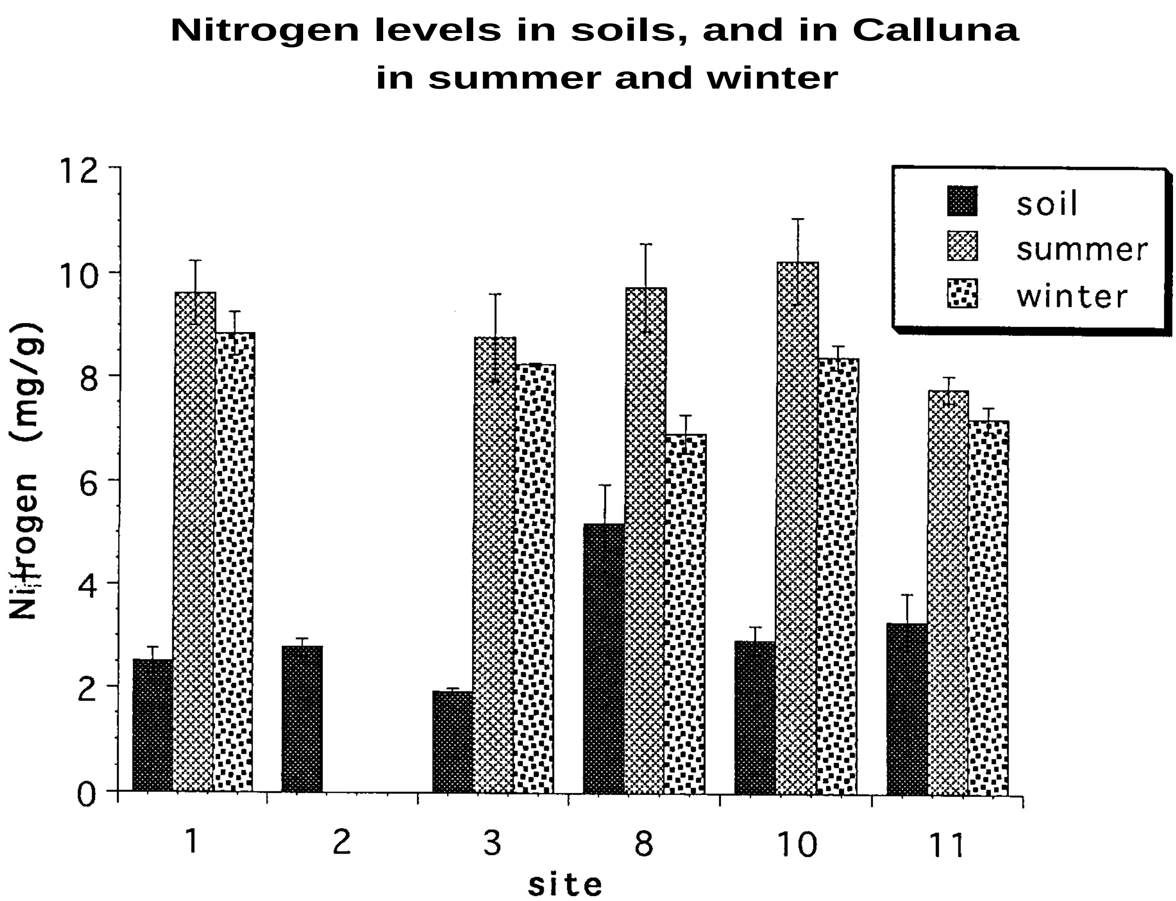
Nitrogen levels in soils, and in Calluna
in summer and winter
Nitrogen (mg/g)
12
10
8
6
4
2
0
soil
summer
winter
1
2
3
8
10
11
site

Fig 3

Insect (Phytophagous) Abundance and Diversity

Table 4 **CORRELATION CO-EFFICIENTS** (Pearson) relating Insect abundance, diversity and nitrogen factors. (A= significance P<0.05)

Insect	soil nitrogen	winter Calluna	summer Calluna	summer total	winter total	total nitrogen
Diversity	-0.704	0.881A	0.127	-0.849	-0.852	-0.085A
Abundance	-0.341	0.762	0.838	-0.603	-0.516	-0.559

Insect abundance is positively correlated with both the summer and winter nitrogen, single bush values, though not significantly (Table 4, Figure 4). But when the total nitrogen of the sampling site, ie. the ecosytem values, are calculated the correlations become negative (Figure 5). There is no correlation with soil nitrogen levels.

Insect diversity has a strong positive correlation with nitrogen levels in *Calluna* (Figure 6, Table 4). There are significant correlations with winter *Calluna* levels and with total nitrogen (ecosystem measure).

phytophagous insect abundance and total calculated nitrogen in Calluna at each site

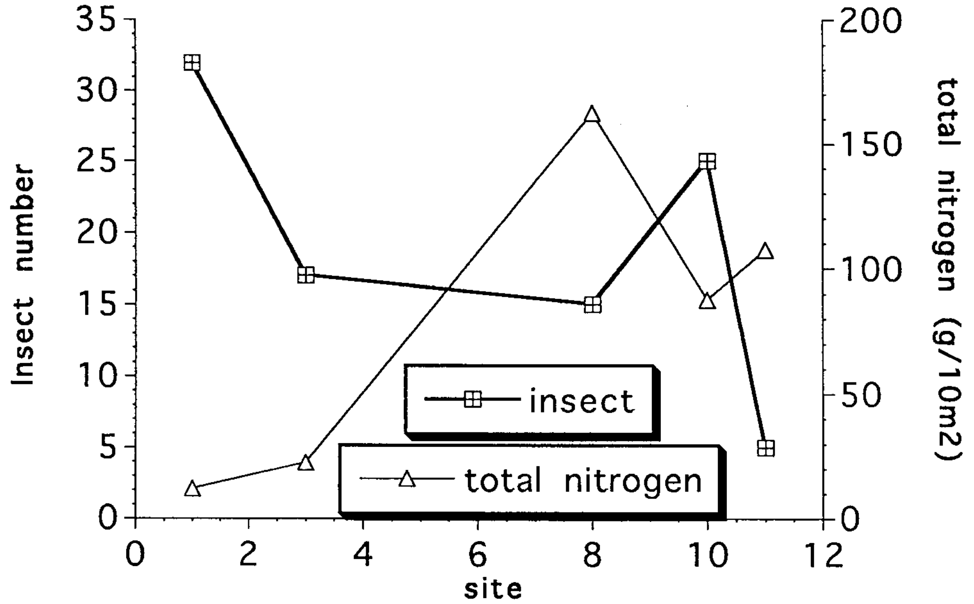

Fig 4

Phytophagous insect number and summer Calluna bush nitrogen levels

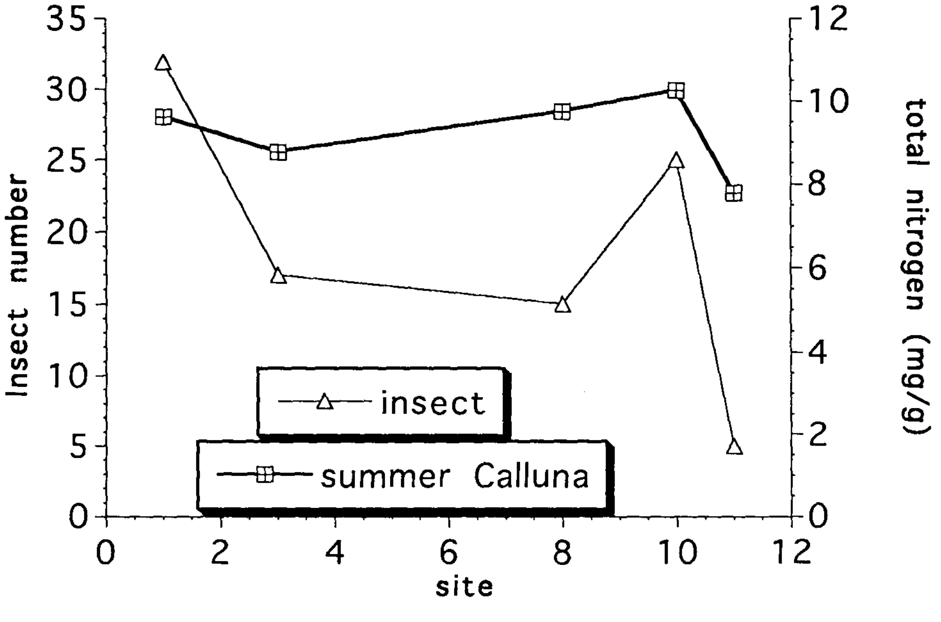

Fig 5

Diversity indices and summer Calluna bush nitrogen levels

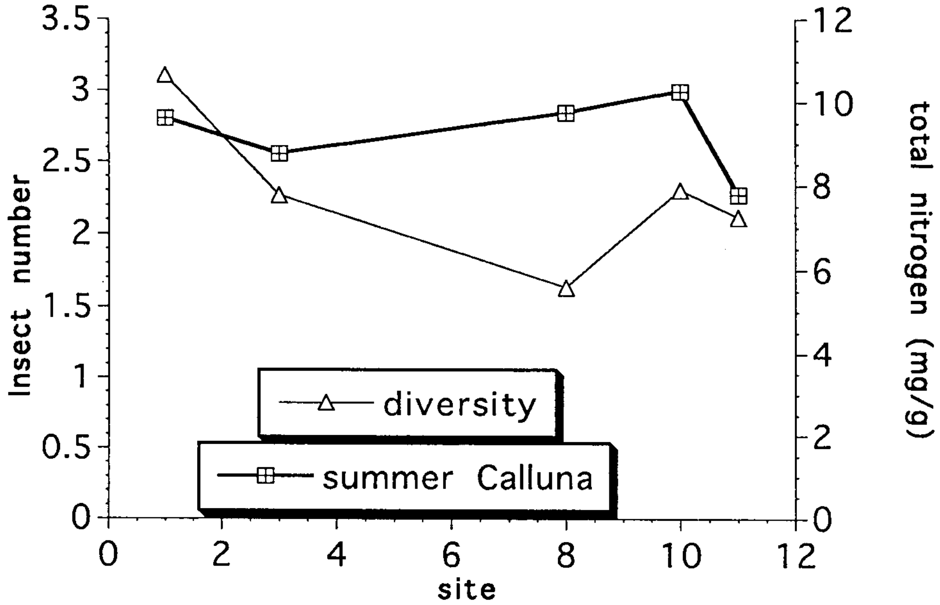

Fig 6

Discussion

Since *Calluna* nitrogen levels are not correlated with soil levels, it appears that soil nitrogen is not limiting growth, or palatability of *Calluna* to insect herbivores. *Calluna* has a high nitrogen content compared to the other native plants tested, with the exception of flax. It is thus a good supply of nitrogen for any phytophagous insect that can eat it. The drop in nitrogen over winter is small, and not of the same proportion as in England (McNeil & Prestidge 1982). This may be due to a milder, oceanic, climate in New Zealand. Clearly seasonal variation in nitrogen level will not affect *Calluna* palatability.

While phytophagous insect diversity and abundance has been adversely affected by the invasion of *Calluna,* (ie. there have been observed drops in abundance, and reduction in the number of taxa due to changing habitat, loss or reduction of normal food plants, or increased arachnid predation), there is a positive correlation between nitrogen level in *Calluna* and phytophagous insect abundance and diversity. It appears that single bush physiology is more important to abundance of insects than the total nitrogen in a stand. The ecosystem picture of nitrogen availability is too broad a view to allow good correlations and hence predictable scenarios to be developed. This is probably a consequence of insect herbivores being largely specialist feeders, seeking out nutritious, nitrogen rich plants within a community, regardless of the overall nitrogen status of that community. This hypothesis is supported by the *Calluna* having higher nitrogen levels than other common native species, except flax.

Comparisons with Europe

Calluna nitrogen levels have been measured in a miriad of ways and expressed in units of measure suited to the researcher's ultimate goals and so no standard measure of nitrogen in *Calluna* exists. Table 5 compares my data (single bush and ecosystem estimates) with some values obtained from studies overseas.

Table 5

Author	summer	winter	unit	place
single bush				
My data	923	791	mg/100g dry wt.	T.N.P.
McNeil & Prestidge	1060	670	mg/100g dry wt.	Sth. England
Brunsting & Heil	220	160	mg/100g dry wt.	Netherland
Glenn & Hester	1150			Scotland
Ecosystem				
My data	258		kg/ha	T.N.P.
Chapman	107.7		kg/ha	Sth. England
Robertson & Davies	102		kg/ha	Scotland

Comparing the values measured in mg/100g dry weight of sample, ie. a value of nitrogen per bush (single bush approach), the *Calluna* around T.N.P. appears to have lower summer values than Sth England and Scotland, but higher winter values. The Netherlands values are much lower. A conversion of my nitrogen values to kilograms per hectare (ecosystem approach) allows comparison with Chapman and Robertson & Davies values. *Calluna* in T.N.P. has twice the nitrogen per hectare than south England and twice to perhaps four times the amount reported by Robertson & Davies in Scotland. The difference in comparisons between the two units of measure (bush as opposed to ecosystem) suggests that in T.N.P. nitrogen is generally lower per bush than in the U.K. but that there is greater biomass of *Calluna,* due to the presence of much more woody tissue in New Zealand *Calluna* (which is not burnt to maintain a high foliage to wood ratio as it is in Scotland and England).

Figure 7 illustrates the difference in heathland faunal taxa abundance between south England and T.N.P. There is a large difference, obviously not all of which is a result of different nitrogen levels, but it is perhaps a factor.

Comparison of Important Plant feeding insects in heathland between Sth England & New Zealand

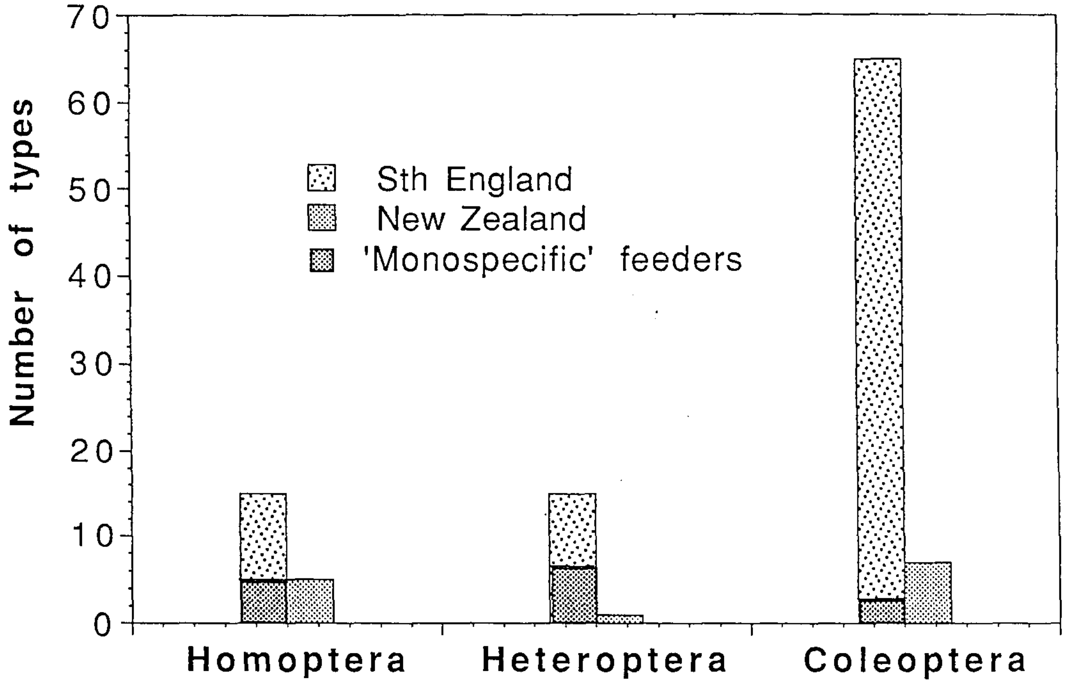

Fig7

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