at 900-1360m.

(5) Nokomai Range to the north east of Garston, Blackmore RAP: four live specimens seen and three collected in 1988 at about 900m.

(6) Irthing Stream to the north of Five Rivers (map ref. NZMS 1 S151 365 070): up to 40 specimens seen and several collected at about 600m in beech forest in 1963.

The five Ecological regions in which *M. chiltoni* is known to have occurred are Central Otago, Lakes, Mavora, Waikaia and Aspiring (Map 1), with most records having come from the first three of these. The Aspiring record from Bold Peak in the Humboldt Mts. appears to be somewhat of an outlier, and the fact that it was identified from an incomplete specimen raises a question of possible misidentification. However, this particular specimen was examined by Britton (1949), and is therefore likely to be accurate.

It should be taken into account that there is a relatively small body of entomologists in New Zealand, and there are parts of Central Otago that have been poorly collected. Once an impressive species like *M. chiltoni* has been discovered, collectors may be inclined to revisit the known localities, rather than look elsewhere for it. Nevertheless, there are areas of Central and western Otago adjacent to those where *M. chiltoni* is known from such as the Old Man Range, the Garvie Mountains, and parts of the Eyre Mountains which have been fairly well studied in recent years (eg. Mark et al. 1987, 1989) but where *M. chiltoni* has not been found.

ABUNDANCE

Although there has been no systematic collecting of *M. chiltoni* with the intention of assessing population density, some specialists have the distinct impression that the species may less common than it was, say 20 years ago. Rowan Emberson and Charles Watt collected on Duffers Saddle, Carrick Range, in October 1979 and other than remains, collected a single specimen near the summit, and another further down on the Bannockburn side of the range. The author also spent several hours at this locality in 1980 and found only fragments. The cuticular exoskeleton of carabids probably persists in a recognisable form for many years, and the impression is gained that there was formerly a good population there which may have declined. Peter Johns spent some time on the Carrick range looking specifically for *M. chiltoni* `with much effort' in 1965 (with R.S.

Bigelow) and 1969 and found only two and one specimen(s) on respective trips.

The specimens collected by Ian Townsend and colleague R.M. Bull near the Irthing Stream, in the southern Eyre Mountains came from a population he noted as being common in 1963. He reported seeing approximately 40 specimens in about an hour.

There is possibly a good population present on the Nokomai range in tussock grassland above the bush remnant in the Blackmore RAP (Dickinson 1989). This was indicated by four live beetles being seen active during the day in the area (B.H. Patrick, pers. comm.) .

Plate 1. *M. chiltoni* in tussock grassland on the Blackmore RAP, Nokomai Range (Photo: Brian Patrick).

BIOLOGY AND ECOLOGY

M. chiltoni is a large, flightless, predatory species with the likelihood of an annual, or longer, developmental life cycle and adult longevity of possibly several years, typical of Carabidae. Larvae are also predatory and are usually soil-dwelling, feeding on soil invertebrates. There has been no formal research carried out on *M. chiltoni* biology or ecology. What little is known is from the author's and other collector's observations noted below, and a few scant comments made on labels in collections.

The habitat in which most specimens of *M. chiltoni* have been collected is tussock grassland. This is true of Duffers Saddle on the Carrick Range, which in the recent past would probably have been dominated by a tall tussock community. This is now considerably depleted with a high incidence of *Aciphylla aurea* (Plate 2) and a large exotic component including *Hieracium*. Up to about 900m on the Bannockburn side the vegetation is dominated by exotic legumes and introduced grass species (Plate 3). The lower slopes of the Hector Range on the Nevis side are also predominately snow tussock, but again there is a component of introduced pasture species especially at lower altitudes.

Plate 2. View from Duffers Saddle, Carrick Range looking down into the Nevis Valley. (Photo: Bruce McKinlay)

The specimens collected from the Blackmore RAP on the Nokomai range were found in snow tussock grassland (Plate 4). The area was described as `moderately rich tussockland communities (Dickinson 1989).

In contrast, the specimens taken by Ian Townsend from Irthing Stream at the southern end of the Eyre Mountains were collected under logs in beech forest. This is a unique habitat record for *M. chiltoni.*

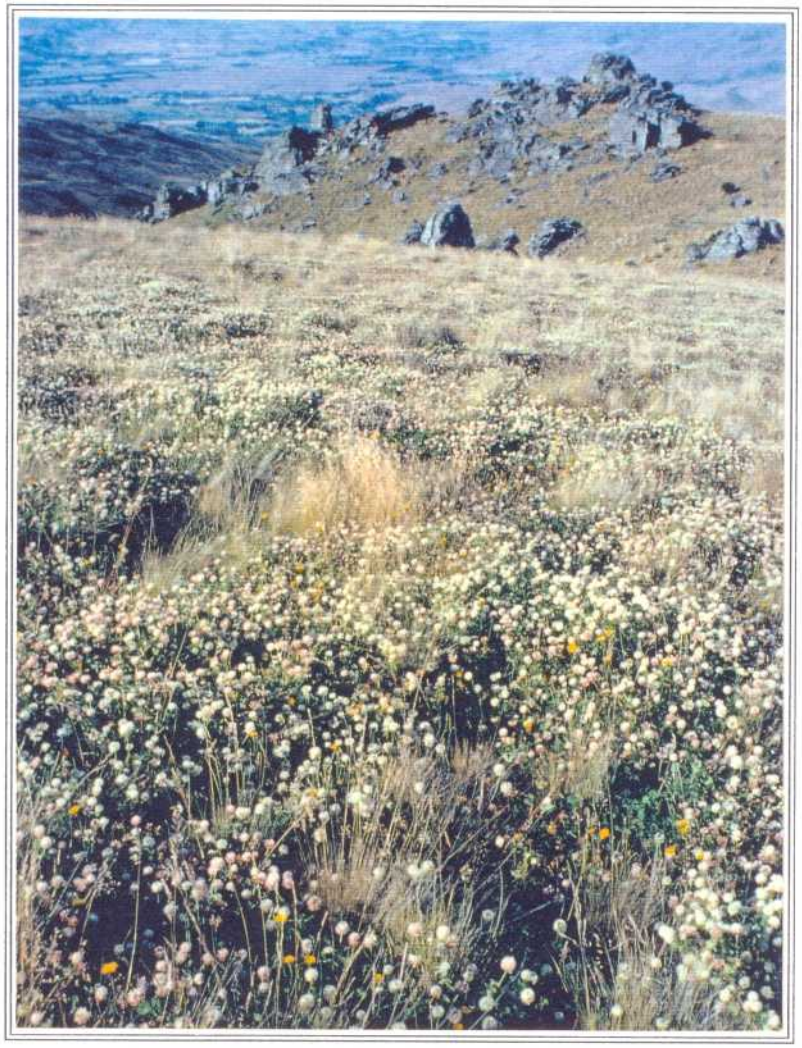

Plate 3. Carrick Range looking down towards Bannockburn, white clover oversown into tussock at about 850m. (Photo: Barbara Barratt).

During a visit to the Hector Mts in 1981, the main purpose of which was to collect *Prodontria pinguis,* Brian Patrick (DOC, Dunedin) and the author each collected a specimen of *M. chiltoni.* One of these specimens was active on the surface, and the other was excavated from the burrow of a weta. We gained the impression that the specimen had entered the burrow to take the weta as prey, since weta remains were found. The Otago Museum specimens were also reported to have been found near large weta holes (A.C. Harris, pers. comm.).

On the Carrick Range, the presence of large schist rocks were noted as a feature of the habitat of *M. chiltoni,* but the presence of insect larvae, both scarabaeid and tenebrionid (and possible elaterid) was also mentioned (P.M. Johns, pers.comm.). Peter Johns also noted an abundance of *Megadromus sandageri* (Broun) in the habitat where *M. chiltoni* was collected only in very low numbers, which may indicate competition, but he suggests

that the former is far less inclined to burrow, and they may therefore not be competing for the same prey items directly. This raises an interesting point, that most collectors of carabids tend to search beneath rocks, rather that dig out burrows, so numbers collected may not very accurately reflect abundance. Furthermore, on the lower slopes of the Hector Mts. on the Nevis River side, there are fewer rocks to serve as refuge sites for carabids than on Duffers Saddle.

Charles Watt collected what he thought to be a *Mecodema* larva while digging soil near Watts Rock (Charles Watt, pers. comm.). This specimen, which is held in the NZAC, was collected on 31 Oct 1979, and is 25 mm long. It is unconfirmed that it is in fact *M. chiltoni* (Trevor Crosby, pers. comm).

DETERMINATION OF CONSERVATION STATUS

As a large, flightless predator, *M. chiltoni* is at risk from habitat modification. Pastoral development would be the main threat to the species because of the associated changes in botanical and hence faunal community changes that occur. Tussock burning seems to take a high toll of carabid beetles, probably because adults normally live on or near the surface. If *M. chiltoni* tends to burrow, it may escape the very high temperatures which would cause mortality. Oversowing and top dressing change many environmental and micro-climatic characteristics of the habitat. Cultivation, or any soil disturbance, disrupt the environment even more dramatically. From the information we have available, it would seem that *M. chiltoni* tends to be found in the altitude range of 800-1300m, the lower end of which is well within the range of current pastoral development, while grazing and burning occur throughout.

Although size should not be a factor in determining priority for conservation, larger insects generally do have longer developmental cycles and therefore slower intrinsic rate of increase. On the other hand, large insects tend to live longer as adults and may be reproductively active over several seasons, and thereby buffered to some extent against particularly unfavourable seasons for larval survival and development.

The most abundant population recorded to date for this species was found at the Irthing Stream locality, where it was found by J.I. Townsend sheltering beneath beech logs in forest at the foot of a bush-covered ridge at the southern end of the Eyre Mountains. This forest may, however, have been felled since that visit (Ian Townsend, pers. comm.)

and so the population may not have survived. The upper reaches of Irthing Stream are included within the areas designated as Priority Places for Protection (Mark et al. 1987), as is a large proportion of Cainard Station, where remains of a specimen of *M. chiltoni* were found by Charles Watt in 1971.

RECOMMENDATIONS

From the information presented above, *M. chiltoni* would appear to be potentially at risk because of its restricted range of known distribution and limited mobility. Furthermore, the altitude zone which it inhabits is within the range which is susceptible to agricultural development and hence habitat modification. It is an impressive member of the Central Otago fauna, with little known of its biology, phenology and ecology. Although a representative of a genus with a relatively large number of species, it has only one close relative in the southern South Island. Apart from the general and well recognised need to conserve biodiversity globally, New Zealand has a particular responsibility to protect its endangered species because of our high level of endemism.

Should it be decided that further investigation of the conservation needs of *M. chiltoni,* is warranted as a result of this preliminary analysis of the *status quo,* it will be important initially to:

(1) establish the current distribution of *M. chiltoni* with an estimate of population abundance and sustainability,
(2) determine the habitat requirements of larvae and adults (or at least characterisation of habitats where it still occurs),
(3) establish the land tenure and the current and future land management and development proposals for areas where *M. chiltoni* occurs,
(4) evaluate the need for and level of protection required to ensure the survival of the species.

Once this evaluation is complete, it would then be prudent to:

(5) draw up a conservation management plan for the species,
(6) instigate a basic research programme to provide further information on the ecology of the species to assist in environmental management decisions,
(7) implement a periodic monitoring programme to detect changes in population

relative abundance and distribution.

Clearly, the initial survey of current distribution and evaluation of risk of habitat degradation are the steps from which the rest will be driven. Depending upon the resources which can be made available for this, it is recommended that sites where specimens have been collected in the past should be revisited. There are basically six main areas which require attention which are listed below. They are placed in order of priority, based on how recent, specific and reliable the records are, population size etc.

(1) Irthing stream, Five Rivers (NZMS151 365 070). This is at the southern end of the Eyre Mts. The site should be inspected since this was the most abundant population recorded and because the habitat may have been recently modified putting the population at risk. Ian Townsend has offered to assist with relocation of the site, which would be most valuable. Other nearby areas of Beech forest in the southern Eyre Mts. (Eyre State Forest) should also be surveyed, namely the Cromel Stream, Eyre Stream and Acton Stream catchments.

(2) Nokomai Range. Four live specimens were seen by Brian Patrick in 1988 at about 900m in tussock grassland above beech forest (Plate 4) in the `Blackmore' (Nokomai 8) RAP (Dickinson 1989). Pitfall trapping by the author just to the north at 1100m on the Nokomai range from November 1986 to February 1987 did not result in the collection of *M. chiltoni* (Dickinson 1989).

Plate 4. Blackmore RAP, Nokomai Range looking down from tussock at about 1000m over beech forest remnant towards Nokomai River Valley (Photo: Brian Patrick).

(3) Nevis Valley and Hector Range. Live specimens have been found on the eastern slopes of the Hector range within the last 12 years. There is a large area through the Nevis valley which could be surveyed for *M. chiltoni,* but it would probably be prudent to start in the Whittens Creek area since this is where the most recent specimens have been found.

(4) Mt. Dick. This is an important area to search for *M. chiltoni* since it is the type locality. The last specimens recorded from Mt Dick were collected by Fairbum in January and April 1955. There was no indication of precise location, altitude or any other ecological information on the labels. It is possible that the specimens were collected somewhere between Kingston and the summit and this would seem to be a reasonable approach in attempting to relocate *M. chiltoni* on Mt. Dick. There are two scenic reserves in this area, Te Kere Haka (196 ha) on the lake shore and extending up to 1000m altitude, and Glen Allen (about 1000 ha), a catchment to the south of Mt. Dick extending up to 1,200m including beech forest and fescue and snow tussock grasslands (Mark et al. 1989).

(5) Carrick Range. Several collectors have visited the Carrick Range via the Nevis Road which links Bannockburn (Cromwell) with the Nevis Valley meeting SH 6 at Garston. The summit is known as Duffers Saddle. Close to the road at the summit is a large rock outcrop named Watts Rock. This area has in the past supported a *M. chiltoni* population, however, live specimens were last found there in 1979.

(6) Bold Peak. Only 1 incomplete specimen has been found here in 1918. As somewhat of an outlier to the other localities where *M. chiltoni* has been found, it would be of interest to determine whether or not it still occurs on Bold Peak or other ranges between Bold peak and Mt. Dick such as the Ailsa Mts., Thompson Mts. and the northern Eyre Mts.

Survey Methods

In forested ares such as Irthing Stream (if it is still forested), the simplest way to search for *M. chiltoni* is to carefully turn over logs. Adult carabids are easily found sheltering

during the day when they are inactive. This type of collecting seems to be most successful after wet weather, or at least not after prolonged dry periods, when beetles tend to be more difficult to find. Logs should be carefully returned to their original positions. If beetles are found and disturbed, they should be carefully replaced to one side of the log to avoid injuring them. Careful notes of precise location, numbers of beetles, vegetation and other habitat characteristics should be noted.

In tussock grassland or other more open sites, rocks are often used by carabids for shelter. As with logs in the bush, these should be replaced carefully to avoid habitat disruption. As mentioned above, there is evidence to suggest that *M. chiltoni* may burrow, especially in the absence of rocks, or perhaps when there is a good supply of weta burrows to exploit. In this situation, digging up burrows would be an acceptable method of searching, especially if turning rocks is unsuccessful. However, this would be more disruptive to the habitat and clearly discretion should be used. Adult *M. chiltoni* may be active during the day as previous records have shown, particularly, but not exclusively, in overcast or misty conditions.

Pitfall traps could be used to collect adult carabids, but it would be advisable to refrain from pitfall trapping until the status of a population is known. Furthermore, pitfalls should be installed to collect live beetles, and inspected regularly so that they can be released in good condition.

Night searching is another way of surveying carabid beetles, but densities of large predators such as *M. chiltoni* are likely to be low and success rate poor.

At survey sites, samples of specimens should be taken at a level of 5-10% of what is found so that comparative morphological, and, if necessary, genetic studies can be under taken. This would be of particular interest and importance if the species exists only in isolated populations. Knowledge of the existence of genetically distinct `ecotypes' would be of consequence should relocation of specimens from threatened environments be contemplated in the future. If numbers of individuals are small, specimens should be photographed to support the record. In all cases, sex of the individuals should be determined by examination of the external genitalia (with appropriate care being taken in handling specimens), and note taken of the reproductive condition of females (abdominal

swelling and visibility of membranes between sclerotised segments).

Habitat information should be recorded for all sites surveyed, namely vegetation description, other invertebrates encountered, altitude, aspect, slope, soil type, rainfall.

CONCLUSION

On the basis of current knowledge, *M. chiltoni,* would seem to be a species which is under threat from reduction of suitable, available habitat. A field survey designed specifically to obtain more information on current status of the distribution and abundance of the species from localities where it is known to have occurred, as well as neighbouring sites with apparently suitable habitat is considered warranted. Recommendations for priority sites, and a sampling protocol have been given.

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