# BENAMBBA LAND SYSTEM

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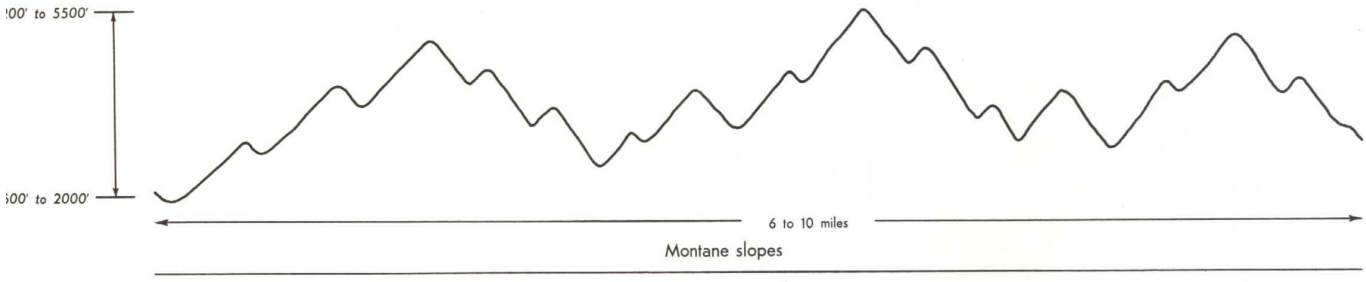
*Area: 1568 square miles 40·6% of catchment*

*Comprising three sub-systems*

*(b) Magorra sub-system*
*(c) Thowgla sub-system*
*(d) Gibbo sub-system*

### a) Distribution of land forms

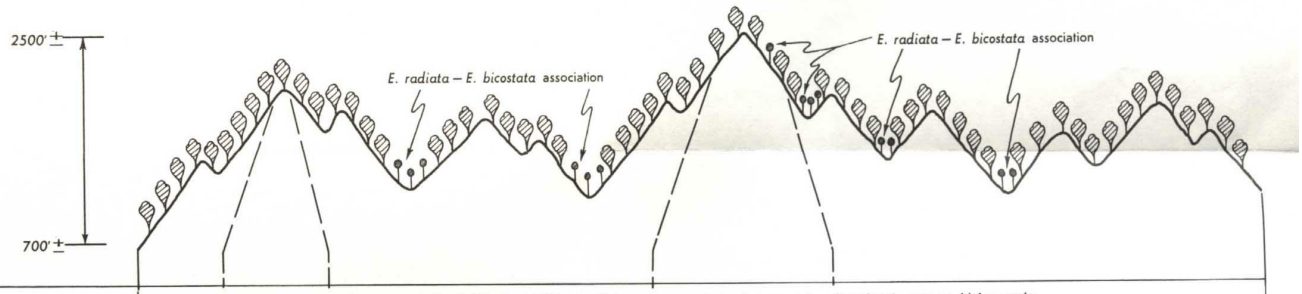



### b) Sub-system diagram

## MAGORRA SUB-SYSTEM

*Area: 330 square miles 8·5% of catchment*

*north to west* ← → *south to east*



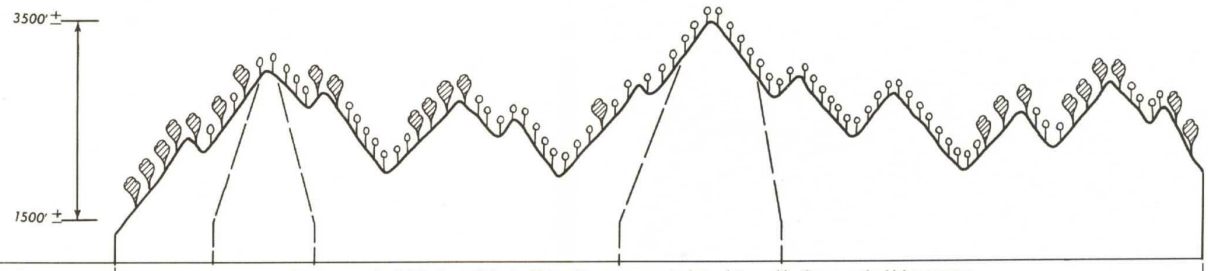

| | |
|---|---|
| Climate | Average annual rainfall about 30 in. to 40 in.; summers hot, winters, cool. Occasional snow on higher peaks |
| Geology | Mainly grey granite with some gneiss, schist and Ordovician fine sandstones and shales |
| Topography | Steep to very steep |
| Land Form | Montane slopes |
| Soil Groups | Leptopodzols, some lithosols<br>Amphipodzols \| Cryptopodzols |
| Vegetation Structure | Dry sclerophyll forest tending to wet sclerophyll forest in moister sites |
| Vegetation Floristics | *E. macrorhyncha* alliance |
| Present Land-use | Forestry—mainly catchment protection. Some utilization of scantling-quality mill-logs and poles, fencing timbers and firewood for local use. Some small areas in the north are cleared and grazed. |
| Potential Land-use | Forestry—management aimed at preserving the ground cover. Improvement of stand quality of selected areas to supply local markets for poles, fencing timbers and possibly scantling-quality mill-logs |
| Hazards | Generally a fairly high sheet erosion hazard if the ground cover is destroyed. Poorly designed, poorly constructed or inadequately maintained roads can lead to rill and gully erosion, stream sedimentation and costly road repairs. Soils derived from granite and gneiss have higher erosion hazard than finer-textured soils |
| Problems | Fire protection, and management to improve and/or maintain ground cover. Additional roads to improve access for fire protection and management. Road design, construction and maintenance to ensure that erosion does not occur. |

## (c) Sub-system diagram

### THOWGLA SUB-SYSTEM

*Area: 811 square miles 21·0% of catchment*

*north to west* ◄——————► *south to east*



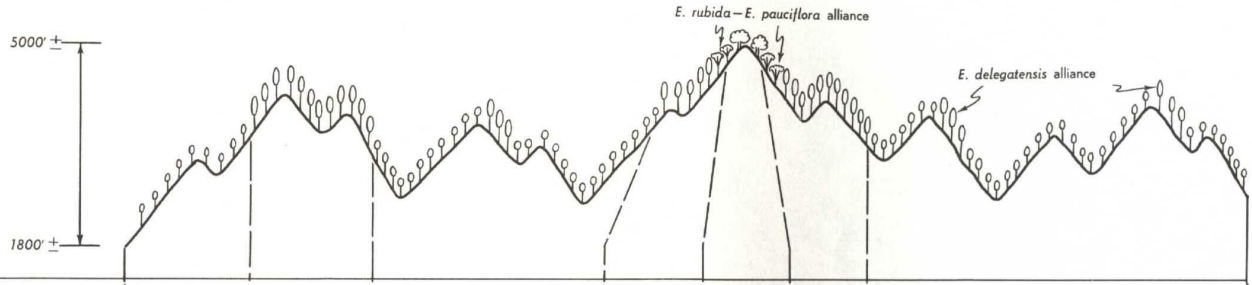

| | |
|---|---|
| Climate | Average annual rainfall about 40 in. to 50 in. Summers warm to hot, winters cold. Snow on the higher country |
| Geology | Mainly Ordovician shales and mudstones, some gneiss, schist, grey granite and generally small areas of other acid-igneous rocks |
| Topography | Steep to very steep |
| Land Form | Montane slopes |
| Soil Groups | Cryptopodzols, some lithosols<br>Amphipodzols \| Acid brown earths |
| Vegetation Structure | Wet sclerophyll forest tending to dry sclerophyll forest in drier sites |
| Vegetation Floristics | *E. radiata–E. rubida–E. dives* alliance to *E. macrorhyncha* alliance. *E. rubida–E. pauciflora* dominant in the south-western corner of the sub-system |
| Present Land-use | Forestry—mainly catchment protection. Some utilization of scantling-quality mill-logs, and poles, fencing timber and firewood for local use |
| Potential Land-use | Forestry—management aimed at preserving the ground cover and the improvement of stand quality of selected areas to supply local markets for poles, fencing timbers and scantling-quality timber |
| Hazards | Moderate sheet erosion hazard. Roads and logging areas can be troublesome if not carefully maintained. The erosion hazards are higher on coarse-textured soils derived from granite and similar textured rocks |
| Problems | Fire protection. Management techniques to improve timber quality and growth rate. Additional roads to assist in fire protection and management |

## (d) Sub-system diagram

### GIBBO SUB-SYSTEM

*Area: 429 square miles 11·1% of catchment*

*north to west* ← → *south to east*




| | | | | | |
|---|---|---|---|---|---|
| Climate | Average annual rainfall, greater than 45 in. Summers warm, winters cold. Higher country is snow covered for several months in winter. | | | | |
| Geology | Mainly granite and metamorphic rocks, with Ordovician shales and mudstones sharing dominance in the east. | | | | |
| Topography | Steep to very steep | | | | |
| Land Form | Montane slopes | | | | |
| Soil Groups | Cryptopodzols to acid brown earths, some lithosols | Acid brown earths | Acid brown earths | Transitional alpine humus soils | Acid brown earths | Cryptopodzols to acid brown earths, some lithosols |
| Vegetation Structure | Wet sclerophyll forest | | | Tall or sub-alpine woodland | Wet sclerophyll forest | |
| Vegetation Floristics | *E. radiata–E. rubida–E. dives* alliance | *E. delegatensis* alliance | *E. delegatensis* alliance | *E. pauciflora* alliance | *E. delegaten-sis* alliance | *E. radiata–E. rubida–E. dives* alliance |
| Present Land-use | Forestry—catchment protection. Utilization of mixed species forest for scantling-quality mill-logs and *E. delegatensis* forests for seasoning-quality mill-logs. Some grazing by beef cattle | | | | | |
| Potential Land-use | Forestry—catchment protection and intensive management, particularly of the *E. delegatensis* forests, would increase yields of better-quality timber. Controlled grazing by beef cattle when forest floor conditions are more favorable. | | | | | |
| Hazards | Low erosion hazard, except on the transitional alpine humus soils where wind erosion can occur when the ground cover is damaged. Roads and logging areas can be troublesome if not well maintained. The erosion hazards are higher on course-textured soils derived from granite and gneiss. | | | | | |
| Problems | Fire protection. Management to improve quality and growth rate, particularly the *E. delegatensis* forests. Additional roads to assist in fire protection and management. Methods of reducing the scrub understorey which is a fire hazard and reduces the value of these areas for grazing. | | | | | |

***Fig. 25 – Benambra Land System***

The Benambra land system is the most extensive in the catchment. It occupies 1,568 square miles or just over 40 per cent of the total area and includes most of the centre of the catchment. Because of its size, three sub-systems have been defined, fundamentally on the basis of differences in climate and altitude, as indicated by the indigenous vegetation. The boundaries between the sub-systems are to some extent arbitrary, although the subdivision is intended to have land-use significance.

***Magorra Sub-System***

This is the northern-most sub-system of the Benambra land system. It is differentiated from the other areas because of lower rainfall and drier vegetation types. The area is broken up into numerous smaller areas by intrusions of other land systems, mainly the Murray land system.

About 70 per cent of the sub-system is Crown land, but there are areas of Timber Reserve and Permanent Forest on the western edge of the catchment, and in the parishes of Thowgla and Khancobin. There is very little freehold land, because the topography is generally too steep to interest land developers. The area occupied by the sub-system is about 330 square miles which is about 81 per cent of the total area of the catchment.

The sub-system is made up almost entirely of the montane slopes land form (Figure 25). Very restricted areas of hillocks and some small stream flats occur, particularly where the sub-system is adjacent to the Murray land system. These, however, are a minor part of the sub-system and are not significant at the present scale of survey. The elevation difference between the valleys and the ridge tops is generally of the order of 1,500 feet to 2,000 feet.

Geologically, the sub-system is rather varied although there are no basic igneous rocks. Grey granite, and gneiss and schists are the most common. Some areas of Ordovician fine sandstones and shales occur, chiefly at the southern edge of the sub-system.

The average annual rainfall varies from about 30 inches up to about 40 inches with a distinct winter maximum. Snow falls only occasionally on the higher areas. Temperatures are generally warmer than in the other two sub-systems. Summers are hot and dry and winters are cool and wet.

The soils of the steeper, less-stable slopes are usually leptopodzols where coarse-textured acidic rocks occur, and may be cryptopodzols where fine-textured sedimentary rocks are the parent material, and more particularly on southerly aspects. Amphipodzols occur on flatter and moister areas, mainly on the broader ridge tops and southern aspects, and cryptopodzols occur on northern aspects at the higher elevations.

The indigenous vegetation of the sub-system has been used as a basis for its separation, as it is a useful indication of the climate. Dry sclerophyll forest of the *E. macrorhyncha* alliance is the dominant vegetation, with aspect affecting the

distribution of the associations within the area. The moister slopes on southern and eastern aspects generally have *E. macrorhyncha, E. radiata* and *E. rubida* as dominants, and *Pteridium esculentum* and *Poa* tussocks may form a continuous ground cover. Drier slopes have *E. polyanthemos, E. goniocalyx* and *E. dives,* with a discontinuous ground flora. A high proportion of the ground cover is forest litter. In wet, sheltered gullies within this sub-system *E. bicostata* and *E. viminalis* may occur.

This sub-system may be expected to contribute relatively little to base flows of streams, but it may yield excessive surface flows from high-intensity storms, and should be carefully managed to minimise surface run-off and sheet erosion.

Forestry is the most suitable form of land-use for this sub-system. The present forest provides supplies of fencing timbers, shed poles and firewood for landholders adjacent to the forest. Fire protection and selective cutting could improve the quality of the timber crop, although the demand is being satisfactorily met from the stands as they are at present.

This is rather a hazardous area for sheet erosion. Its present condition is fairly satisfactory, but because it is adjacent to freehold land in many places, it has been burnt frequently in the past. The destruction of the protective forest litter leaves the soil bare, and as accumulation of litter is slow, the soil is

inadequately protected for a considerable period. Evidence of sheet erosion from such areas can frequently be seen on the up-slope side of boundary fences where the ground level may be raised a foot or more. Erosion of forest roads can lead to stream sedimentation and necessitate expensive repair work.

The main problems of this sub-system are protection from fire, and management to maintain or improve the ground cover. A good road network is essential for fire protection and forest management. The correct design, construction and maintenance of roads are important aspects of management of the sub-system.

***Thowgla Sub-System***

This is the largest of the sub-systems. It occurs over practically the length and breadth of the catchment. Its most northerly occurrence is two small areas, one on either side of the Wodoriga-Cudgewa railway near Shelley. In the south-west it extends into the catchment of the Victoria River, and in the south-east the country around Mt. Brothers is included. The greatest extent of the area is in the central part of the catchment.

The area of the sub-system is about 811 square miles, which is 21 per cent. of the total catchment. Most of it is Crown land but there is some Timber Reserve around The Brothers and to the north, and also around Mt. Wills, Glen Wills and Middle Creek.

As in the Magorra sub-system, the area consists of montane slopes with virtually no other land form (Figure 25). Slopes are steep to very steep. Ridge-top elevations range up to about 4,000 feet and valleys are generally about 2,000 feet to 3,000 feet lower. Ridge tops are narrow, and valley bottoms generally are steep-sided almost right down to the edge of the streams.

Because of the extent of this sub-system, a range of rock types is included within its boundaries. The rocks are mainly Ordovician fine sandstones, mudstones and shales, although there are also grey granite and various grades of metamorphic rocks. There are small areas of a number of acid igneous rocks, such as syenite and quartz porphyry. A fairly large part of the area of quartz porphyry, which extends north from near the junction of the Mitta Mitta and Gibbo Rivers, is in this sub-system.

The average annual rainfall of this sub-system is intermediate to the Magorra and Gibbo sub-systems. Rainfall of 40 inches to 50 inches per annum may be expected, with snow on the higher ridges several times during the winter. Temperatures are warm in summer and cool to cold in winter. Aspect and elevation cause considerable variation in rainfall and temperature, and in the availability of soil moisture for plant growth. The area to the east of Mt. Hotham is probably influenced by the rain shadow, and seems to be somewhat drier than most of the rest of the sub-system.

The most widely occurring soils are the cryptopodzols which grade into the acid brown earths at the higher elevations. On the coarse-textured rocks, amphipodzols and occasionally leptopodzols may be present. Soils in drier situations have less organic matter in the surface and are usually of harder consistence and poorer structure.

The vegetation of the Thowgla sub-system ranges from dry sclerophyll forest of the *E. Macrorhyncha* alliance, through its moister counterpart to wet sclerophyll of the *E. radiata-E. rubida-E. dives* alliance. Wet sclerophyll forest to tall woodland of the *E. rubida-E. pauciflora* alliance occurs in the south-west. Available soil moisture, as influenced by aspect, slope and elevation, is a major factor determining the distribution of the vegetative forms. Wet sclerophyll forest may occur in moist sheltered gullies at low elevations, but has its widest distribution at higher elevations. Similarly, although the drier forms of vegetation occur mainly at lower elevations they can also occur on dry, exposed sites at higher elevations. However, low temperatures restrict them from the uppermost elevations. The occurrence of the *E. rubida-E. pauciflora* alliance in the south-west is the result of the lower rainfall and the cooler temperatures described earlier.

There is little erosion from this sub-system and the hazard is moderate. Because of the higher rainfall, the recovery of the vegetation after damage by fire is fairly rapid. Protection of the soil is not dependent on leaf litter to the extent that it is in the Magorra sub-system. However, if heavy rains follow closely on the destruction of ground cover, sheet erosion will occur.

Because this sub-system occupies such a large proportion of the catchment, it is an important contributor to the total water yield. However its water yield per unit area is not as high as for the Gibbo sub-system or the Bogong land system. it may be estimated from Table 10 that the average yield of water per square mile would be about 700 ac. ft., a fairly large proportion of which would be winter flow, although perennial flow may be expected in most of the larger streams originating in the sub-system.

The forests of this sub-system, excluding the drier associations, have a higher potential than those of the Magorra sub-system. The main obstacles to their utilization for sawn timber are that the present quality is relatively low, and extraction costs are relatively high because of the steepness of much of the area and the distances logs have to be transported to conversion centres.

As in all sub-systems of this land system, one of the greatest problems is the protection of the area from fire. More access roads would help by making possible more rapid attack on fires. The essence of fire fighting is to get to the fire as early as possible, before it has a chance to spread. However, for all roads, and particularly for roads used only for fire protection, design, construction and maintenance must be thorough, so that erosion is not caused by the concentration of drainage water. Markets for low-quality timber could make silvicultural treatment for improvement of stand quality an economic proposition.

***Gibbo Sub-System***

This, the third sub-system of the Benambra land system, occurs in the higher-rainfall areas of the mountains, and consists of two main areas. The area on the western side of the catchment includes the headwaters of the various branches of Snowy Creek, and the Big River north of Glen Wills, and extends around into the headwaters of Middle Creek and the Bundarrah and Cobungra Rivers. Mt. Wills and the headwaters of Lightning, Christmas and Wombat Creeks are also included. The other area is in the central-east of the catchment and includes the mountainous country at the head of the Dart River and several of its tributaries, the upper parts of the ridge which forms the Dart River-Zulu Creek divide, and extends down the Larsens Creek-Gibbo River divide. The bulk of this second area occurs in the headwaters of Wheelers Creek around Mt. Gibbo and just below the Pinnibar plateau, and extends eastward to include a large amount of the Buckwong Creek catchment and the Davies Plain ridge below the plateau remnants. A smaller separate area is located on the Divide between Mt. Phipps and Mt. Delusion.

In all, an area of 429 square miles is involved, which is about 11 per cent. of the total catchment. Most of the sub-system is Crown land, but there is some Timber Reserve around Mt. Wills and in the valleys of the Big River and Middle Creek, and there is Permanent Forest between Mt. Phipps and Mt. Delusion.

As with the other two sub-systems, this is composed entirely of steep to very steep montane slopes (Figure 25). Ridge-top elevations range up to about 4,500 feet and valley elevations are about 2,000 feet to 3,000 feet lower. Some peaks are up to 5,700 feet (Plate 32).

**Plate 32. The upper part of the catchment of the Gibbo River which forms part of the Benambra land system. Over 60 per cent of the Hume catchment is mountainous.**

The geology is varied. In the western part of the sub-system granite and various grades of metamorphosed Ordovician rocks are dominant, but there are some unaltered Ordovician shales and mudstones, mainly towards the centre of the catchment. In the eastern part of the sub-system Ordovician rocks are dominant, but small areas of granite occur, mainly around and to the east of Mt. Gibbo.

This sub-system has the highest rainfall of the three in the Benambra land system. Average annual rainfall is generally higher than 45 inches and winter snow is common on the higher peaks and ridges. Temperatures are milder in the summer and colder in the winter than in most other parts of the catchment. Aspect and elevation play an important part in controlling micro-climate.

On the lower parts of the sub-system, soils are the same as for the Thowgla sub-system, but because of the higher elevations and higher rainfall, there is a greater accumulation of organic matter. Acid brown earths occupy the upper slopes, and on the highest peaks may be replaced by transitional alpine humus soils or even alpine humus soils. Cryptopodzols are the most common soils at the lower elevations. In some sheltered gullies, there may occur deep red clay loams which resemble krasnozems. In most soils in these steeper areas small fragments of stone are common. They are usually orientated down slope, indicating the direction of the movement of soil creep.

Wet sclerophyll forest is the main form of vegetation over the whole of the sub-system. In the drier parts, the *E. radiata-E. rubida-E. dives* alliance is dominant, and where soil-moisture availability is higher the *E. delegatensis* alliance occurs. On the higher parts of the sub-system the *E. rubida-E. pauciflora* alliance occurs in wet sclerophyll forest formation. It tends towards the tall woodland form and may ultimately give way to sub-alpine woodland of *E. pauciflora* alliance on the highest peaks, such as Mt. Pinnibar and Mt. Gibbo. Most of the area has suffered some fire damage which appears to have resulted in an increase in the density of leguminous shrubs. Fire scars occur on the butts of most of the older eucalypts that have survived the fires. Such damage to the *E. delegatensis* forest results in reduction of quality and loss of valuable merchantable timber.
The patches of *E. delegatensis* forest in the Cobungra valley are small and scattered. The environment seems to be marginal for the species in these areas and the site quality is low.

The present condition of this sub-system is such that no erosion is occurring. The soils are generally permeable, and because of the high and reliable rainfall, recovery of the ground vegetation is fairly rapid. Major disturbances as a result of logging do not seem to cause any serious or persistent erosion, although colloidal material from compacted areas may result in stream turbidity after high-intensity rain. On the higher, exposed areas, the transitional alpine humus soils are prone to wind erosion when the ground cover is destroyed.

Of the three sub-systems in the Benambra land system, this one is by far the most productive. Only the Bogong land system, with its higher total precipitation and higher proportion of winter snow, has a higher yield of water. It may be estimated from Table 10 that this sub-system would yield an average of a little over 1,000 acre feet per square mile. A large proportion of this is winter flow, but practically all streams flow for the whole year.

Forestry is the major form of land-use, and logging of the *E. delegatensis* forests provides considerable quantities of high-quality mill-logs. Grazing of beef cattle on an annual licence system has also been a form of land-use practised, but because of increasing scrub density and a consequent lowering of grazing potential, many graziers no longer run cattle in their licensed areas.

Fire protection is of great importance, not so much as an erosion-prevention measure, but as a pre-requisite for improvement of the productivity of the area. Frequent burning in the past has caused deterioration of the quantity of sound timber which can be cut from most trees. A fire scar in the butt of a tree generally leads to introduction of rot or termites, either of which may cause the discarding of part of, or even the whole trunk, when the tree is felled. Periodic burning is also blamed for the increase in scrub density and the lowering of grazing potential. It is suggested that complete protection from fire would ultimately result in the degeneration of the scrub layer and its reversion to an open grassy forest floor which is now so rare. The length of the period of complete fire protection would need to be at least as long as the life cycle of the longest lived of the fire-induced shrubs. This is not known at

present but is probably not less than 20 years under normal conditions. Once the forest understorey has returned to its open grassy form, the so-called "protection burning" should no longer be necessary. An essential part of any plan for fire protection, is an extensive network of well constructed roads which must be regularly maintained.

Defoliation of large areas of forest has occurred in some parts of the sub-system as the result of the development of plague numbers of a stick insect, or phasmatid *(Didymuria violescens),* which feeds on the leaves of eucalypts and prefers the higher-rainfall species such as *E. radiata, E. rubida* and even *E. delegatensis.* The control of this pest has caused some concern. Fears that defoliation may lead to erosion do not appear to be justified (R. K. Rowe 196 1, unpublished report to S.C.A.). The plagues appear to run through several life-cycles and then wane. Unless valuable stands of F. *delegatensis* are threatened, the best policy appears to be to regard the plague development as a normal occurrence and to do nothing to interfere with the natural processes which have maintained control of the populations of the phasmatid in the past.