# THE EFFECT OF CLIMATE ON THE STEM-GALLING MOTH, *EPIBLEMA STRENUANA* IN EASTERN AUSTRALIA

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*Summary.* The stem-galling moth, *Epiblema strenuana*, is now widely established in Queensland, the Northern Territory and northern N.S.W. for the biocontrol of parthenium weed, annual ragweed and Noogoora burr. Erratic rainfall and low summer temperatures will severely limit its effect inland south of Dubbo and on the coast south of Coffs Harbour. In areas north of N.S.W. it should give good control at least in wet years.

## INTRODUCTION

The stem-galling moth, *Epiblema strenuana* (Walker), has been released widely in northern Australia for the biological control of its three host plants, parthenium weed, *Parthenium hysterophorus*, Noogoora burr, *Xanthium pungens*, and the annual and perennial ragweeds, *Ambrosia* spp. By May, 1987, it had become established throughout most of Queensland, and in N.S.W. along the north coast to Coffs Harbour, on the Namoi River near Narrabri and probably along the Culgoa, Barwon, and Warrego Rivers near the Queensland border. In the N.T. it is established along the Victoria and Daly Rivers and on the Roper, Macarthur and Robinson Rivers on the Gulf of Carpentaria. In W.A., releases were made this year on the Ord River near Kunanurra.

## LIFE HISTORY

Adult moths are small (6-10 mm long), dark grey, nocturnal, and live for 7-11 days. The small whitish flattened eggs are laid singly on the leaves of the host plants, and hatch in 3-5 days. Larvae bore into the stem at tips or side shoots, and their feeding causes the stem to swell into a hollow gall 1-2 cm wide. After four to six weeks the 1.0-1.5 cm long fully-grown larva pupates inside the gall and the moth emerges through a hole in the side. Galls form in any size of plant including the smallest seedlings. Single galls may kill seedlings but have little effect on large plants. Heavily attacked larger plants with 30 to 100 galls each are severely stunted and produce little seed.

In most areas, galls develop continuously throughout summer, but during April and May larvae enter dormancy in response to cold weather. Adults do not emerge until mid to late August and galls are first seen in September-October, but north of Mackay winter dormancy may not occur. Despite the small size of the adult, moths travel more than 20 km to find isolated plants. The first releases were made in January 1983 and the moth has since spread rapidly till it now occurs throughout most of Queensland.

## CLIMATIC EFFECTS

1. Rainfall. On the east coast of Australia from Gin Gin in Queensland to Port Macquarie in N.S.W., where annual ragweed and Noogoora burr are the host plants for the stem-galling moth, the rainfall is reliable and germination and growth of these annuals occurs regularly each year. West of the Dividing Range, however, where the host plants are Noogoora burr and parthenium, the rainfall is much more erratic. Burr in particular grows in very dry country subject to periodic floods, and in many areas may only germinate one year out of ten. The stem-galling moth requires green living plants to develop; females will not lay on brown or wilted leves and larvae in wilting plants die

or develop into very undersized adults. In these areas, therefore, the chief limiting factor is the rainfall, and the following sections apply only to development and increase of the moth when the weeds have germinated after rain.

2. Effect of temperature on development of the moth. Development rates in insects are temperature-dependent, with a linear relationship between temperature and development rate (1). Fluctuating temperatures in the field make it difficult to calculate the rate of development at a particular place. Development period is therefore measured in physiological rather than chronological units and this physiological development period, expressed as day degress, is constant at different temperatures within the optimum range[4].

The insect is reared at different temperatures within the normal range and the development period at each is determined. A linear regression gives the lower threshold temperature and the mean development period in day degrees. For the stem-galling moth, the lower threshold is 12.4°C and the development period 517 day degrees. The upper threshold is taken as the temperature where mortality begins to rise steeply (5); for the stem-galling moth this is approx. 35°C. Thermal summation is then used to calculate the accumulated number of day degrees from the daily maximum and minimum temperatures recorded in the field. Using the monthly mean maxima and minima (3), accumulated day degrees were calculated for 40 sites in Queensland and northern N.S.W. for the period September-May inclusive. The theoretical number of generations possible for each site was then plotted on a map (Fig. 1). Based on this and on the seasonal isotherms[2] equi-generation lines were plotted. The same method was used to calculate the minimum number of days required for a complete generation in summer (Fig. 2) and equi-duration lines were plotted using these and the January isotherms.

## DISCUSSION

Figs. 1 and 2 show the maximum number of stem-galling moth generations theoretically possible in different areas of Queensland and northern N.S.W. Actual field results may differ for several reasons. 1) Only shade air temperatures were used. Larvae and pupae are usually in full sunlight, but protected inside the stem of a living and transpiring plant. No attempt has been made to measure temperatures actually experienced by larvae in the field. 2) Average monthly maxima and minima are used but particular months or years may be hotter or colder than the average. 3) These results refer only to well-fed larvae. Stressed or underfed larvae in old or drought-stressed plants develop more slowly.

Nevertheless, these maps serve as a useful approximation of the results to be expected. For example, in most of Queensland except for the south-east, the stem-galling moth will have more than six generations each year, while in the ragweed areas of northern N.S.W. there will be less than four generations. As increase rates of 100-fold per generation have been recorded under optimal conditions, the extra two generations could mean a further 10,000-fold increase in the year. In practical terms this means a slower build-up in the spring in N.S.W. and fewer galls on the plants later on. It is likely that the stem-galling moth will be ineffective against ragweed in the high country from Stanthorpe to Armidale, and on the coast south of Coffs Harbour.

Phytotron studies (6) showed that parthenium weed can "grow and flower in most of the seasonally humid nd subhumid regions of Australia". Unfortunately if parthenium weed ever becomes established in central and southern N.S.W., this

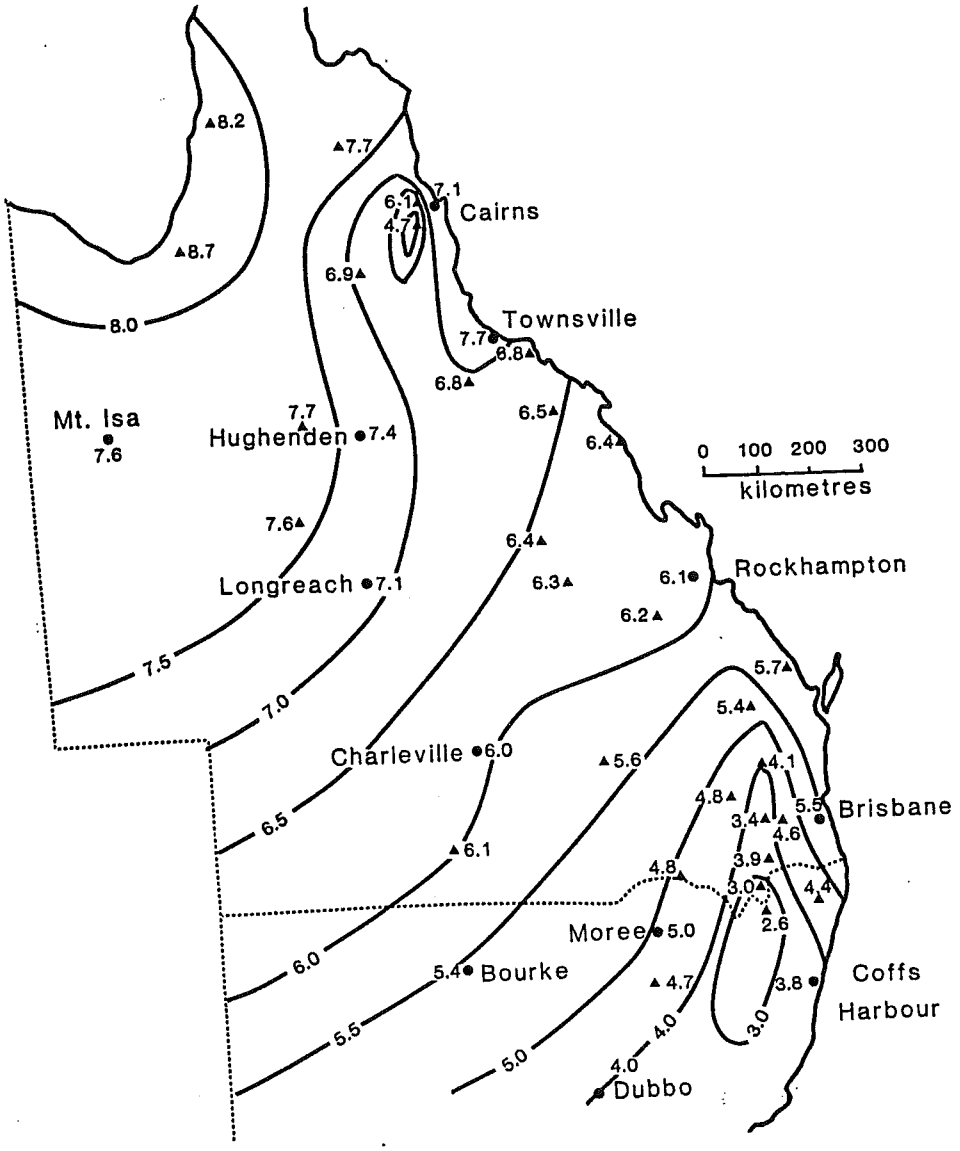


Figure 1 : Calculated maximum number of generations per year, September to May, of the stem-galling moth for Queensland and northern N.S.W.
7.7▲ values calculated for individual localities
7.0 equi-generation lines

moth is unlikely to be an effective biocontrol agent in those areas.

Fig. 2 shows the minimum theoretical generation time in the summer, 28 days at Winton, 65 days at Tenterfield, and between 30 and 35 days in central and south-west Queensland and north-west N.S.W. This is significant in relation to Noogoora burr germinating over a large area after cyclonic rains or floods. Noogoora burr in dry country is noted for its long seed dormancy and rapid germination after heavy rain in summer. During dry years, there are very few plants and the moth population will be reduced to the few that can survive in plants around dams, bores, tanks, water holes etc., or where local storms have occurred. Numbers would be very low and scattered, and in very dry areas the moth may die out completely.

To have any impact on the massive growth of Noogoora burr after widespread rains, the moth must be capable of very rapid increase. The average female moth lays 400-500 eggs and large moths from well-fed larvae lay over 1000 eggs. The potential is there; the problem is time. Moths will lay and larvae develop in seedling burr plants, and Fig. 2 shows that in central and far west Queensland, the second generation of large weel-fed moths will emerge four weeks later. An explosive increase in gall numbers can be expected five or six weeks after the burr germination, as in fact occurred in northern and central inland Queensland after Cyclone Winifred in February 1986. The Noogoora burr germinated over a large area and by the first week of April there were 20-30 galls per plant, in places where the stem-galling moth had not previously existed, over 100 km from the nearest releases. This heavy galling reduced the seed produced by up to 90% (M. Ablin, pers. comm., 1986). Fig. 2 shows that similar results could be expected after cyclonic rain in the burr country in Queensland and the N.T., and in the north-west corner of N.S.W.

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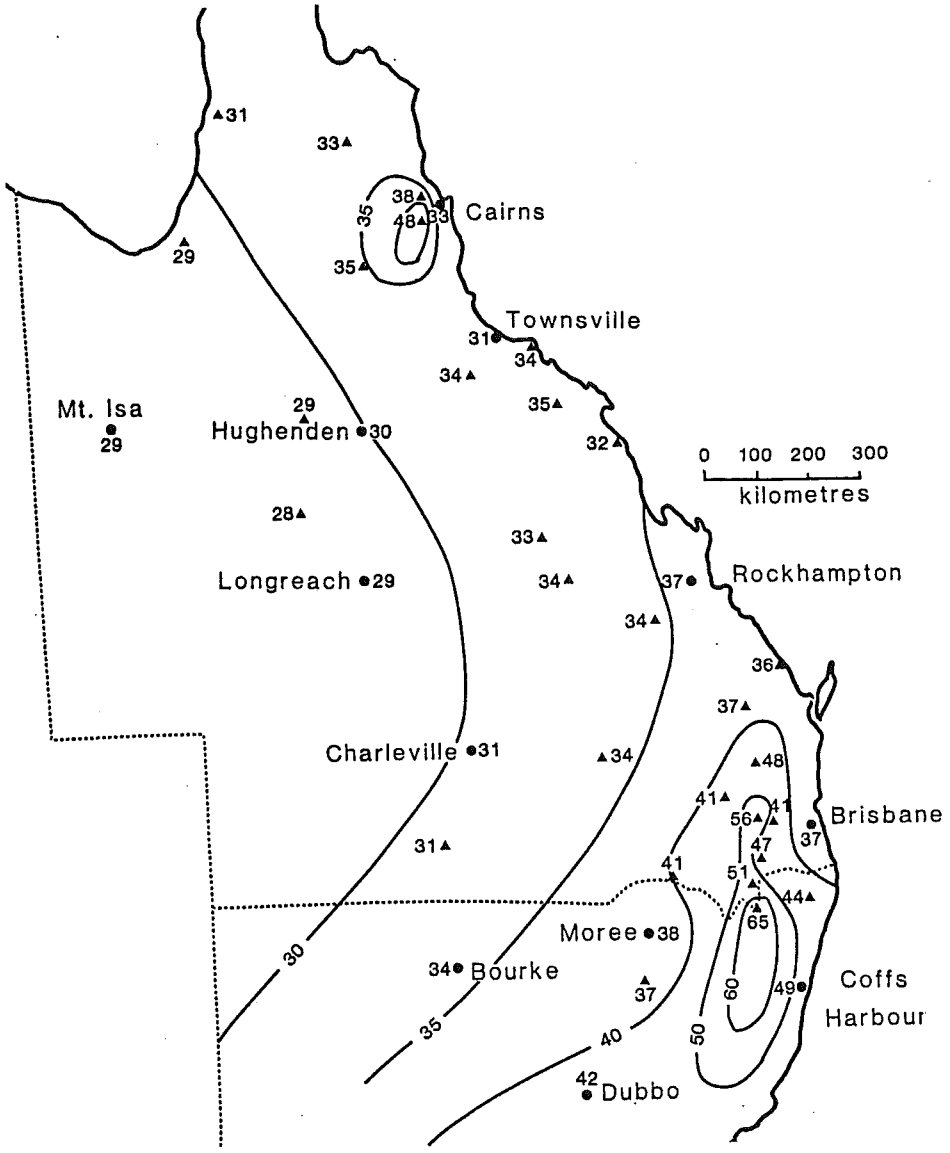


Figure 2 : Calculated minimum number of days per summer generation of the stem-galling moth for Queensland and northern N.S.W.
33▲ values calculated for individual localities
~ 35 ~ equi-duration lines