

REVIEWS

Distribution and abundance of St John's wort, *Hypericum perforatum* L., and its introduced biological control agents in Victoria

Rosamond C. H. Shepherd

Keith Turnbull Research Institute, Frankston, Victoria 3199

Summary

A questionnaire sent to the Department of Crown Lands and Survey Inspectors showed that St John's wort was present in approximately half the Inspectors' districts, and mainly present in sown forest plantations and unsown native forests. Only a small amount of agricultural land is still infested by this weed. The beetle *Chrysolina quadrigemina* had a more extensive distribution than *C. hyperici* and was present in larger numbers.

Introduction

St John's wort (*Hypericum perforatum* L. var. *angustifolium* DC) was introduced from Europe as a garden plant to Bright in north-eastern Victoria, in the 1880s. It soon became established and now covers a large area of north-eastern and central Victoria, parts of Gippsland, the Wimmera and south-western Victoria, and parts of New South Wales, South Australia and Western Australia (Parsons, 1973). In 1893 St John's wort was proclaimed a noxious weed for the Bright Shire and in 1903 for the whole of Victoria (Parsons, 1973). The most severe infestations of St John's wort occur at altitudes up to 1000 m, with an annual rainfall of about 750 mm. It occurs in areas of disturbed soil, such as dredge tailings, forestry areas, along railway lines and roadsides, and also in young *Pinus radiata* plantations and under partial shaded conditions such as open sclerophyll forests (Moore and Cashmore, 1942; Parsons, 1973; Wilson, 1943).

St John's wort is toxic to stock. The

poisonous principle is hypericin (Everest, 1981) which causes photosensitization, but the central nervous system may also be affected causing loss of condition and possibly death (Parsons, 1973). Because of the poisonous nature of the plant and the amount of land it infested, a decision was made in the 1920s to attempt biological control. In the 1930s five species of insects, three beetles and two moths, were introduced from England and released in the Bright district (Wilson, 1943). The beetles were *Chrysolina varians* Schall., *C. hyperici* Forst. and *C. brunsvicensis* Grav. (Chrysomelidae), and the moths were *Anaitis plagiata* L. and *A. efformata* Guen. (Geometridae). *C. hyperici* was the only species known to have become established. The beetles, *C. quadrigemina* (Suffrian) (syn. *C. gemellata* Rossi) (Chrysomelidae) and *Agrius hyperici* Cr. (Buprestidae) were later introduced from the Var in France and released at Bright in 1939–41. *C. quadrigemina* became established at Bright, but although *A. hyperici* persisted for several years it did not establish. The midge *Zeuxidiplosis giardi* Kieffer (Cecidomyiidae), was introduced to Bright during the 1930s (Wilson, 1943) and has become established. The insects which became established have now spread to other districts.

The distribution of St John's wort was known for Victoria (Parsons, 1973), but it had not been investigated according to land usage or altitude, and the distribution and abundance of *Chrysolina* spp. was not known. To determine these factors a questionnaire was sent to each Department of Crown Lands and Survey Inspector.

Materials and methods

Hypericum perforatum survey

The questionnaire covered the yearly activity of the plant and its biological control agents. Based on their local knowledge and observations over the years, Inspectors were asked to comment on the aspects raised in the questionnaire.

The survey recorded which land forms were most heavily infested, the area (ha) and parishes infested per district, the presence or absence of *Chrysolina* spp. and whether or not they controlled the plant. The biological and ecological information requested included altitude range, seasonal activity of the beetles and their numbers per plant, the portion of plant most frequently and severely attacked and whether adults or larvae did most damage to the plant. Information on the presence of other insects, either introduced or indigenous, and whether they damaged the plants was also requested.

Chrysolina collection and identification

All Department of Crown Lands and Survey Inspectors in districts where *Chrysolina* spp. are present were requested to collect and send in samples for identification. The samples were to be collected four times per annum — just after emergence in September or October, when the maximum number of beetles was present in late October–November, before aestivation occurred in early December, and when they reappeared on the plant in autumn after aestivation during March–April. Aestivation is the summer resting period during which the ovarioles develop. During that time beetles are not present on the plant and no feeding occurs. These collection dates covered the times of the year when adult *Chrysolina* spp. were present in the field. The samples were to be taken from the same site for each collection and were to include all beetles on four to six plants.

All specimens were identified to species. Identification of males depends mainly on the shape and size of the aedeagus (Wilson, 1943). Other characters used to identify both sexes included the number and diameter of punctata along the edge of the elytra, 14 to 23 with an average of 19 for *C. quadrigemina*, and 11 to 16 for *C. hyperici*, and their total lengths, 7 mm and 6 mm respectively (Nelson, 1962; Wilson, 1943). All specimens were measured and their punctata counted to differentiate between the

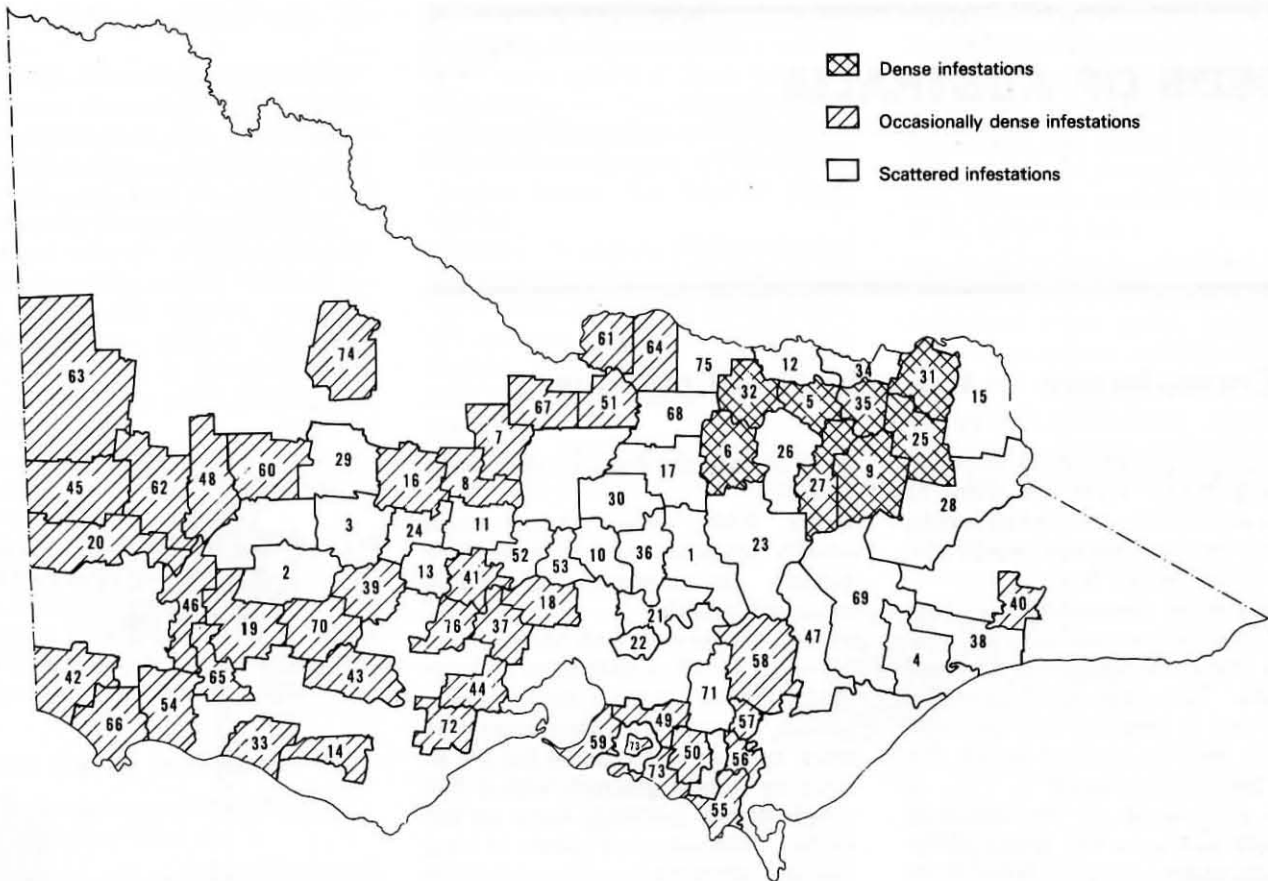


Figure 1 Distribution of St John's wort in Victoria showing Inspectors' Districts with nearly all parishes infested, some parishes heavily infested, and some parishes with scattered infestations. See Table 1 for numbers 1-36 and 76, and Table 4 for numbers 37-75.

species. The smaller specimens were dissected and the aedeagus of males examined.

Results

Summary of St John's wort distribution survey

The districts of Victoria in which St John's wort is present are shown in Figure 1. Sixty-four Inspectors reported that St John's wort was not present in their district, 41 that it was only present as scattered plants in some parishes, and 27 that it was occasionally present in dense stands but not present in all parishes. The heaviest infestations were reported from north-eastern Victoria, in the Beechworth, Benalla, Bright, Mitta Mitta, Myrtleford, Tallangatta, Wangaratta and Yackandandah districts where nearly all parishes were infested (Figure 1). The total amount of land estimated to be infested by St John's wort was 175 195 ha.

Of the total number of infestations, 83% were found in unsown native forests, mainly in the Bright district, and 7% in sown forest plantations of *Pinus radiata*, mainly in the Bright and Beechworth districts. About 7% of the total area of infestation occurred in agricultural land, mainly in the Mitta

Mitta, Beechworth and Benalla districts and infestations on land used for purposes other than forestry and agriculture only amounted to 4% of the total, including roadsides, railway lines, National Parks, dredge tailings, golf courses and river beds. The amount of infested land according to land use categories is shown in Table 1. The districts which reported the presence of St John's wort on agricultural and forestry land are shown in Figure 2.

Chrysolina collection and identification

Most samples were collected in October and November 1978 and only a small number was collected during December 1978 and April, October and November 1979. Most *Chrysolina* were therefore collected before aestivation took place.

Altogether 6811 beetles were collected from 21 districts and identified. In October 1978 the samples ranged from 10 (Yea) to 767 (Beechworth), in November they ranged from 66 (Clunes and Corryong) to 382 (Wangaratta) and in December from 11 (Wangaratta) to 53 (Myrtleford). Fewer collections were made in 1979. In April the range was from 3 (Euroa) to 132 (Benalla), while in October 161 beetles were

collected from Myrtleford and also 48 in November (Table 2).

The male *C. hyperici* collected in October 1978 came from Bright (2) and Mansfield (3) and the December *C. hyperici* from Myrtleford (3). These represented 0.13% of the 1978 sample. No female *C. hyperici* were collected that year. All other *Chrysolina* collected in 1978 were identified as *C. quadrigemina*.

No *C. hyperici* were found in the limited number of samples collected in autumn 1979. However, the sample collected from Myrtleford in spring 1979 had a higher percentage of *C. hyperici* than the 1978 collections. Of the sample collected during October 13% of males and 27% of females were *C. hyperici*, and during November 57% of males and 81% of females collected were *C. hyperici*.

The sexing of *C. quadrigemina* showed that the male:female ratio varied seasonally. The ratio for the samples collected prior to aestivation 1978/79 was 1:1.01, after aestivation in April 1979 it was 1:3.08 and during late spring 1979, 1:1.08. It appears from this limited sample that fewer males survived aestivation and returned to the St John's wort than females.

Continued from page 145

Females from all collections were examined for ovariole development and, as expected, only a very few small developing ovarioles were present in non-aestivated beetles and the eggs had not developed.

Colour variations in *C. quadrigemina* were noted by Wilson (1943) in southern France where he found that 77% were bronze, 16% green and 7% blue. Of the samples sent in during this survey 81% were bronze, 9% green and 10% blue. The number of *C. hyperici* collected was too small to show any significant colour variations.

Chrysolina survey

Inspectors were asked to report on the annual activity of *Chrysolina*. Nearly all Inspectors in whose districts beetles were found were aware of the damage caused by adults but only one Inspector reported plant damage by larvae. The Inspectors were therefore not aware that larvae as well as adults fed on the plant. Most Inspectors knew that adults were present on the plant between September and January but only two reported that adults were present later than January. Inspectors were aware that the beetles disappeared in summer but aestivation of adults and their re-emergence during April was neither observed nor fully understood.

Inspectors were asked the number of *Chrysolina* present per plant. Numbers of beetles seldom exceeded 50 adults per plant, although more than 100 per plant was reported in the Chiltern and Mansfield districts (Table 3).

Most Inspectors reported that fewer than 50% of plants were usually attacked by *Chrysolina* and only three Inspectors considered that 100% of plants could be infested. All parts of the plant were usually reported as attacked (Table 3). One Inspector reported that the root system could be attacked.

No beetles were reported to occur in numbers above 1000 m. The Bright Inspector reported that they could be occasionally found up to 1800 m (Table 3). St John's wort can occasionally be found at altitudes of 2000 m but I observed no *Chrysolina* at that height.

Reports from field staff suggested that adult *Chrysolina* do not naturally move far to colonize unattacked plants and so Inspectors were asked to comment on their observations of beetle movements. Two Inspectors did not report any movement by *Chrysolina* because of the limited infestations of St John's wort in their districts, but all

Table 1 The areas* (ha) infested by St John's wort according to land use categories in Inspectors' districts

Number, related to Figures 1 and 2	District	Areas (ha)		
1	Alexandra	40 ¹	405 ³	810 ⁴
2	Ararat	10 ³	120 ⁶	
3	Avoca	80 ¹	200 ⁶	
4	Bairnsdale No.1	25 ³	80 ⁷	
76	Ballarat No.2	60 ²		
5	Beechworth	810 ¹	2025 ³	1010 ⁴
		80 ⁵	9300 ⁶	2160 ⁷
6	Benalla	1215 ¹	2025 ³	3020 ⁶
		450 ⁷		
7	Bendigo No.1	10 ³		
8	Bendigo No.2	10 ³		
9	Bright	100 ¹	405 ³	810 ⁵
		101250 ⁶	2025 ⁷	
10	Broadford	400 ³	50 ⁶	
11	Castlemaine	10 ³	20 ⁸	
12	Chiltern	120 ³	405 ⁶	
13	Clunes	40 ³		
14	Cobden	15 ¹		
15	Corryong	60 ³	810 ⁶	450 ⁷
16	Dunolly	10 ³		
17	Euroa	100 ³	20 ⁷	
18	Gisborne	10 ³		
19	Glenthompson	10 ³		
20	Harrow	10 ³		
21	Healesville	30 ³	120 ⁶	
22	Lilydale	100 ³	100 ⁶	
23	Mansfield	405 ⁶	325 ⁷	
24	Maryborough	10 ²	50 ³	15 ⁶
25	Mitta Mitta	200 ¹	2430 ³	80 ⁵
		8100 ⁶		
26	Moyhu	20 ¹	610 ³	810 ⁶
		1215 ⁷	25 ⁸	
27	Myrtleford	455 ³	1215 ⁶	810 ⁷
28	Omeo	405 ³	810 ⁶	
29	St. Arnaud	140 ³		
30	Seymour	140 ³	90 ⁶	
31	Tallangatta	60 ¹	385 ³	8100 ⁶
32	Wangaratta	160 ¹	155 ³	15 ⁶
		7290 ⁶	405 ⁷	
33	Warrnambool	10 ³		
34	Wodonga	500 ³	810 ⁶	405 ⁷
35	Yackandandah	180 ¹	810 ²	520 ³
		810 ⁶	15 ⁷	
36	Yea	245 ³	205 ⁶	

Totals (ha) — roadsides¹, 3050 (42)**; railway lines², 880 (14); agricultural land³, 11850 (34); National Parks⁴, 1820 (4); dredge tailings⁵, 985 (7); unsown native forests⁶, 145200 (26); sown forest plantations⁷, 11390 (16); river banks⁸, 20 (1); golf courses 1 (1).

* Areas less than 10 ha not included in table.

** No. of districts with St John's wort on this land use.

Table 2 The number of *C. quadrigemina* and *C. hyperici* submitted each month by Department of Crown Lands and Survey Inspectors

Collection date	Number of districts submitting samples	<i>C. quadrigemina</i>	<i>C. hyperici</i>
October 1978	13	3451	5
November 1978	12	2886	0
December 1978	2	61	3
April 1979	4	196	0
October 1979	1	131	30
November 1979	1	14	34

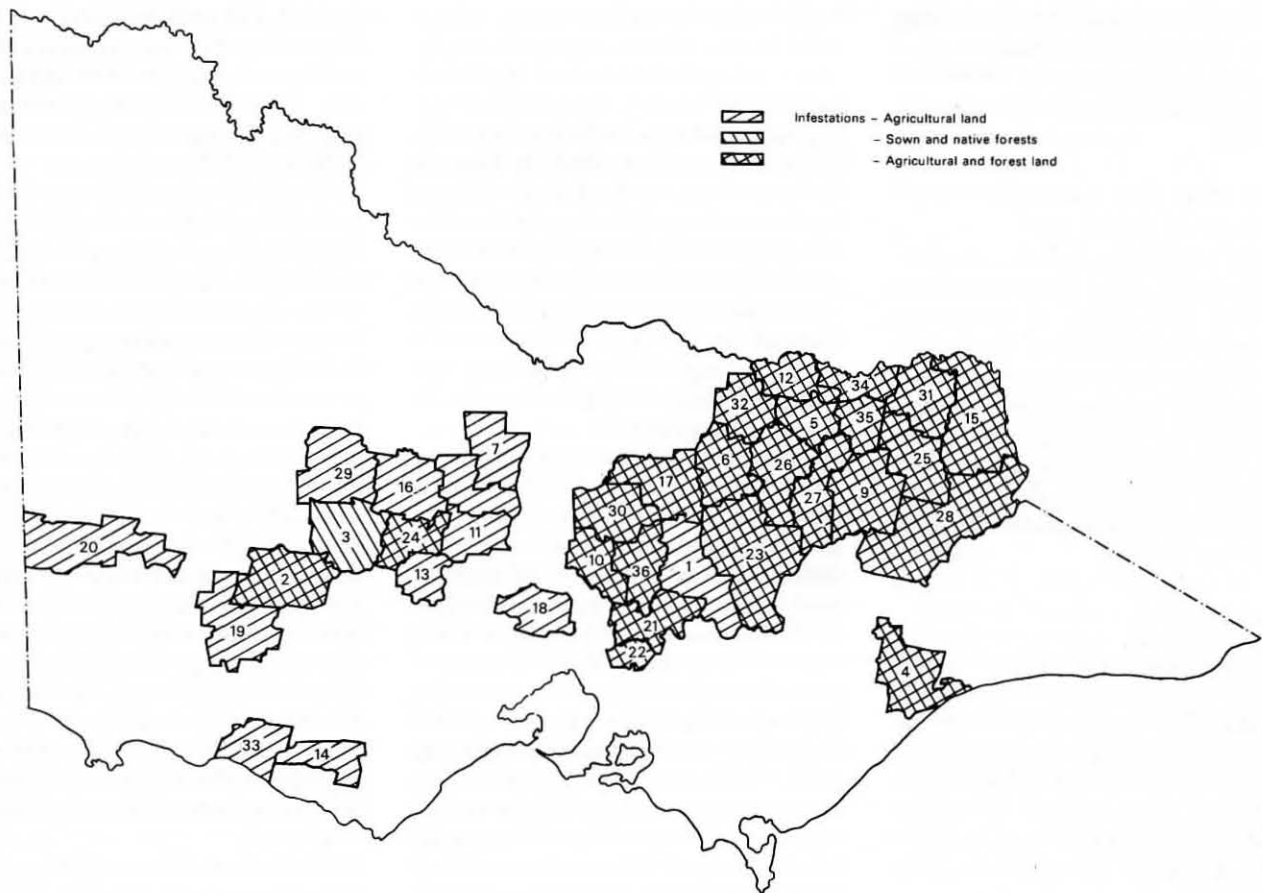


Figure 2 The Inspectors' districts which recorded the presence of St John's wort on agricultural and forestry land. See Table 1 for numbers 1-36.

Table 3 Summary of *Chrysolina* activity, observed by Department of Crown Lands and Survey Inspectors

District	Altitude (m) where <i>Chrysolina</i> observed	Stage of <i>Chrysolina</i> damaging plant	Number of <i>Chrysolina</i> per plant	Percentage of plants attacked	Parts of plant attacked
*Alexandra		A ¹	10-50	<50	Mainly procumbent growth and root system
*Bairnsdale No.2	115	A	5	<50	All, mainly flower heads
*Beechworth	240-760	A	20-30	50-99	All, mainly flower heads
*Benalla		A	2-3, max.12	<50	All
*Bright	Up to 1000, occasionally 1800	A	5-25	50-99	All
*Broadford	470-530	A L ²		<50	All, mainly flower heads
*Castlemaine		A	50-90	50-99	All
*Chiltern		A	>100	<50	Flower heads
*Corryong	330-550	A	10	<50	All
*Euroa	200-550	A	30-40	50-99	All
*Lilydale		A	10	<50	All
*Mansfield	200-1000	A	>100 occasionally 50-90 normally		All
*Maryborough	200-250	A	10-30	<50	All, mainly flower heads
*Mitta Mitta	230-330	A	10-12	50-99	All, mainly flower heads
Moyhu	280-400	A	50-99	100	All
*Myrtleford		A	50-99	100	All
Nathalia	Up to 330	A	<50	<50	All, mainly procumbent growth
*Stratford	500	A	<50	<50	All
*Tallangatta	1000	A	20-30	100	All, mainly procumbent growth
*Wangaratta	230-510	A	15-20, max. 60-70	<50	All
*Wodonga	250	A	2-50	<50	All, mainly flower heads
Yackandandah	670	A	20	50-99	All
*Yea	350	A	<50	<50	All

A¹ Adult L² Larval
 * Districts from which *Chrysolina* spp. collected, also Bairnsdale No.1.

other Inspectors reported that beetles moved through an infestation on a front and therefore spread by natural means and distribution by man was not necessary.

Insects other than Chrysolina present on St John's wort

Very few Inspectors reported the presence of insects other than *Chrysolina* spp. The gall midge *Z. giardi* was reported from six districts, but in only three of these was it reported to damage the plant, by either preventing seed formation or attacking the flower heads. Several Inspectors reported the presence of spittle bugs, *Bathylus albicinctus*, but did not consider that they caused any damage.

Discussion

The area of land covered by St John's wort in Victoria appears large, but in some areas the density of plants is low, and if *Chrysolina* spp. are not entirely suited to their environment these stands may not be dense enough to support a colony large enough to control the plant, although co-existence may occur.

St John's wort appears at present to be a weed of bushland, sown forests

and wastelands rather than a major weed of agricultural areas. It can be controlled by herbicides and appears to be lessened when in competition with improved pastures. As St John's wort is a declared noxious weed in Victoria and poisonous to stock it should not be a common weed of agricultural or accessible lands. However, the nature of the plant and its extensive range on various land use categories, its altitude, from about 100 m to 1800 m, and its ability to reproduce vegetatively and sexually means that it will probably always be a problem.

This survey was compared with one carried out in 1970 in which the presence or absence of St John's wort was recorded on a parish basis for each district and no estimates of area or land type infested were made (Parsons, 1973). Fifteen of the 84 districts which reported its presence in 1970 reported it as absent in 1978, while seven districts which had previously reported no St John's wort reported its presence in 1978 (Table 4). St John's wort has spread into parts of the Wimmera and central Victoria and has disappeared from some of the districts around Melbourne and in parts of Gippsland, and central Victoria. In 23 districts there was a decrease in the number of

parishes infested per district, while in 26 districts there was an increase in the number of parishes infested per district. There has, therefore, been a slight decrease in St John's wort between 1970 and 1978.

The distribution of the two surviving leaf-eating beetles, *C. quadrigemina* and *C. hyperici* appears to be limited to the parts of north-eastern Victoria where *H. perforatum* stands are the densest, as no specimens were collected from districts where the weed had only a scattered distribution. *C. quadrigemina* was found to be more widespread than *C. hyperici*, which was limited to the Bright, Myrtleford and Mansfield districts. Clark (1953) suggested that both *Chrysolina* spp. were probably near the limit of their environmental and climatic tolerance at Bright, where conditions are similar to those in Europe where the Victorian *Chrysolina* originated. The beetles are less likely to be successful in other areas of Victoria as environmental conditions are less similar to the area in Europe from which the *Chrysolina* originated.

Clark and Clark (1952) studied *C. hyperici* in the Mannus Valley of New South Wales and concluded that it was unable to suppress mature stands

Table 4 A comparison of St John's wort surveys carried out in 1970 and 1978, according to the number of parishes infested per Inspectors' districts

Disappeared	Appeared	Decreased	Increased	Same
Ballarat No.1	Bacchus Marsh (37)*	Ararat	Alexandra	Avoca
Dimboola	Gisborne	Bendigo No.2	Bairnsdale No.1	Bairnsdale No.2(38)
Eltham	Harrow	Castlemaine	Ballarat No.2	Beechworth
Ferntree Gully	Natimuk (62)	Chiltern	Beaufort (39)	Bright
Foster	Nhill (63)	Corryong	Benalla	Buchan (40)
Leongatha	Rochester (67)	Dartmoor (42)	Bendigo No.1	Cobden
Meredith	Wycheproof (74)	Derrinallum (43)	Broadford	Healesville
Orbost No.1		Dunolly	Clunes	Heathcote
Pakenham		Geelong No.2 (44)	Daylesford (41)	Horsham (48)
Rushworth		Glenthompson	Euroa	Korrumburra (50)
St Arnaud		Goroike (45)	Heyfield (47)	Kyneton (52)
Swifts Creek		Hamilton (46)	Kooweerup (49)	Moe No.1 (57);
Traralgon		Kyabram (51)	Lilydale	No.2 (58)
Yarra Junction		Lancefield (53)	Mirboo North (56)	Moyhu
Yarram No.2		Macarthur (54)	Mitta Mitta	Nathalia (61)
		Mansfield	Mornington (59)	Penshurst (65)
		Maryborough	Myrtleford	Portland (66)
		Meenyan (55)	Numurkah (64)	Streatham (70)
		Murtoa (60)	Omeo	Wonthaggi (73)
		Seymour	Shepparton (68)	Yackandandah
		Wangaratta	Stratford (69)	
		Warrnambool	Tallangatta	
		Winchelsea (72)	Warragul (71)	
			Wodonga	
			Yarrowonga (75)	
			Yea	

* Numbers refer to Figure 1.

of St John's wort, while Clark (1953) reported that it only damaged stands with large, relatively old crowns and with little suckering. Such damage was not reported in this survey. Because *C. quadrigemina* adults emerge one to two months ahead of *C. hyperici*, Clark (1953) concluded that *C. quadrigemina* more readily defoliated plants and could kill all plants in treeless areas. He also found that where *C. hyperici* predominated in mixed populations destruction was not as great as where *C. quadrigemina* predominated, and concluded that *C. quadrigemina* alone would have been as effective as mixed populations. Thus, the fact that *C. hyperici* does not appear to have persisted in large numbers in Victoria may not be important.

Few specimens of *C. hyperici* were collected during this study, especially during 1978. The differences in the timing of their life cycles probably interacted with the different rainfall patterns of 1978 and 1979, to cause the differences in species numbers in these two years.

It appears that there may be differential mortality in the sexes during aestivation. The female re-emergence ratio was three times greater than that of males, suggesting that males may mate with more than one female. Whether this preponderance of females was an actual effect or a collection effect is not known; however, another study (Shepherd, unpublished data) tended to indicate that this is a real effect. Wilson (1943) indicated that the usual sex ratio was about 1:1 but did

not mention whether this was before or after aestivation.

Wilson (1943) in his description of St John's wort insects in France, referred to colour variations in *C. quadrigemina*. He found that the bronze insects predominated in the Var while the green-blue insects were dominant in Gard, and only purple insects were collected in the Alpes Maritimes. This colour variation was not thought to be due to climatic optima, it could be a genetic factor maybe accentuated by reproductive rate. However, if only purple beetles were found in the Alpes Maritimes purple may be an altitude factor. As most of our *C. quadrigemina* were introduced from the Var bronze would be expected to predominate in Victoria.

As it is more than 40 years since *Chrysolina* were introduced and widespread distribution by man and natural means has occurred during those years, the districts in which they are now found probably indicate their ecological limits of distribution. Thus spread within Victoria by movement to other areas may not be of great benefit and further control of the weed may be limited. The *Chrysolina* present in Victoria do not appear to attack St John's wort growing under shaded conditions, therefore a biotype which is shade tolerant was introduced from France recently (CSIRO, 1982).

Acknowledgements

I wish to thank all the Inspectors of the Department of Crown Lands and Survey for answering the questionnaire

and specially thank those who collected the *Chrysolina* samples. I also wish to thank Dr T. W. Donaldson who constructively criticized the manuscript during its preparation.

References

Clark, L. R. (1953). The ecology of *Chrysolina gemellata* Rossi and *C. hyperici* Forst., and their effect on St John's wort in the Bright District, Victoria. *Australian Journal of Zoology* 1:1-69.

Clark, L. R. and Clark, N. (1952). A study of the effects of *Chrysolina hyperici* Forst. on St John's wort in the Mannus Valley, N.S.W. *Australian Journal of Agricultural Research* 3:29-59.

C.S.I.R.O. (1982). *Division of Entomology. Annual Report*. C.S.I.R.O., Melbourne. p. 61.

Everist, S. L. (1981). *Poisonous Plants of Australia*. Second edition. Angus and Robertson, Sydney. pp. 364-5.

Moore, R. M. and Cashmore, A. B. (1942). *The control of St John's wort (Hypericum perforatum L. var. angustifolium DC.) by Competing Pasture Plants*. C.S.I.R. Bulletin No. 151, Melbourne. pp. 5-6.

Nelson, H. S. (1962). Untersuchungen zur biologischen Bekämpfung von *Hypericum perforatum* L. mit Hilfe von Insekten *Chrysolema varians* Schall., Coleoptera, und *Semasia hypericana* Hb., Lepidoptera. *Zeitschrift für Angewandte Entomologie* 50:290-327.

Parsons, W. T. (1973). *Noxious Weeds of Victoria*. Inkata Press, Melbourne. pp. 160-6.

Wilson, F. (1943). The Entomological Control of St John's wort *Hypericum perforatum* L. with Particular Reference to the Insect Enemies of the Weed in Southern France. C.S.I.R. Bulletin No. 169: 1-87, Melbourne.

AUSTRALIAN weeds Volume 3 1983/84

Subscription rates

Inkata Press Pty Ltd,
4 Longbourne Ave,
North Clayton,
VIC. 3168 Australia

Within Australia (post paid)	Individuals	A\$22.50	Overseas (post paid)	Individuals	Surface mail A\$30.00	Airmail A\$40.00
	Companies Institutions	A\$30.00		Companies Institutions	A\$35.00	A\$45.00

Please note overseas subscriptions must be paid in Australian currency.

Name

Address

..... Postcode.....

Position..... Date.....

Back issues of Volumes 1 and 2 are available. Prices supplied on request.