the important fact is that the value of wood in accessible sites is rising proportionately more rapidly than virgin value in less accessible sites. Current trends in countries with long forestry histories, Sweden for example, show that management is insisting on, and getting, marginal returns in excess of 10 per cent where fertilizer additions are being made to forest on the basis of potential value return.

Forest managers should also keep in mind that the return from fertilizer additions is almost immediate and in well-researched programs will give a faster, surer, return than say, an equivalent investment in seed orchards. The investment approach to fertilizers has been adopted very rapidly and generally by the private forestry sector in Australia, which has been forced by the economic climate to see the benefits of fertilizing marginal lands located advantageously to markets or major processing centres. For the same investment reasons the trend in this sector is towards shorter rotations which will admit of higher capital investments, some percentage of these in fertilizer.

It could well be that with declining fertility of S.Q. I and S.Q. II land, and with fertilization raising the quality of S.Q. VII and S.Q. VI land, the management dream of one site quality (III to IV) may yet eventuate. My own attitude is that this medium level of fertility will be the most economic one to aim for in Australia by means of fertilizers in forestry.

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A Survey of Siricid Attack on Radiata Pine in Europe

SUMMARY

A survey was made of the older plantations of radiata pine (*Pinus radiata* D.Don) in Spain, Italy, France, Portugal and England in the period May to August 1966 to determine the extent of attack by siricids.

Of the stands that were considered to contain susceptible host material (non-vigorous trees under full canopy) 78 per cent showed some signs of siricid attack, and 54 per cent yielded insects, mainly larvae. Adult *Sirex noctilio, S. cyaneus, S. juvencus* and *Urocerus gigas* were obtained.

The infestations were generally at low levels, apart from one windbreak at Sabaudia (Italy) and they were not important economically. The low levels were presumably due to natural biological control which appears adequate provided the stands are thinned regularly.

The siricids appeared to be attracted most to the occasional trees that had lost their crowns through wind or other mechanical damage.

INTRODUCTION

During April to August 1966, the author was on assignment to the Forestry and Timber Bureau of Australia 'to make a detailed examination of plantations of radiata pine (*Pinus radiata* D.Don) in Europe to determine the extent, if any, of the attack of *Sirex noctilio* or other European siricids'. Finance for this survey came from special grants for research purposes on *Sirex* made by A.P.M. Forests Proprietary Limited to be used at the discretion of the Forestry and Timber Bureau.

The wood wasp *Sirex noctilio* (Fab.) was first seen in Australia in 1952, near Hobart, Tasmania, but it was not until 1962 that the National Sirex Fund was established following the finding of new outbreaks near Melbourne in December 1961. Over the past six years the Fund has had annual grants of $200,000 made up of contributions from Commonwealth and State Governments and from private forest owners. The Fund pays for the survey and eradication of the outbreaks in Victoria and for research. Research activities are divided among three organizations — the Division of Entomology, Commonwealth Scientific and Industrial Research Organization, the Forest Research Institute of the Forestry and Timber Bureau, and the Waite Agricultural Research Institute, University of Adelaide. Full details have been given by Cromer (1966).

In contrast with the writing on *Sirex* in New Zealand since 1948 and more recently in Australia, there is no published account known to the author of siricids attacking radiata pine in Europe. However Dr. J. P. Spradbery of the C.S.I.R.O. Sirex Biological Control Unit, at Silwood Park

near London, found *Sirex noctilio* and its parasites *Rhyssa persuasoria* and *Ibalia leucospoides* in radiata pine near Rome and Lisbon in 1965 (Wilson 1966). Investigations at Silwood Park have shown that there are three genera of siricids found in conifers in Europe. The species reported are *Sirex juvencus* (L.), *Sirex noctilio* (Fab.), *Sirex cyaneus* (Fab.), *Urocerus gigas* (L.), *Urocerus augur* (Klug.), *Urocerus fantoma* (Fab.), and *Xeris spectrum* (L.). *Sirex noctilio,* which predominates in Spain, Portugal and western France, is the only one known to be established in Australia and New Zealand, but *Sirex juvencus* and *Urocerus gigas* have been seen at times in shipments of crates and lumber in Australian ports.

The purpose of the survey in Europe was to determine whether radiata pine was being attacked by siricids over its full range and by what species. The survey was of necessity rather sketchy and subjective, but did include the main plantations of radiata pine in five countries: Great Britain, Portugal, Italy, France and Spain, with the major effort on the large areas of plantations in Spain.

RADIATA PINE IN EUROPE

Spain is the only country in the northern hemisphere where radiata pine has been planted extensively. Tornero (1965) states that 64,009 hectares were planted by government organizations and 75,000 hectares privately between 1940 and 1965. Although the plantings in the other four countries are much smaller, they are important in widening the ecological range studied.

TABLE 1
Approximate areas of radiata pine plantations in Europe.

Country	Hectares	References*
Great Britain	94	Robertson (1966)
France	50-60 (not including Corsica)	Delabraze (1966)
Italy	500	Giordano (1966)
Portugal	20	e Silva (1966)
Spain	139,000	Tornero (1965)

* Personal communications

Geographical Distribution

The distribution of radiata pine has been dictated mainly by minimum temperatures during the spring growing period. It is not tolerant of frosts and cold winds, and planting is limited to altitudes below 500-600 metres in Spain and Italy and to the milder coastal areas of Brittany and the south of England.

In countries other than Spain it has been grown by the forest services in numerous small experimental plots and farmers have used it for windbreaks and woodlots. In England these plantings are mainly in the counties of Cornwall, Dorset and Hampshire; and in France in the Department of Finistere.

In Spain it is restricted to the coastal area north and west of the Cordillera Cantabrica in the provinces of Pontevedra, La Coruna, Lugo, Oviedo, Santander, Vizcaya and Guipuzcoa. These areas receive around 1,250 mm of rain, which is well distributed through the year due to the influence of the Atlantic Ocean.

There are 200 hectares of 3-year-old trees near Naples and a number of widely distributed sample plots along the west coast of Italy from Genoa to Naples at altitudes up to 500 metres.

Conditions

In view of its success as an exotic in the southern hemisphere it is not surprising that radiata pine has been tried on a great number of sites in Europe. The results of these trials have ranged from complete failure to unqualified success. Some of the plantations are small and distant from markets, and many of them have had no silvicultural treatment. Under this range of conditions numerous nutritional, insect and fungal disorders have developed.

Nutrition

Particularly poor growth of radiata pine was seen on shallow granite soils in the province of La Coruna, and on the Landes sands, south of Bordeaux. Growth on these sites could be improved by adding phosphatic fertilizers (Illy 1966, Cuervo personal communication).

Fungal Disorders

In the more humid areas of England and Spain needle cast fungi were very noticeable during May and June. Martinez (1942) records *Naemacyclus niveus* Sacc. and *Lophodermium pinastri* Chec. in Spain. Cold winds and salt spray were blamed for the loss of exposed crowns of radiata pine in England, and needle cast fungi may also have been associated with this damage. *Armillaria mellea* (Fr.) Quel. was often seen, particularly where the soil was poorly drained.

Insect Problems

The major insect pests in Spain are the processionary caterpillar *Thaumetopoea pityocampa* (Shiff.), the weevil *Pissodes notatus* (F.), the scolytid *Blastophagus piniperda* (L.), and evitrea, the lepidopterous *Rhyacionia buoliana* (Schiff.) (Anon 1965, Torrent and Romanyk 1966).

The processionary caterpillar is a defoliator and the worst widespread attack by this species seen on radiata pine was in the Pontevedra Province where conditions are relatively warm and humid. It occurs throughout the full range of radiata pine in Spain and Italy, and severe attacks can kill entire stands.

Pissodes can kill young regeneration, and can also develop on freshly felled or windblown material. *Blastophagus* is a small beetle which develops on the cambium, and can kill large trees.

Evitrea larvae tunnel in the growing tips of the pine, killing the shoot, and where the epidemic is serious and continuous the trees become permanently stunted.

The siricids are not considered as pests in the economic sense in any of the countries visited.

TABLE 2
Locations of radiata pine inspected and evidence obtained.

Code Figure 1	Location	Siricids *	Parasites †
1	Marazione, Cornwall	l, a	
2	Isle of Wight, Hants	t	
3	Bisterne, Hants	t	
4	Poole, Dorset	t	
5	Bedgebury, Kent	t	
6	Oxford, Oxon	t	I, R
7	Monte Cartes, Santander	l	
8	Monte Corona, Santander	l, p	
9	City Park, Santander	t	
10	Rio Aquera, Santander	a	
11	Monte de los Munecas, Vizcaya	l, a	I, R
12	Monte Sollano Aquas, Vizcaya	a	
13	Monte Miravalles, Vizcaya	l	
14	Monte Umba, Vizcaya	l	
15	Monte Vergara, Guipuzcoa	l	
16	Monte Ergoyen, Guipuzcoa	p, a	
17	Monte Jaizquibel, Guipuzcoa	l, p, a	R
18	Monte Castanedo (E), Oviedo	l, p, a	R
19	Monte Castanedo (W), Oviedo	l	R
20	Monte de Cruz la Peon, Oviedo	l, p	
21	Monte Parres de Cuengos, Oviedo	l	
22	Monte Rasa Nueva, Oviedo	l, p, a	I, R
23	Monte Sierra Plana, Oviedo	l	R
24	Monte de Fito, Oviedo	t	
25	Monte Fieitose de Areno, La Coruna	t	
26	Monte Sobrado, La Coruna	t	
27	Monte Puentes de Garcia, La Coruna	l	
28	Monte Furadoura, Portugal	l	R
29	Montejunta, Portugal	l, p	R
30	Capalbio, Grosseto	t	
31	Scopetone, Arezzo	l, p, a	
32	Sabaudia, Latinum	l	R
33	Meslan, Brittany	t	
34	Pont l'Abbe, Brittany	p	
35	Sizan, Brittany	t	
36	Monte Porrino, Pontevedra	–	
37	Monte Villaboa, Pontevedra	–	
38	Monte Castrove, Pontevedra	–	
39	Monte Durango, Vizcaya	–	
40	Monte Sumbilla, Pamplona	–	
41	Tehidy, Cornwall	–	
42	Herodsfoot, Cornwall	–	
43	Wareham, Dorset	–	
44	Monte Queimada, La Coruna	–	
45	Mimizan, Landes	–	
46	Culbin Sands, Morayshire	t	

* l = larva
† I = *Ibalia*
R = *Rhyssa*
p = pupa
a = adult
t = tunnelling only

SEARCHING FOR SIRICID ATTACK

The method of search was evolved steadily as experience was gained so no attempt was made to assess quantitatively the level of infestation, nor to compare one area with another by any standard sampling technique.

In each district the forester was asked to point out a number of older stands of radiata pine that needed thinning as shown by suppressed trees dying through excess competition. These stands were inspected, and the first investigation usually was made of trees that had lost their crowns through wind damage. It was repeatedly found that siricids were often present in either the standing trunk below the break or in the broken crown itself, but not in any surrounding trees. This probably indicates some attractiveness of the broken tissues to the female. If no damaged trees were present, any dead trees were felled and investigated. Trees which had died

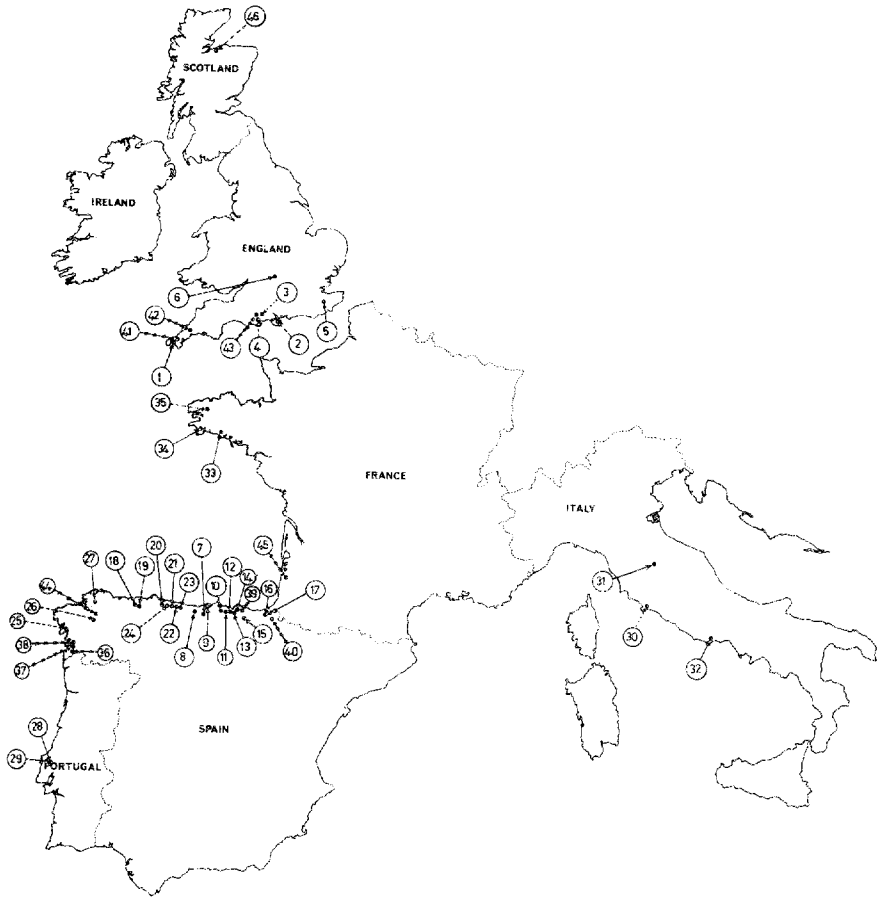

Figure 1
Survey of siricid attack on radiata pine in Europe. Definite evidence of insects at locations arrowed with full lines, characteristic tunnelling arrowed with broken lines, indications arrowed with dotted lines, and locations thought favourable but having no evidence arrowed with barbed lines.

recently were investigated for larvae, but those that had been dead for long periods were checked for tunnelling and exit holes.

Forty-six areas in five countries were investigated. The locations are listed in Table 2 and mapped in Figure 1.

Each locality at which positive evidence of attack was obtained was classified in one of the following three categories:

(1) Areas where definite evidence was found of activity such as larval, pupal or adult stages of either siricids or of the parasites *Ibalia* or *Rhyssa*.

(2) Areas where strong circumstantial evidence was found, such as characteristic tunnelling and exit holes of siricids or their parasites.

(3) Areas where the only indications were a single exit hole or a little tunnelling.

Where no positive evidence was obtained, after a search of several hours, the locality was classified as having either —

(4) abundant supply of apparently suitable host material available, or

(5) little or no supply of suitable host material due either to lack of crown closure and competition or recent thinnings and removal of logging debris.

TABLE 3

Proportion of locations of radiata pine investigated with evidence of siricids.

	Number	
Definite evidence with insect stages	25	36
Strong indications of presence of siricids	8	
Indications only of presence of siricids	3	
No indication of Siricids but host material seemed favourable	8	
No indication of Siricids but host material seemed unfavourable	2	
Total	46	

RESULTS OF THE SEARCH

Siricids were found at between 71 and 78 per cent of localities investigated (Table 3). In three-quarters of these localities siricids were difficult to find as only a few scattered trees were infested. The evidence was more abundant in the remaining localities, but in one only at Sabaudia (No. 32), Italy, was the infestation serious. These trees were not at all vigorous and they appeared to be suffering from water stress. The sandy soil had a pan at 20 to 30 cm depth and the trees probably suffered from both excess water in winter and drought in summer. Spradbery (personal communication) visited this area in 1965 and found the trees infested with the processionary caterpillar in addition to *Sirex noctilio*. Under these conditions the siricids had multiplied greatly with particularly large numbers emerging in the summer of 1965 and whole sections of the windbreak were dead and dying.

Adults were obtained occasionally. *Sirex noctilio* was identified in radiata pine in Spain at Monte Jaizquibel (17). Spradbery had previously obtained *S. noctilio* adults at Sabaudia (32) and in Portugal near Lisbon. *Sirex cyaneus* was found in Italy at Scopetone (31) and with *Sirex juvencus* in Spain at Monte Rasa Nueva (22). *Urocerus gigas* was obtained at Marazione (1) in England. Since most of the specimens were larvae it was not possible to determine the relative importance of each species. It seems that all species of the genera *Pinus Abies, Picea* and *Larix* can be attractive to all the siricids (Wilson 1966) although opportunities for infestation vary with

distribution of the tree and siricid species. It was noted that maritime pine (*Pinus pinaster* Ait.) was attacked at localities 17, 26, 27, 28, 34 and 45, and the nature of attack seemed comparable with that in radiata pine.

In general the siricids had attacked the least vigorous trees after canopy closure had occurred. It was repeatedly found that siricids had been attracted first to the occasional tree that had lost its crown due to wind or other mechanical damage. We examined these first, and if there were exit holes from the previous summer there would often be live stages in an adjacent suppressed tree that had died recently. Usually parasitic larvae of *Ibalia* or *Rhyssa* were also present. At three locations (8, 23 and 24) where large numbers of trees had been blown over or damaged by wind, and large gaps had been created, the number of siricids had not increased proportionally, although there were siricid exit holes dating from a time before the storm. It would be expected that the partially-severed trees after such a storm would have been attractive to siricids for long periods.

DISCUSSION AND CONCLUSIONS

The survey covered a range of European plantations of radiata pine. Most were overstocked. In general it can be concluded that siricids are present in most if not all such plantations, but are not considered important because of their restriction to the less vigorous and mechanically damaged trees.

When a tree was found with live stages of siricids it was usual to find signs of the parasites *Rhyssa* or *Ibalia*. Therefore it was assumed that biological control maintains siricids at a low and unimportant level in Europe. However, the one exception found at Sabaudia, Italy, suggests that their numbers can become high on occasions. At Sabaudia it may have been due to the unfavourable site and previous defoliation by the processionary caterpillar. This must surely be an unusual and temporary occurrence because the siricids are not considered a problem by district foresters in any of the countries visited.

Editorial Note: Reference Annual Report of the Sirex Biological Control Unit for 1967. One hundred and eleven logs were collected from Sabaudia by Spradbery in November 1966 and from these 11 siricids and 51 *Rhyssa* adults emerged during 1967 at Silwood Park. Although the final figures have not been obtained from the sample, parasitism of about 80 per cent indicates that siricid numbers have been checked and that the build-up in 1965 was temporary.

At Pontevedra (36, 37 and 38) the stands were apparently free of siricids yet they were severely defoliated by the processionary caterpillar. However in this region very good hygiene was practised due to the demand for pulpwood, and even for branchwood and litter for use by farmers.

This short survey leaves a number of questions unanswered and there is a subjective element in some of the results and conclusions, but the following recommendations are offered because of the importance of the projected increases in the areas of pine plantations in Australia.

Forest hygiene.—It is desirable to maintain hygiene by frequent thinnings and this raises problems of (i) location of plantings in respect to markets for small sizes (ii) topography or ease of access and (iii) the productive potentials of the sites selected.

Detection of pests.—Selected trees should be made attractive to insects by high-ringing (Madden 1965, personal communication) and used as bait trees. They should be inspected regularly for forest pests such as bark beetles (*Dendroctinus* sp.) in addition to siricids.

Quarantine.—All species of siricids should be considered equally dangerous for quarantine purposes at entry points into Australia.

Ecology of siricids in relation to radiata pine in Europe.— A further study in Europe to obtain information on the effectiveness of parasites over a wide range of conditions should be made before full reliance is placed on parasites for control in Australia.

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Taxes on Private Forests in Australia

SUMMARY

The applications of current income and property taxes to forests in Australia are described. Commonwealth income tax is not considered to be a significant obstacle to investment in forest land and forestry, but State and Local Government property taxes could deter some investors. Uniform fiscal treatment of forest owners throughout Australia, including deferred collection of death duties, is advocated to encourage investment in forestry.

INTRODUCTION

Whether the system of government is autocratic or democratic, taxes are regarded nowadays as necessary impositions, the communal benefits of which should far outweigh the cost to individuals. The objectives of taxation have been summarized by Taylor (1949) as being:— to raise revenue, to regulate or control (the economy), and to influence the level of private consumption and investment and, in turn, of the national income.

No longer are the fiscal policies which arise from tax levies expected to provide only public services. Of comparable importance are their economic influences on direct national development, maintenance of a stable monetary system and the equable distribution of wealth amongst the community (Slinn 1966). The efficiency of a taxation policy is now judged by its effects upon the economic and social system as a whole and the degree to which it promotes or reduces the economic advantage and social welfare, not only of the nation, but of the world as a whole (Rhys Williams 1953).

Modern democracies are characterized by a distribution of taxing authority between different levels of government. It may therefore be regarded as anomalous that each is required constitutionally to remain part of a national economy in the market sense, and yet they are obliged to behave as if they were completely independent economic units in their respective fiscal activities. On this theme Buchanan (1960) comments: 'The policy objectives for intergovernmental transfers becomes one of providing or ensuring equal fiscal treatment for equal individuals. If this objective is attained, the individual's place of residence will no longer have a significant effect upon his fiscal position.'

It has been suggested during recent years that one of the principal obstacles to private investment in Australian forestry is the inequitable appli-

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