QUARANTINE RISKS IMPOSED BY OVERSEAS PASSENGERS

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ABSTRACT

The role of clothing and baggage of visitors arriving from Australia at Wellington International Airport in introducing plant pathogenic fungi was evaluated. In the 1980 survey pathogenic fungi comprised 17% of the total spores collected and included *Ustilago* spp., *Puccinia* spp., and *Drechslera* spp. The most frequently encountered spore types in the 1982 survey were *Alternaria* and *Pithomyces* (64% of samples), rust urediniospores (57%), *Drechslera* and *Epicoccum* (51%), *Cladosporium* (49%), and smut teliospores (45%). Approximately 10% of spore types were viable. Passengers originating from farms carried a significantly greater number of spore types and more rust urediniospores than those from other areas. The likelihood of air passengers introducing new diseases into New Zealand is considered to be high.

Keywords: quarantine; fungi; introduced diseases; rusts.

INTRODUCTION

International Visitors

The number of international visitors to New Zealand increased from just under 500 000 in 1983 to over 700 000 in 1987. Thirty-six percent originated in Australia, 26% in North America, 11% in Europe and the United Kingdom, and 9% in Japan in 1987 (Department of Statistics 1988). The remainder originated in some 20 countries (Table 1). The total expenditure by the visitors in New Zealand was estimated at over $1000 million. Most came to New Zealand on holiday (58%). Many were attracted by the distinctive features of the New Zealand countryside and farm life, and had interests in skiing, tramping, walking, and camping.

New Zealand Agriculture and Forestry

Farming and horticulture provide a high proportion of New Zealand's export earnings. Sheep (70 million) and cattle (5 million) are farmed to produce sheep meat, beef, wool, dairy produce, and hides, and since the 1970s deer, goats, and fur-bearing animals such as fitch have become important. Cereal crops are grown mainly for the home market. Multiplication of grain air-freighted from the Northern Hemisphere is

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TABLE 1—Country of origin of international visitors

Country of origin	Numbers (and percentages) of visitors			
	1986		1987	
Australia	219 044	(42)	272 214	(36)
North America	166 059	(24)	197 940	(26)
Europe	23 895	(3)	29 195	(4)
United Kingdom	42 698	(6)	53 146	(7)
Japan	52 204	(8)	66 404	(9)
Others	113 173	(16)	144 310	(19)
TOTAL	689 073		763 209	

Source: New Zealand Official Year Book 1988–89.

becoming popular. Since the 1970s horticulture has become an important export earner, particularly kiwifruit with a value of around $500 million in 1987. New Zealand's forest industry is based largely on 1.1 million ha of *Pinus radiata* D. Don and earned about $800 million in 1987.

Pests and Diseases

New Zealand is relatively free of major agricultural and forestry pests and diseases, although in recent years some serious pests and diseases have been introduced (Table 2). New plant diseases caused by fungal pathogens are commonly discovered in New Zealand soon after they are recognised in Australia. This is particularly true of rust diseases (Table 3). The poplar leaf rusts caused by *Melampsora medusae* and *M. larici-populina* were recorded in New Zealand in 1973 (Dingley 1977), oxalis rust (*Puccinia oxalidis*) in 1977 (Versluys 1977), willow rust (*M. coleosporioides*) in 1978 (Latch 1980), and stripe rust of wheat (*P. striiformis*) in 1980 (Harvey & Beresford 1982). All were identified approximately 1 year earlier in Australia. Long-distance dispersal of rust spores across the Tasman Sea by wind currents is the commonly accepted explanation for many of these occurrences (McEwan 1966; Wilkinson & Spiers 1976; Close *et al.* 1978). For those rusts which are first identified in New Zealand some other explanation is required (see Table 3).

Other possible modes of entry are:

(1) On infected host or alternative host materials;

(2) On non-host materials;

(3) On clothing and baggage of travellers.

Many interceptions of plant materials and pathogens are made at seaports and airports. A report in the *Wellington Evening Post* on 2 April 1981 stated that during the 2-week period from 19 January, 2062 items were taken from 41 282 passengers arriving on 280 flights into New Zealand. These included flowers, nuts, seeds, fruits, vegetables, nursery stock, and soil (on shoes, tent pegs, and sacking). Assuming that these figures are representative, over 35 000 items are entering New Zealand illegally each year. Many of these must surely pose a threat to New Zealand agriculture and forestry. New diseases have become established in other countries despite quarantine measures, e.g., coffee rust in Brazil (Firman 1972) and black sigatoka disease of bananas in Australia (Jones 1984). Chrysanthemum white rust has been intercepted in

TABLE 2—Some recordings of plant pests and diseases in Australia and New Zealand

Pests	Australia	New Zealand
Aphids		
*Grain aphid (*Macrosiphum miscanthi* Takahashi)	before 1966	1966
Blue green lucerne aphid (*Acyrthosiphon kondoi* Shinji)	*P*	1975
Pea aphid (*A. pisum* Harris)	–	1977
Spotted alfalfa aphid (*Therioaphis trifolii* f. *maculata* (Buckton))	1977 QLD	1982 AK
Rose grain aphid (*Metopolophium dirhodum* (Walker))	1984	1981
Nematodes		
Potato cyst nematode (*Globodera rostochiensis* (Wollenweber))	1986 WA	1972 CH, 1988 M
(*G. pallida* (Stone))	–	AK, CH
Beet cyst nematode (*Heterodera schachtii* Schmidt)	*P*	1977
Cereal root knot nematode (*Meloidogyne naasi* Franklin)	–	1977 W
Diseases		
Pine needle blight (*Dothistroma septosporum* (Doroguine) Morelet)	1976 Nsw	1964
Potato wart disease (*Synchytrium endobioticum* (Schilberszky) Percival)	–	1970 S
†Barley leaf stripe (*Drechslera graminea* (Rabenhorst ex Schlechtendal) Shoemaker)	1917	1977 W, 1983 C, S,
Dandelion mildew (*Erysiphe cichoracearum* de Candolle)	–	1978 WGN
Tobacco blue mould (*Peronospora tabacina* Adam)	Indigenous	–
Gooseberry mildew (*Sphaerotheca mors-uvae* (Schweinitz) Berkeley)	1980	1986 W
Boil smut of maize (*Ustilago maydis* (de Candolle) Corda)	1982 Nsw	–
Sun blotch of avocado (*Viroid*)	1983 QLD	–
Ovularia spot of barley (*Ovularia hordei* (Cavara) Sprague)	–	1986 W
†"Spot" type of net blotch (*Drechslera teres* (Saccardo) Shoemaker)	1982	1986 O

* Trans-Tasman air currents suggested by Close & Tomlison (1975).
† Introduced into New Zealand on seeds from Europe (Arnst *et al.* 1978; Sheridan & Nendick 1988).

Nsw = New South Wales
QLD = Queensland
WA = Western Australia
P = present
– = not recorded
AK = Auckland
CH = Christchurch
M = Manawatu
O = Otago
W = Wairarapa
WGN = Wellington
S = Southland
C = Canterbury

quarantine on imported chrysanthemums from Singapore in various Australian ports but no records of its occurrence in Australia were known up to 1983 (Walker 1983). Since then it has become established in Victoria and continued to spread after the phase down of the national erdication campaign (Smith 1987). It is thus essential that effective quarantine measures are maintained.

An aspect often overlooked when considering ways in which new pests and diseases may be introduced is the role of clothing and baggage of air passengers. There appear to be only two published reports on the examination of air passengers or their baggage. Baker (1966) cultured fungi from shoes of air travellers arriving in Honolulu International Airport and identified 65 fungal species. Gadgil & Flint (1983) examined 45 tents accompanying incoming passengers at Auckland International Airport from 3 to 9 December 1981. Potentially pathogenic fungi were present on the debris collected from the tents and live insects were also found in the tents. Plant pathologists could conceivably become contaminated with fungal spores during visits to research plots and during plant disease surveys. In January 1982 I monitored myself and a student assistant each day on return from a disease survey of cereal crops in the Wairarapa. Our bodies and clothing carried many viable pathogenic fungi including urediniospores

TABLE 3–Some recordings of plant rusts in Australia and New Zealand and postulated mode of entry to New Zealand

Diseases	Australia	New Zealand	Mode of entry to New Zealand
Antirrhinum rust (*Puccinia antirrhini* Dietel & Holway)	Oct 1952 SYD	Dec 1953 AK	Seed (Dingley 1969); wind (Close *et al.* 1978)
Euphorbia rust (*Melampsora euphorbiae* (Schubert) Castagne)	Sept 1953	Feb 1954 AK	Wind (Close *et al.* 1978)
Iris rust (*P. iridus* Wallroth)	1962	1956 AK	Bulbs from Holland (Dingley 1969)
Mint rust (*P. menthae* Persoon)	1967	1959 CH	Imported mint plants (Dingley 1969)
Chrysanthemum white rust (*P. horiana* P. Hennings)	1987 VIC	1964 PN	–
Safflower rust (*P. carthami* Corda)	1954 QLD	1966 L	Seed (Laundon 1970)
Sunflower rust (*P. helianthi* Schweinitz)	1893	Apr 1970 AK	Wind (Laundon 1973)
Poplar rust (*M. medusae* Thuemen)	Jan 1972	Mar 1973 AK	Wind (Wilkinson & Spiers 1976)
(*M. larici-populina* Klebahn)	Feb 1973	Mar 1973 NP	Wind (Close *et al.* 1978)
Stripe rust (*P. striiformis* Westendorp var. *dactylidis* Manners) on *Dactylis*	1979	Mar 1975 PN	– (Latch 1976)
Oxalis rust (*P. oxalidis* Dietel & Ellis)	Apr 1976	Feb 1977 AK	Wind (Close *et al.* 1978; Anon 1977)
*Senecio rust (*Coleosporium senecionis* Kickx)	1983 NSW	Jan 1978 WGN	–
Dandelion rust (*P. hieracii* (Roehling) Martius)	1949	May 1978 AK	–
Willow rust (*M. coleosporioides* Dietel)	Apr 1978	Nov 1978 AK	Wind (Latch 1980)
†Maize rust (*P. polysora* Underwood)	1959	–	–
(*P. sorghi* Schweinitz)	?	1931	–
Stripe rust (*P. striiformis* Westendorp var. *tritici*) on wheat	Oct 1979 VIC	Nov 1980 G	Wind (Harvey & Beresford 1982)
Fig rust (*Cerotelium fici* (Butler) Arthur)	1904	1986 AK	Wind (McKenzie 1986)

* Present on herbarium specimen collected Aug 1977, Westland

† *Puccinia polysora* may be transmitted by bees (Turner 1974)

NSW = New South Wales
QLD = Queensland
SYD = Sydney
VIC = Victoria

AK = Auckland
CH = Christchurch
G = Gore
L = Levin
NP = New Plymouth
PN = Palmerston North
WGN = Wellington

of rusts (*Puccinia coronata* Corda, *P. graminis* Persoon, *P. hordei* Otth), smut spores (*Ustilago* spp.), and *Drechslera sorokiniana* (Saccardo) Subramanian & Jain and *D. teres* (spot blotch and net blotch of barley) spores (Sheridan & Nendick 1988). Very recently it was clearly demonstrated that urediniospores of the wheat stripe rust pathogen *P. striiformis* var. *tritici* remained viable on clothing for at least a week and were capable of infecting wheat plants (Wellings *et al.* 1987). It appears that this destructive pathogen reached Australia on the clothing of an air passenger from Europe, and entered New Zealand from Australia.

The results of two surveys of clothing and baggage of air passengers arriving from Australia at Wellington International Airport in the autumn of 1980 and 1982 are presented here.

MATERIALS AND METHODS

A full description of the sampling device designed for this survey has been given by Sheridan & Nendick (1988). Sampling was based on a suction impaction method using double-sided sticky tape without (1980) or with (1982) a smear of sterile petroleum jelly. A total of 137 passengers and 15 pieces of baggage were sampled from 10 flights between 10 March and 7 June 1980 (Broadwith 1980). Eight aircraft were from Sydney, one was from Brisbane and one from Melbourne. Eighty-eight slides were made from samples taken from passengers and their baggage. In the 1982 survey 97 out of 1451 passengers were sampled from 12 flights between 12 March and 5 April (Dawson 1982). Six aircraft were from Sydney, and three each from Brisbane and Melbourne. Two hundred slides were made from samples from passengers and their baggage. Sampling of the passengers in both years was from the knees down, including shoes (uppers only).

RESULTS

1980 Survey

The overall percentage of each spore type collected was Ascomycetes 8%, Basidiomycetes 21%, Deuteromycetes 44%, Unidentified 27%. Pathogenic fungi comprised 17% of the total spores collected and included smuts (*Ustilago* spp.), rusts (*Puccinia* spp.), and *Drechslera* spp. The following species were identified:

Drechslera dematioidea (Bubak & Wroblewski) Subramanian & Jain

D. dictyoides (Drechsler) Shoemaker

D. sorghicola (Lefebvre & Sherwin) Richardson & Fraser

D. teres (Saccardo) Shoemaker

Pithomyces chartarum (Berkeley & Curtis) M.B. Ellis

Puccinia graminis Persoon

Tetraploa aristata Berkeley & Broome

T. ellisii Cooke

A list of fungi collected from 20 passengers is given in Table 4. A large proportion (27%) of spores were not identifiable because they were misshapen, broken, obscured, or unrecognisable.

TABLE 4–Fungal spores collected from 20 passengers and baggage arriving at Wellington International Airport, 1980

	No. of spores identified	Percentage of total
Ascomycetes		
Ascopores	25	6.5
Basidiomycetes		
Basidiospores	41	10.6
Smut spores	10	2.6
Rust urediniospores	14	3.6
Deuteromycetes		
Alternaria	41	10.6
Cladosporium	3	0.8
Curvularia	10	2.6
Drechslera	24	6.2
Epicoccum	20	5.2
Pithomyces	20	5.2
Stemphylium/Ulocladium	6	1.6
Conidiophores	33	8.6
Unidentified	138	35.8
TOTAL	385	

An attempt to determine the concentration of spores per unit area of clothing was not successful except for a sandshoe upper which carried 10.6 spores/cm^2. Many spores did not adhere to the surface of the sticky tape but bypassed the slide and were entrapped on the vacuum cloth (about 40% of those collected). Hence spore loading per passenger would be under-represented. In the 1982 survey the tape surface was coated with sterile petroleum jelly in an attempt to retain a larger proportion of spores.

Viability tests revealed that *Alternaria, Epicoccum, Pithomyces, Stemphylium/Ulocladium,* and some other non-pathogens germinated regularly. *Drechslera* spp. did so less regularly, and rust urediniospores and smut spores germinated only rarely.

1982 Survey

Thiry-five genera were identified. The most frequently encountered spore types were rust urediniospores (57% of samples), smut teliospores (45%), spores of the imperfect genera *Alternaria* and *Pithomyces* (64%), *Drechslera* and *Epicoccum* (51%), and *Cladosporium* (49%) (Table 5).

The mean spore load per passenger was calculated (Table 6). Over 1000 spores of rusts, smuts, *Pithomyces*, and *Alternaria* were carried on clothing from the knees down. Approximately 10% of spores were viable. Higher numbers of fungal spores were recovered from passengers originating from farm or recreation areas than from urban or transit areas (Table 6). Passengers of farm origin carried a significantly greater number of spore types than those of urban or transit origin and more rust urediniospores than all the other groups combined.

DISCUSSION

High numbers of fungal spores, many of which are plant pathogens, were collected from clothing and baggage of air passengers arriving at Wellington International

TABLE 5–Spore types and frequency of occurrence of fungal spores collected from passengers and baggage arriving at Wellington International Airport, 1982. Total number of samples examined was 200.

Spore type	Frequency of occurrence*	Spore type	Frequency of occurrence*
Ascomycetes		Deuteromycetes	
Chaetomium	4.5	*Alternaria*	64.0
Daldinia	3.6	*Pithomyces*	64.0
Venturia	3.6	*Drechslera*	50.5
Nectria	2.7	*Epicoccum*	50.5
Sordaria	0.9	*Cladosporium*	48.6
		Curvularia	44.1
Basidiomycetes		*Stemphylium* / *Ulocladium*	40.5
Ustilago	45.0		
Urocystis	4.5	*Torula*	27.0
Melampsora urediniospores	3.6	*Tetraploa*	9.0
Puccinia urediniospores	3.6	*Polythrincium*	8.1
Other rust urediniospores	56.8	*Fusarium*	0.9
		Unknown	100.0

* The percentage of samples in which the spore types were found.

TABLE 6–Mean number of common spore types from passengers from different areas of origin, and spore load per passenger, 1982

Spore type	Mean No. of spore types and passenger origins				Total No. of spores/person	No. of viable spores/person
	Urban	Transit	Farm	Recreation		
Ustilago	2.0	4.0	7.0	130.0	4260–5960	230–320
Rust urediniospores	1.5	0.5	11.0	2.5	850–1180	360–500
Pithomyces	1.5	1.0	7.0	63.0	1890–2650	410–570
Alternaria	0.5	1.0	5.0	34.0	1140–1600	370–510
Curvularia	0.5	0.5	1.0	31.5	730–1020	600–840
Epicoccum	0.5	0.5	3.0	7.0	390–550	90–110
Drechslera	0.5	0.5	1.0	1.5	390–550	150–210
Stemphylium / *Ulocladium*	0.5	1.0	3.0	13.0	260–360	40–60
Cladosporium	0.5	0.5	1.5	2.5	200–290	–
TOTAL	8.0	9.5	39.5	285.0	–	–

Airport from Australia in 1980 and 1982. During the 4-week period of sampling in 1982 an estimated 70 000 viable rust urediniospores were brought in. Passengers originating from farms or recreational areas pose the greatest risk, particularly if they engage in outdoor activities and farm visits in New Zealand. The recent demonstration that urediniospores of *Puccinia striiformis* var. *tritici* remain viable and infective on clothing for a week emphasises the seriousness of the problem (Wellings *et al.* 1987). The Australian Plant Quarantine Service recognises the risks of clothing as a means of transporting rusts, and laundering of clothing suspected to be contaminated is recommended. Plant pathologists are likely to carry a heavier loading of plant pathogenic fungi than any other sector of the community by virtue of their employment, and should be particularly careful to decontaminate clothing before visiting new places. Studies on the effect of washing shirts and shorts indicated that

one wash reduced the number of spores by only 50% (Sheridan & Nendick 1988). With 700 000 overseas visitors each year the likelihood of introducing new diseases is high. Further studies on plant pathogens carried on clothing of air passengers and their risks to New Zealand are urgently needed.

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