THE ANIMAL HEALTH STATUS OF WALLIS & FUTUNA

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ABSTRACT

Various aspects of animal health in Wallis & Futuna have been studied and recorded by resident and visiting veterinarians over many years. In 1997 and 1998 a serological survey of livestock diseases was conducted in Wallis & Futuna, and this report combines the findings both of this survey and previous reports.

Wallis & Futuna is free of the contagious livestock diseases of serious socio-economic or public health significance (OIE List A diseases). The pig population is also free of the important viral diseases transmissible gastroenteritis and porcine respiratory and reproductive syndrome. Brucellosis and Aujeszky's disease are two infections that appear to have been greatly diminished by the introduction in the late 1980s of compulsory penning of pigs. Leptospirosis is prevalent among pigs in Wallis & Futuna, and there is some serological evidence of trichinosis on Wallis, so the territory has at least two important livestock diseases of public health concern. Tuberculosis has never been identified in livestock.

Both village and commercial poultry have serological evidence of infectious bronchitis, infectious bursal disease, infectious laryngotracheitis and avian encephalomyelitis, and it is likely that Marek's disease is also present.

Tropical canine pancytopaenia and its tick vector have both been identified in the territory.

RESUME

Différents aspects de la santé animale à Wallis et Futuna ont été étudiés et rapportés par des vétérinaires installés ou de passage depuis bon nombre d'années. En 1997 et 1998, une étude sérologique des maladies du cheptel a été réalisée à Wallis et Futuna, et le présent rapport rassemble les résultats de cette étude et des précédents rapports.

Wallis et Futuna est exempt des maladies animales contagieuses d'une grande importance sur le plan socio-économique ou de la santé animale ou publique vétérinaire (maladies de la liste A de l'OIE). Le cheptel porcin est également indemne des maladies virales importantes telles que la gastro-entérite transmissible et le syndrome dysgénésique et respiratoire du porc. La brucellose et la maladie d'Aujeszky sont deux infections qui semblent avoir fortement reculé depuis l'enfermement obligatoire des porcs à la fin des années 80. La leptospirose est répandue chez les porcs à Wallis et à Futuna et les résultats sérologiques donnent à penser que la trichinose est présente à Wallis. Le Territoire compte donc deux zoonoses importantes sur le plan de la santé publique. Aucun diagnostic de tuberculose n'a encore été porté.

En ce qui concerne les oiseaux de basse-cour des villages et les volailles élevées à des fins commerciales, la bronchite infectieuse, la bursite infectieuse, la laryngotrachéite infectieuse et l'encéphalomyélite aviaire, ainsi que, très probablement, la maladie de Marek, ont été mises en évidence par les analyses sérologiques.

L'ehrlichiose canine et son vecteur, la tique, ont été identifiés sur le Territoire.

ACKNOWLEDGMENTS

The cooperation and assistance of the staff of the Service Territoriale de l'Economie Rurale is gratefully acknowledged, notably the director Bernard Guegan, and the veterinarians Vincent Perrot and Philippe Mazerolles and their assistants Fololiano Tanifa and Vitoli Faigauku on Wallis, and Sepeliano Talomafaia and Ezekiele Lie on Futuna.

In addition the advice and assistance of the staff of the following laboratories is much appreciated:

?? Central Animal Health Laboratory, MAF Quality Management, Upper Hutt, New Zealand

?? Laboratoire Territorial de Diagnostic Vétérinaire, New Caledonia

?? WHO/FAO Collaborating Centre for Reference and Research on Leptospirosis, Queensland Health Scientific Services

?? WHO Arbovirus Reference and Research Laboratory, Queensland Health Scientific Services

?? Koronivia Veterinary Pathology Laboratory, Ministry of Agriculture, Fisheries and Forests, Fiji

INTRODUCTION

The Veterinary Epidemiology project of the Secretariat of the Pacific Community (SPC) funded a serological survey of Wallis and Futuna in 1997 and 1998 and the presentation of these results is the principal motivation of this report. The survey was carried out by the SPC veterinary epidemiologist and staff of the Service de l'Economie Rurale of Wallis and Futuna. The objective of the survey was to demonstrate the presence or absence of selected livestock diseases of public health or economic importance. The results may be used as a basis for control programmes for livestock diseases and public health investigations and control programmes. Where the absence of an infection is confirmed by the survey it is important that this be interpreted with the stated confidence limits.

PREVIOUS RECORDS AND STUDIES

Giraud et al published a summary of livestock production and health in Wallis & Futuna in 1987, drawing from various reports of studies by resident and visiting veterinarians. Bertin reported in 1985 on the animal health status of the territory, and other more specific studies have been conducted since then by veterinary officers of the Service Territorial de l'Economie Rurale et de la Pêche, who each spend 16 months in the post under the Volontaires à l'Aide Technique (VAT) programme[1] of the French Government. Information and results from these studies are incorporated in this report.

LOCATION AND TOPOGRAPHY

Wallis & Futuna is a French Overseas Territory, and comprises two island groups lying NE of Fiji and West of Samoa:

Wallis, comprising Uvea and its associated reef islets, at 176º10'W, 13º20'S. . The land area of Uvea is 159 km², with the highest point at 151 m. Much of the island is habitable, but the majority of the 8,000 population live on the east and south coasts.

Futuna (64 km², 524 m) and the associated uninhabited island of Alofi (51 km², 417 m) at 178ºW, 14º20'S. Futuna is mountainous and the human population of 4,000 is confined to a narrow coastal strip, mainly on the SW coast.

The islands of Wallis and Futuna are approximately 200 km apart, and Wallis lies about 750 km NE of Suva. Fresh water is available on both Uvea and Futuna, but not on Alofi or the small islets of Wallis.

AGRICULTURE AND LIVESTOCK

Agricultural production is almost exclusively for local consumption. Despite high pig and poultry populations much meat is imported for sale in shops and restaurants, since there is no abattoir or meat inspection in the territory. There are one or two small commercial piggeries and egg production units. For these and the occasional more exotic livestock

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[1] VATs are young veterinarians who choose service in French overseas territories instead of military service. The VAT programme will end in 2001.

enterprise (e.g. rabbits, ducks, goats) complete rations are imported, while village pigs are fed primarily on coconut, and village poultry fend for themselves.

Approximate livestock numbers at the time of the survey are given in Table 1. Both cattle and horse populations have declined from the numbers reported in 1982 by Fouquet (50 and 75 respectively) while pig numbers are thought to have increased from his estimates of 13,000 in Wallis and 7,000 in Futuna, and numbers of other species have remained similar. Fouquet’s estimates were derived from a sample of 10 per cent of village households, while the figures in Table 1 have no such formal basis.

Table 1. **Estimated livestock populations of Wallis & Futuna, 1997**

	Wallis	**Futuna**	**Total**
Pig	20,000	10,000	30,000
Poultry	22,000	10,400	32,400
Horse	30	0	30
Cattle	20	0	20
Goat	11	0	11
Duck	200	0	200
Rabbit	20	0	20
Bees (hives)	10	0	10

Day-old layer chicks are imported periodically from Fiji or New Caledonia, and there are also occasional imports of pigs from New Caledonia.

Village pigs were managed extensively until the late 1980s, when compulsory penning was introduced. Before that pigs were kept at the edge of the lagoon, and prevented from venturing inland by stone walls. Many pigs are now kept in small concrete-floored pens, while some are kept in larger stone-walled enclosures that are otherwise unimproved. Public health issues were cited as the motivation behind penning up the pigs. This report documents a subsequent decrease in the prevalence of some significant infections, but an increase in the prevalence of others.

SURVEY DESIGN

Populations

Both Wallis and Futuna are small islands on which there is considerable mixing of pig and poultry populations among households. The village pigs of Wallis were therefore taken to form a single population, as were the village poultry. Those of Futuna were considered to be separate populations from those of Wallis. Other species, being so few in number and mostly confined to Wallis, were taken to form single populations for each species. Commercial laying hens were considered to be a separate population from the free range village birds. Because of potential differences in disease prevalence between pigs in large dirt-floored enclosures and those in small concrete pens, these two populations were also considered separately on Wallis.

The list of separate livestock populations identified when designing the survey was as shown in Table 2.

Table 2. **Livestock populations and survey sample sizes: Wallis & Futuna 1997**

Island	Species	Management system	Estimated population	Desired no. of samples	Number sampled
Wallis	Pig	Penned on concrete	6,000	60	49
Wallis	Pig	Penned on dirt*	14,000	60	53
Wallis	Poultry	Housed layers	2,000	60	44
Wallis	Poultry	Free	20,000	60	47
Wallis	Horse	Tethered	30	26	6
Wallis	Cattle	Free	20	19	0
Wallis	Goat	Penned	11	11	11
Wallis	Duck	Penned	200	51	0
Futuna	Pig	Penned on concrete	3,000	60	48
Futuna	Pig	Penned on dirt*	7,000	60	15
Futuna	Poultry	Confined	400	55	15
Futuna	Poultry	Free	10,000	60	35

* Includes animals that spend part of their lives on concrete and part elsewhere.

Each livestock population was assumed to be homogeneous with regard to disease exposure, so that a random sample of animals taken from the population would be representative of the population, and estimates of the prevalence of antibodies to different infectious agents in the population could be made from such a sample.

Sample sizes

Each livestock population was to be tested for the presence of antibodies to a variety of infectious agents. If present, the likely prevalences of these agents in the population vary considerably, from perhaps <1% for trichinosis in pigs to >50% for classical swine fever. In addition the likely sensitivity and specificity of different serological tests vary from poor to very good. In order to determine sample size for either demonstration of disease freedom or estimation of prevalence of exposure to disease, the critical information needed is:

?? Population size

?? Likely prevalence[2]
?? Acceptable error levels in the estimation
?? Test sensitivity[3]
?? Test specificity[4]

Apart from the acceptable error levels, all of the above vary from one infection to another for all populations. We aimed to collect serum from 60 animals in each population, to test them all for each infection, and then interpret the results appropriately for each infection, depending on the values for each of the variables listed above. The figure of 60 was chosen because this allows demonstration of freedom from exposure to disease with 95% confidence, given a likely prevalence if present of 15% for a test with reasonable sensitivity and specificity, or 10% for a test with excellent sensitivity and specificity.

For housed laying hens each flock was treated separately, with 15 birds sampled. In these circumstances we considered that antibody prevalence would be very high if infections such as infectious bronchitis, Newcastle disease, etc. were present.

The figures quoted above and the procedures used to interpret laboratory results assume random sampling from the population. For village poultry and pigs, we did not consider this feasible in this survey, so sampling in these populations was performed to give geographic representation. Most households keep pigs in both Wallis and Futuna, and many keep poultry. Households were selected based on convenience. Within each herd 3 pigs were selected (again by convenience): one less than 6 months old, one between 6 months and adult, and one adult. For free range poultry the sampling was done during the day, and as many birds were sampled as could be caught (usually one or two).

Caged layers were taken from cages in all parts of the shed, and layers in an outdoor enclosure were selected based on convenience (the first 15 birds caught).

All adult goats were sampled in the one flock on Wallis, and as many horses were sampled as could be caught. The two herds of cattle on Wallis could not be handled without building fences and yards, so none were sampled. The one flock of ducks was not sampled either.

Within each poultry and pig population considered we made a serious attempt to sample a representative selection of animals, although this was not done randomly. In presenting the results, confidence and prevalence estimates are given that assume random sampling, despite the fact that this is not strictly valid.

Selection of diseases

Infections for serological testing were selected based on potential public health risk, potential economic importance and regional epidemiological significance. Wallis &

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[2] The proportion of animals infected (prevalence of infection), or with antibodies to the infectious agent (antibody prevalence)

[3] The proportion of those animals that have been infected with the disease agent that give positive results with the test

[4] The proportion of those animals that have never been infected with the disease agent that give negative results with the test

Futuna does not export any livestock products, but does import layer chicks and occasional porcine breeding stock.

Classical swine fever (CSF) has occurred twice in Pacific Island countries and territories (PICTs) this century, but otherwise there have been no outbreaks or observations of OIE list A diseases in any of the 22 PICTs, including Wallis & Futuna. No vesicular disease has been seen in pigs in the territory, and we did not include these infections in our serological testing. We did include CSF, and for the poultry we included the two list A diseases: Newcastle disease and avian influenza. Goat sera were tested for antibodies to bluetongue virus.

Serological testing for the mycoplasmas and salmonellas of poultry has poor specificity when preserved (frozen) serum is used; we therefore did not include these infections in the serological survey.

Leptospirosis testing was carried out by the WHO/FAO Collaborating Centre for Reference and Research on Leptospirosis of Queensland Health Scientific Services, which uses a panel of 21 serovars representing 18 serogroups for antibody testing of sera from the tropics. There are over 200 serovars of the causative organism *Leptospira interrogans*, and these are classified into serogroups. Unfortunately serological cross-reactions are common with the MAT, and low titres (50 or less) may be associated with such cross reactions, poor serum quality, natural agglutinins which are not induced by leptospiral infections, as well as vaccination (not applicable in Samoa), early serological response or declining titre.

Blood samples

Blood was collected from pigs, goats, horses and dogs using evacuated 9 ml tubes. Poultry were bled using 3 ml syringes and 23g needles, and the blood was immediately transferred to a 5 ml evacuated tube. After standing at ambient temperature for a few hours, samples were centrifuged, the serum separated using disposable pipettes, then stored at –20°C.

Blood samples from pigs and commercial poultry were collected in 1997, and these samples were then taken to Suva, Fiji for distribution to laboratories. Free range chickens, horses, goats and dogs were sampled in 1998. Horse, goat, dog and some of the chicken samples were taken to Fiji for distribution to laboratories, but some chicken samples were sent direct to the laboratory. The laboratories and tests used for all the serum samples are given in Appendix B.

RESULTS AND DISCUSSION

Dogs

In 1981 Giraud reported identifying ascarid worms, the hookworm *Ancylostoma caninum*, the tick *Rhipicephalus sanguineus*, and the dog flea *Ctenocephalides canis*. There are no records of clinical findings in dogs.

In 1998 ten blood samples were taken for serology from dogs on Wallis, with the following results:

Infection	No. of samples		Apparent prevalence %
	Tested	Positive	
Parvovirus	8	2	25
Canine distemper	10*	0	0
Brucella canis	10	0	0
Ehrlichia canis	7	5	71
Japanese encephalitis	10	0	0

* Includes 2 samples for which no result was obtained (toxic to cell culture)

Canine parvovirus titres were observed in 2 dogs, at 1:256 and 1:512. These titres do not suggest recent infection, but the dogs have not been vaccinated, so they have been infected at some stage.

The SNT for Canine distemper virus antibodies is sensitive to bacterial and other cytotoxic contaminants of the serum samples, and 2 of the 10 samples were contaminated, while the other 8 were negative.

No sample had detectable *Brucella canis* antibodies.

Ehrlichia canis, the causative agent of tropical canine pancytopaenia, is clearly present in Wallis. This infection is spread by the common brown dog tick, *Rhipicephalus sanguineus*, which was recorded in Wallis & Futuna by Giraud (1981).

The number of samples taken and the non-random sampling procedure mean that no conclusions can be drawn from the absence of antibodies to brucellosis and CD: these infections might still be present in Wallis & Futuna.

Rabies has not been reported in Wallis & Futuna, and can safely be said not to be present in the territory.

Leptospirosis

The 10 canine sera were tested against a panel of 21 serovars of *Leptospira interrogans*. One adult female reacted to 7 serovars at dilutions of 50 or greater, with titres of 800 to *cynopteri*; 400 to *djasiman*; 200 to *pomona*; 100 to *copenhageni* and *bulgarica*, and 50 to *grippotyphosa* and *australis*. Each of these serovars is from a different serogroup, suggesting that this dog has encountered more than one leptospiral serovar. A second adult female dog had titres of 200 to *copenhageni* and 100 to *pomona*. The remaining 8 dogs, including 5 of 4 or more years of age and 3 of less than a year, were negative to all 21 serovars.

Goats

There is only one herd of goats, and all 11 adults were blood sampled in 1998 for serology. They are mostly Sannen x Anglo-Nubian crosses, and were imported from New Caledonia in 1997. The herd has not had any health problems. Serology results were as follows:

Infection	No. of samples		Apparent prevalence %
	Tested	Positive	
Caprine arthritis and encephalitis	11	0	0
Brucellosis	11	0	0
Toxoplasmosis	11	0	0
Q Fever	11	0	0
Johne's disease	11	0	0
Bluetongue	11	0	0
Japanese encephalitis	11	0	0

All test results were negative for all serological tests. This herd is probably free of CAE, brucellosis, toxoplasmosis, Q fever and bluetongue. The RBPT used for *Brucella* serology used *Brucella abortus* antigen, which also reacts to antibodies against *Brucella melitensis*, so these results suggest freedom from both *Brucella* species commonly affecting goats. The sensitivity of the Johne's ELISA is so poor that negative results on 11 young goats cannot be taken as proof of herd freedom, although there have been no suggestions of clinical JD in the herd.

Leptospirosis

All 11 sera were negative to all 21 leptospiral serovars.

Horses

Giraud (1981) recorded strongyle eggs in the faeces of horses on Wallis.

Six horses were bled for serology in 1998, with results as follows:

Infection	No. of samples		Apparent prevalence %
	Tested	Positive	
Equine infectious anaemia	6	0	0
Equine herpes virus	6*	1	20
Equine viral arteritis	6	0	0
Japanese encephalitis	6	0	0

* Includes one sample for which no result was obtained (toxic for cell culture)

Leptospirosis

Three of the six horses had titres, all of 100 or less, to a total of 8 different serovars, namely *pomona* (1), *hardjo* (1), *tarassovi* (1), *copenhageni* (2), *australis* (1), *zanoni* (1), *javanica* (1) and *panama* (1).

Pigs

Parasites of pigs identified by Giraud in 1981 were:

Demodex sp.	Mange mite
Ctenocephalides canis	Dog flea
Haematopinus suis	Pig louse (sucking)
Metastrongylus elongatus	Lungworm
Choerostrongylus pudendodectus	Lungworm
Stephanurus dentatus	Kidney worm
Strongyloides sp.	
Trichuris sp.	Whipworm

Given the high prevalence of mange, which appears typical of porcine mange elsewhere, it is likely that *Sarcops* is also present and thriving.

Stephanurosis has been frequently diagnosed by all veterinarians in the territory, as a cause of posterior paralysis. It is an important cause of porcine losses.

Ill-thrift due to endoparasitism was the most common cause of illness in pigs in Wallis & Futuna reported by Giraud (1981) and Fouquet (1982); ectoparasitism was the second most common reason for veterinary consultation. This situation has not changed.

Bertin and Domenech conducted a serological survey of pigs in Wallis (76) and Futuna (12) in 1984–5 (Bertin, 1985). The results for brucellosis, leptospirosis and Aujeszky's disease are shown in Table 1 of Appendix C. Fouquet (1982) reported taking 150 sera from pigs for disease surveillance, but did not give any results of analyses.

The 1997 survey collected 167 sera, with results summarised in Table 2 of Appendix C, and below with the discussion of each disease.

Classical swine fever

(Pestivirus group ELISA at CAHL)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	62	0	0
Wallis – All pigs[†]	103	0	0
Concrete pen	49	0	0
Dirt enclosure*	52	0	0
Wallis & Futuna	165	0	0

* Includes pigs that spend some time in dirt enclosures and some in concrete floored pens.
† Includes 2 pigs for which housing was not recorded

If CSF were present in Wallis & Futuna we would expect the prevalence of antibodies to be at least 25%. These results give virtually 100% confidence that CSF is not present in any of the populations listed in Table 4 at this prevalence. For CSF to be present in Wallis & Futuna, there must be either a very low prevalence (<5%) or a small isolated population of infected pigs that we did not sample. There is considerable exchange and contact among pigs within Wallis and within Futuna, and the latter scenario is highly unlikely.

Transmissible gastroenteritis

(ELISA at CAHL)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	62	0	0
Wallis – All pigs[†]	103	0	0
Concrete pen	49	0	0
Dirt enclosure*	52	0	0
Wallis & Futuna	165	0	0

[*] Includes pigs that spend some time in dirt enclosures and some in concrete floored pens.
[†] Includes 2 pigs for which housing was not recorded

Another highly contagious viral infection, antibodies to which would be present in a high proportion of Wallis & Futuna pigs if it were present. This infection is not present in Wallis & Futuna.

Porcine reproductive and respiratory syndrome

(ELISA at CAHL)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	62	0	0
Wallis – All pigs[†]	103	0	0
Concrete pen	49	0	0
Dirt enclosure*	52	0	0
Wallis & Futuna	165	0	0

[*] Includes pigs that spend some time in dirt enclosures and some in concrete floored pens.
[†] Includes 2 pigs for which housing was not recorded

As for TGE and CSF, we can be confident that this infection is not present in Wallis & Futuna.

Brucellosis

(LTDV, 1983 and 1985; RBPT at FVPL, 1997)

	RBPT at FVPL, 1997			Test unknown LTDV 1985		
	No. of samples		Apparent	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**	**Tested**	**Positive**	**prevalence %**
Wallis & Futuna	117[?][†]	0	0	88	21	24
Dirt enclosures	36[*]	0	0	41	5	12
Free range				47	16	34
Wallis – all pigs	63[†]	0	0	76	19	25
Concrete pen	39	0	0			
Dirt enclosure	22[*]	0	0			
Futuna	54	0	0	12	2	17

[*] Includes pigs that spend some time in dirt enclosures and some in concrete floored pens
[†] Includes 2 pigs for which housing was not recorded
[?] Includes pigs in concrete pens

The RBPT using *Brucella abortus* antigen also reacts with *Brucella suis* antibodies in pigs, with a sensitivity of 79% and a specificity of 98% (Rogers *et al.*, 1989).

This infection was clearly present in the early 1980s, before pigs were confined in small pens, and the antibody prevalences observed in different populations (Table 3) are comparable to those found elsewhere in infected populations of free ranging pigs (Rogers *et al.*, 1989). In addition to Bertin's findings in 1985, blood samples taken over the period 1980 – 1983 were reported to demonstrate a 19% prevalence of antibodies among the pigs of Wallis & Futuna, and in 1986 Rabany bled 32 sows presented for service by boars of the Service de l'Economie Rurale, and demonstrated *Brucella* antibodies in 7 (22%).

The 1997 survey results failed to find any antibodies, although the numbers of samples tested were low. We can be 99% confident that the Wallis pigs penned on concrete do not have an antibody prevalence of 12%, as found for penned pigs in 1985. It is possible that there is a prevalence of 5% or less that we failed to detect because of small sample size. For Wallis pigs penned in dirt enclosures we can only be 93% confident that antibodies are not present at a prevalence of 12%, since only 22 of these pigs were tested. In Futuna the observed antibody prevalence in 1985 was 17%, and the results give virtually 100% confidence that the infection is not still present at that prevalence, and 95% confidence that it is not present at a prevalence of 4%.

These results cannot be taken as proof that *Brucella suis* is no longer present in Wallis & Futuna, but they clearly demonstrate that the prevalence of antibodies has been reduced considerably over the last 12 years. This reduction is very probably associated with the compulsory penning of pigs on both Wallis and Futuna, which was introduced in the late 1980s. With pigs confined there are fewer opportunities for transmission of infection.

Aujeszky's disease

(LTDV, 1985; ELISA at CAHL, 1997)

	ELISA at CAHL, 1997			Test unknown LTDV 1985		
	No. of samples		Apparent	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**	**Tested**	**Positive**	**prevalence %**
Wallis & Futuna	165	14	8	88	48	55
Dirt enclosures	66*	7	11	41	10	24
Free range				47	38	81
Wallis – all pigs	103†	5	5	76	36	47
Concrete pen	49	1	2			
Dirt enclosure	52*	4	8			
Futuna	62	9	15	12	7	58

* Includes pigs that spend some time in dirt enclosures and some in concrete floored pens
† Includes 2 pigs for which housing was not recorded

In 1985 Bertin found antibodies to this virus in 55% of 88 pigs sampled. In 1997 we found them in 8.5% of 165 pigs tested. This is a dramatic reduction, and as with brucellosis it is almost certainly associated with compulsory penning of pigs on both islands, since there have been no other control measures practised. In 1985 free range pigs had an antibody prevalence of 81%, while penned pigs had a prevalence of only 24%. Further reduction or elimination of AD would probably require testing and slaughter of reactors.

Clinical Aujeszky's disease has not been recorded in pigs or any other species in the territory.

Trichinosis

(ELISA at CAHL, 1997)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	62	0	0
Wallis – all pigs	103†	1	1
Concrete pen	49	0	0
Dirt enclosure*	52	1	2
Wallis & Futuna	165	1	0.6

* Includes pigs that spend some time in dirt enclosures and some in concrete floored pens
† Includes 2 pigs for which housing was not recorded

A single reactor in 165 samples suggests a false positive result, although it was confirmed by the highly specific immunoblot test. This pig had been killed by the time the test result was known, so the result could not be followed up with *post mortem* tests to find cysts. Trichinosis can be present in a pig population at very low prevalence, since various other species may be involved in its local epidemiology, notably rodents. Because of this and the fact that the specificity of serological testing in the Pacific island environment is uncertain, it is not possible to make any definite assertions concerning the presence of *Trichinella spiralis* in Wallis & Futuna. However, as a serious zoonosis in a country where pig meat is often not well cooked, this finding must be taken seriously.

Recent investigations elsewhere in the region have found muscle cysts, and the precise nature of the parasite is being studied.

Porcine parvovirus

(LTDV, 1985)

Two sera were tested in 1985 and one gave a positive result. This infection is ubiquitous, and is certainly present in Wallis & Futuna today.

Swine erysipelas

(LTDV, 1985)

Thirteen sera were tested in 1985 and one gave a positive result. It is seen clinically in Wallis & Futuna, and is certainly present.

Leptospirosis

(1985; MAT at QHL, 1997)

While the prevalences of antibodies to brucellosis and AD have decreased between 1985 and 1997, this is not true of leptospirosis. In 1985 14% of 88 pigs tested had antibodies to one or more serovar, while in 1997 33% of 163 pigs were positive to one or more. In 1985 a panel of 14 serovars was tested using a minimum serum dilution of 1:24; in 1997 a panel of 21 was tested using a minimum dilution of 1:50 (Table 3). For the 1997 sera, the number with titres to one or more of the 14 serogroups used in the 1985 testing was 33 (20%), a figure which does not differ significantly from the 1985 results.

In 1985 positive titres were found for serogroups *pomona*, *autumnalis*, *cynopteri*, *australis*, *tarassovi*, *pyrogenes*, *grippotyphosa*, and *icterohaemorrhagiae*. In 1997 we found titres to all of these except *tarassovi*, plus several others, notably *hebdomadis*, *panama* and *shermani*. Clearly there is a range of serovars infecting the pigs of Wallis & Futuna.

In 1985 antibody titres were present in only 2.4% of penned pigs (Appendix C, Table 1), while 25.5% of free range pigs had titres. In 1997, when all pigs were penned, 20% of all pigs had titres to those serogroups tested in 1985, and on Wallis 14% of pigs in concrete pens and 19% of those spending at least part of their time in dirt enclosures were positive to these serogroups (these proportions are not significantly different; $p>0.75$). While at first glance it appears that there has been a dramatic increase in the occurrence of leptospirosis in pigs in the territory between 1985 and 1997, the discrepancy is in fact due to the wider range of serovars tested in 1997.

Table 3. Positive titres for leptospiral serovars tested against pig sera from Wallis & Futuna at LTDV in 1985 and at QHL in 1997.

	LTDV 1985 (88 pigs)		**QHL 1997 (163 pigs)**	
Serogroup	**Serovars**	**Titres ? 24**	**Serovars**	**Titres ? 50**
Australis	*australis*		*australis*	12
Autumnalis	*autumnalis*		*bulgarica*	2
Ballum	*ballum*		*ballum*	0
Bataviae	*bataviae*		*bataviae*	1
Canicola	*canicola*		*canicola*	2
Celledoni	*celledoni*		*celledoni*	0
Cynopteri	*cynopteri*		*cynopteri*	3
Djasiman			*djasiman*	1
Grippotyphosa	*grippotyphosa*		*grippotyphosa*	1
Hebdomadis			*kremastos*; *szwajizak*	16
Icterohaemorrhagiae	*icterohaemorrhagiae*		*copenhageni*	16
Javanica	*javanica*		*javanica*	2
Panama			*panama*	10
Pomona	*pomona*		*pomona*	4
Pyrogenes	*zanoni*		*robinsoni*; *zanoni*	9
Sejroe	*sejroe*		*hardjo*; *medanensis*	2
Shermani			*shermani*	5
Tarassovi	*tarassovi*		*tarassovi*	0

Positive titres recorded

The proportion of pigs with titres in Futuna (40%) is not significantly different from that in Wallis (28%) ($p = 0.096$). Titres to the same serovars occur on the two islands, but the frequencies are different: on Futuna the most commonly reacting serovars (>10% of pigs tested) were *copenhageni*, *australis* and *panama*. On Wallis *kremastos* was the commonest in both populations (concrete pens and dirt enclosures), and *copenhageni* and *zanoni* titres both occurred in 10% of pigs in dirt enclosures.

Further unravelling of the epidemiology of leptospirosis in Wallis & Futuna would entail culturing *Leptospira* from a range of animals potentially involved, namely dogs, cats, rats and mice as well as pigs.

Salmonella

Salmonella cholerae suis was isolated from the liver and spleen of a pig in 1981.

Tuberculosis

Tuberculosis has not been reported in Wallis & Futuna livestock. There is no abattoir or meat inspection, so TB cannot be picked up this way. In 1982, 65 pigs were tuberculin tested by Fouquet; 40 single intradermal tests with bovine tuberculin, and 25 comparative tests with bovine and avian tuberculins; all were negative. It is possible that tuberculosis is present in one or more species of livestock, but there is no evidence for this.

Poultry

Endoparasites (nematodes, cestodes) were cited by Rabany (1986) as the main health problem of village poultry, but none were specifically identified. Rabany also recorded coccidiosis in a broiler enterprise.

Sera taken in 1997 and 1998 gave the results summarised in Table 3 of Appendix C, and shown below with discussion of each disease.

The three flocks of imported layers were vaccinated against Marek's disease at day old, but not against IB, or IBD, implying that the 100% prevalences of positive titres to these two viruses were acquired naturally in Wallis.

Newcastle disease

(HI at CAHL, 1997; HI at LTDV, 1998)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	**49**	**0**	**0**
Flock5: penned layers	15	0	0
Free range	34	0	0
Wallis	**91**	**0**	**0**
All layers	44	0	0
Flock1: caged	13	0	0
Flock2: penned	10	0	0
Flock4: penned	10	0	0
Flock3: local birds	11	0	0
Free range	47	0	0
Wallis & Futuna	**140**	**0**	**0**

There have been no reports of clinical Newcastle disease. All 1997–8 serum samples tested negative. The HI test for antibodies to ND is highly specific (close to 100%) but not very sensitive (79% (Miers, Bankowski and Zee, 1983)). However, given the likely high prevalence of ND antibodies if virus were present (assumed to be 50% in housed/penned flocks; 25% in free range birds) the results give over 99% confidence that each individual flock tested is free of ND, and close to 100% confidence that ND is not present in free range birds. There are lentogenic strains of the virus present in some

PICTs, but Wallis & Futuna appears to be free of all strains of the virus. The poultry are therefore 100% susceptible to ND, and a velogenic strain could wipe out the poultry population if introduced.

Avian influenza

(AGID at CAHL, 1997; AGID at LTDV, 1998)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	**48**	**0**	**0**
Flock5: penned layers	15	0	0
Free range	33	0	0
Wallis	**91**	**0**	**0**
All layers	44	0	0
Flock1: caged	13	0	0
Flock2: penned	10	0	0
Flock4: penned	10	0	0
Flock3: local birds	11	0	0
Free range	47	0	0
Wallis & Futuna	**139**	**0**	**0**

All samples tested negative. As for Newcastle disease, there have been no reports of clinical AI; the territory is almost certainly free of this virus, and a virulent strain would wipe out the poultry population if introduced.

Infectious bronchitis

(ELISA at CAHL, 1997; ELISA at LTDV, 1998)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	**50**	**42**	**84**
Flock5: penned layers	15	11	73
Free range	35	31	89
Wallis	**91**	**83**	**91**
All layers	44	44	100
Flock1: caged	13	13	100
Flock2: penned	10	10	100
Flock4: penned	10	10	100
Flock3: local birds	11	11	100
Free range	47	39	83
Wallis & Futuna	**141**	**125**	**89**

Ninety-one per cent of birds tested on Wallis and 84% of those tested on Futuna had antibodies to IB, which is therefore well established and ubiquitous in the territory, in both commercial flocks and village birds.

Infectious bursal disease (Gumboro disease)

(ELISA at CAHL, 1997; ELISA at LTDV, 1998)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	**50**	**47**	**94**
Flock5: penned layers	15	15	100
Free range	35	32	91
Wallis	**91**	**84**	**92**
All layers	44	44	100
Flock1: caged	13	13	100
Flock2: penned	10	10	100
Flock4: penned	10	10	100
Flock3: local birds	11	11	100
Free range	47	40	85
Wallis & Futuna	**141**	**131**	**93**

All populations examined showed antibody prevalences over 90%, and each flock of commercial layers had a prevalence of 100%. This virus is clearly well established in the territory. Unfortunately we did not distinguish between strains serologically, so the virulence of the strain(s) present in Wallis & Futuna is unknown. Clinical disease has not been recorded.

Infectious laryngotracheitis

(ELISA at CAHL, 1997; ELISA at LTDV, 1998)

	No. of samples		Apparent
Population	**Tested**	**Positive**	**prevalence %**
Futuna	**48**	**13**	**27**
Flock5: penned layers	15	0	0
Free range	33	13	39
Wallis	**90**	**25**	**28**
All layers	43	3	7
Flock1: caged	13	0	0
Flock2: penned	9	1	11
Flock4: penned	10	0	0
Flock3: local birds	11	2	18
Free range	47	22	47
Wallis & Futuna	**138**	**38**	**28**

Antibodies were found on both Wallis and Futuna, and in both commercial layers and village birds. We did not find antibodies in the one commercial flock on Futuna, or in one of the two commercial flocks on Wallis. The sensitivities of the ELISAs are unknown, so it is not possible to say with confidence that ILT is not present in these flocks. It appears that ILT is endemic in the territory.

Avian encephalomyelitis

(AGID at CAHL, 1997; ELISA at LTDV, 1998)

Population	No. of samples Tested	Positive	Apparent prevalence %
Futuna	**50**	**11**	**22**
Flock5: penned layers	15	0	0
Free range	35	11	31
Wallis	**91**	**41**	**45**
All layers	44	23	52
Flock1: caged	13	0	0
Flock2: penned	10	7	70
Flock4: penned	10	7	70
Flock3: local birds	11	9	82
Free range	47	18	38
Wallis & Futuna	**141**	**52**	**37**

Antibodies to AE virus were found on both islands, and in both village and commercial birds. Similar prevalences of antibody titres were found in village birds on each island, yet 2 confined flocks on Wallis showed high prevalences and the one confined flock on Futuna had none. This may well be associated with the relative isolation of the layer flock on Futuna, which is high in the hills, well away from the villages. The 13 samples taken from Flock 1 (caged layers on Wallis) were all negative, yet among 6 free range birds caught on the same property, there were 5 with AE titres. This is probably explained by the fact that the caged layers were all 5 months old and the free range birds adult. There is certainly ample opportunity for transmission of infection, with the local birds having full access to the cages. We have found no information on the sensitivity or specificity of either of the serological tests used, so we are not able to comment on whether some flocks are genuinely free of infection, or whether others with apparent low prevalence might in fact be free of infection.

A 37 per cent prevalence of antibodies among the samples taken in the territory suggests strongly that infection is endemic.

Marek's disease

(AGID at CAHL, 1997)

Population	No. of samples Tested	Positive	Apparent prevalence %
Futuna	**19**	**2**	**11**
Flock5: penned layers	15	1	7
Free range	4	1	25
Wallis	**51**	**2**	**4**
All layers	44	2	5
Flock1: caged	13	1	8
Flock2: penned	10	0	0
Flock4: penned	10	1	10
Flock3: local birds	11	0	0
Free range	7	0	0
Wallis & Futuna	**70**	**4**	**6**

Clinical MD has not been reported in Wallis & Futuna, but it has been suspected on occasion. The AGID test is fairly specific, so positive titres probably represent truly infected birds. Six per cent of 70 sera were positive in 1997, but unfortunately none were tested in 1998. We therefore do not have information for many village birds in either Wallis or Futuna. It would appear however that the infection is endemic in the territory.

Japanese Encephalitis

All mammalian sera collected in 1997 and 1998 were tested for antibodies to the human viral infection Japanese B encephalitis. Ten canine, 163 porcine, 6 equine and 11 caprine sera all gave negative results to the HI test. In the absence of clinical cases of JE we can be confident that this virus is not present in Wallis & Futuna.

CONCLUSIONS

Wallis & Futuna appears to be free of all OIE list A diseases.

The presence of AE, MD, IB and IBD among village birds in Wallis and Futuna means that commercial layers bought from breeders in other countries should either be vaccinated or housed away from village birds, if these significant infections are to be avoided in the layers.

Both porcine brucellosis and Aujeszky's disease have been greatly reduced by compulsory penning of pigs. Further reduction in their prevalence would require extensive testing and culling of infected animals, and this would be of questionable benefit from the pig health or economic viewpoint. Brucellosis is a zoonosis, and eradication of porcine brucellosis might be desirable from the human health perspective.

Leptospirosis is present in Wallis & Futuna, as everywhere else in the Pacific. The serological survey of 1997 demonstrated the presence of more serovars than were identified in 1985. If the prevalence is to be reduced by control measures, we need a better understanding of the epidemiology of the infection, and to pursue this it would be necessary to culture leptospires from the range of animals that may be involved in the epidemiology of the different serovars present.

Antibodies to *Trichinella spiralis* have been identified, and this is another zoonosis that would merit further investigation. As a human health hazard its threat can be minimised in Wallis & Futuna by ensuring thorough cooking of all pig meat.

Periodic importations of pigs, poultry and their meat and products from other countries pose a threat of disease introduction. Wallis & Futuna is free of ND, AI, CSF, FMD, SVD, rabies, TGE and PRRS, and introduction of any of these diseases would cause considerable economic loss; in the case of the OIE list A diseases the effects would be devastating. It is important to maintain vigilance with importations that could carry livestock pathogens.

Control programmes for endemic diseases should be considered (as they have been in the past), and are now possible with all pigs kept in pens.

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APPENDIX A

Laboratories

CAHL	Central Animal Health Laboratory MAF Quality Management Ward Street Upper Hutt New Zealand
FVPL	Koronivia Veterinary Pathology Laboratory Ministry of Agriculture, Fisheries and Forests P.O. Box 77 Nausori Fiji
LTDV	Laboratoire Territorial de Diagnostic Vétérinaire BP 42 – 98890 Paita New Caledonia
QHA	WHO Arbovirus Reference and Research Laboratory Queensland Health Scientific Services 39 Kessels Road Coopers Plains Queensland 4108 Australia
QHL	WHO/FAO Collaborating Centre for Reference and Research on Leptospirosis Centre for Public Health Sciences 39 Kessels Road Coopers Plains Queensland 4108 Australia

Organisations

OIE	Office International des Epizooties
SPC	Secretariat of the Pacific Community
CPS	Secrétariat générale de la Communauté du Pacifique
PICT	Pacific Island countries and territories

APPENDIX A *(continued)*

Serological tests

AGID	Agar Gel Immunodiffusion
C-ELISA	Competitive Enzyme-Linked Immunosorbent Assay
CFT	Complement Fixation Test
ELISA	Enzyme-Linked Immunosorbent Assay
HI	Haemagglutination Inhibition
IFAT	Indirect Fluorescent Antibody Test
LAT	Latex Agglutination
MAT	Microscopic Agglutination Test
RBPT	Rose Bengal Plate Test
SAT	Serum Agglutination Test
SNT	Serum Neutralisation Test

Diseases

AD	Aujeszky's disease
AE	Avian encephalomyelitis
AI	Avian influenza
Brucella	Brucellosis
BT	Bluetongue
CAE	Caprine arthritis and encephalitis
CD	Canine distemper
CSF	Classical swine fever / hog cholera
EIA	Equine infectious anaemia
ER	Equine rhinopneumonitis
FMD	Foot and mouth isease
IB	Infectious bronchitis
IBD	Infectious bursal disease
IBR	Infectious bovine rhinotracheitis
ILT	Infectious laryngotracheitis
JD	Johne's disease
Lepto	Leptospirosis
MD	Marek's disease
ND	Newcastle disease
PRRS	Porcine reproductive and respiratory syndrome
SVD	Swine vesicular disease
TB	Tuberculosis
TGE	Transmissible gastroenteritis
TS	Trichinosis

APPENDIX B

Distribution of the 1997 samples for testing was as follows:

Species	**Laboratory***	**Infectious agent***	**Serological test***
Pig	CAHL	TGE	ELISA
		PRRS	ELISA
		Classical swine fever	ELISA
		Aujeszky's disease	ELISA
		Trichinella spiralis	ELISA
	FVPL	Brucella	RBPT
	QH Lepto	*Leptospira* panel	MAT
	QH Arbo	Japanese Encephalitis	HI
Chicken	CAHL	Infectious bronchitis	ELISA
		Infectious bursal disease	ELISA
		Infectious laryngotracheitis	ELISA
		Newcastle disease	HI
		Avian influenza	AGID
		Marek's disease	AGID
		Avian encephalomyelitis	AGID

* For explanation of abbreviations and acronyms, see Appendix A

APPENDIX B *(continued)*

Distribution of the 1998 samples for testing :

Species	Laboratory*	Infectious agent*	Serological test*
Chicken	LTDV	Infectious bronchitis Infectious bursal disease Infectious laryngotracheitis Newcastle disease Avian influenza Avian encephalomyelitis	ELISA ELISA ELISA HI AGID ELISA
Goat	CAHL	*Toxoplasma* Q fever Bluetongue CAE Johne's disease	LA CFT AGID ELISA ELISA
	FVPL	Brucellosis	RBPT
	QHL	Leptospirosis	MAT
	QHA	Japanese encephalitis	HI
Horse	CAHL	Equine infectious anaemia Equine herpes (types I & IV) Equine infectious arteritis	AGID SNT SNT
	QHL	Leptospirosis	MAT
	QHA	Japanese encephalitis	HI
Dog	CAHL	*Brucella canis* *Ehrlichia canis* Canine distemper virus Canine parvovirus	SAT IFAT SNT HI
	QHL	Leptospirosis	MAT
	QHA	Japanese encephalitis	HI

* For explanation of abbreviations and acronyms, see Appendix A

APPENDIX C

Table 1. **Percentages of serum samples with antibodies to brucellosis, leptospirosis and Aujesz 1985 (reproduced from Bertin, 1985).**

Population	No. of samples	Brucellosis	Leptospirosis	Auje dis
Total, W + F	88	23.86	13.63	5
Penned pigs*	41	12.19	2.43	2
Free range†	47	34.04	25.53	8
Futuna	12	16.66	16.66	5
Wallis	76	25.00	13.15	4
Hihifo district	34	29.41	5.88	5
Hahake district	19	21.05	10.52	3
Mua district	23	21.73	26.08	7

* Dirt enclosures
† Confined to the beach/littoral zone

Table 2. **Numbers of porcine sera in selected sub-populations giving positive reactions to tests infections: Wallis & Futuna, 1997.**

Population	TGE†		PRRS†		AD†		CSF†		TS†		P
	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	
Wallis & Futuna	**0**	165	**0**	165	**14**	165	**0**	165	**1**	165	
Wallis – all pigs?	**0**	103	**0**	103	**5**	103	**0**	103	**1**	103	
Concrete pen	**0**	49	**0**	49	**1**	49	**0**	49	**0**	49	
Dirt enclosure*	**0**	52	**0**	52	**4**	52	**0**	52	**1**	52	
Futuna	**0**	62	**0**	62	**9**	62	**0**	62	**0**	62	

* Includes pigs that spend some time in dirt enclosures and some in concrete floored pens.
† See Appendix A for explanation of abbreviations
? Includes 2 pigs for which housing was not recorded

APPENDIX C *(continued)*

Table 3. **Numbers of poultry sera in selected sub-populations giving positive reactions to tests infections: Wallis & Futuna, 1997.**

	ND†		AI†		IB†		IBD†		ILT†	
Population	**Positive**	**Total**	**Positive**	**Total**	**Positive**	**Total**	**Positive**	**Total**	**Positive**	**To**
Wallis & Futuna	**0**	140	**0**	139	**125**	141	**131**	141	**38**	1
Wallis	**0**	91	**0**	91	**83**	91	**84**	91	**25**	
All layers	**0**	44	**0**	44	**48**	44	**49**	44	**5**	
Flock1: caged	**0**	13	**0**	13	**13**	13	**13**	13	**0**	
Flock2: penned	**0**	10	**0**	10	**10**	10	**10**	10	**1**	
Flock4: penned	**0**	10	**0**	10	**10**	10	**10**	10	**0**	
Flock3: local birds	**0**	11	**0**	11	**11**	11	**11**	11	**2**	
Free range	**0**	47	**0**	47	**39**	47	**40**	47	**22**	
Futuna	**0**	49	**0**	48	**42**	50	**47**	50	**13**	
Flock5: penned layers	**0**	15	**0**	15	**11**	15	**15**	15	**0**	
Free range	**0**	34	**0**	33	**31**	35	**32**	35	**13**	

† See Appendix A for explanation of abbreviations