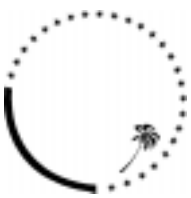
THE ANIMAL HEALTH STATUS OF SAMOA

by

Tony Martin
Veterinary Epidemiologist



Noumea, New Caledonia
1999

SECRETARIAT OF THE PACIFIC COMMUNITY

THE ANIMAL HEALTH STATUS OF SAMOA

by

Tony Martin
Veterinary Epidemiologist

Noumea, New Caledonia
1999

Original text: English

Secretariat of the Pacific Community Cataloguing-in-publication data

Martin, Tony

The Animal Health Status of Samoa / by Tony Martin

1. Animals—Diseases—Solomon Islands 2. Animal Health Technology
1. Title II. Secretariat of the Pacific Community

636.089´9614 AACR2
ISBN 982-203-694-9
Agdex 650

Secretariat of the Pacific Community
98848 Noumea Cedex
BP D5
New Caledonia

Telephone: +687 26 20 00
Facsimile: +687 26 38 18
E-mail: spc@spc.org.nc
http://www.spc.org.nc/

Secretariat of the Pacific Community
Private Mail Bag
Suva
Fiji

Telephone: +679 370733
Facsimile: +679 370021
E-mail: spc@spc.org.fj
http://202.0.157.4

Prepared for publication by the SPC Regional Media Centre,
And printed by Quality Print, Suva, Fiji, 1999

ABSTRACT

A serological survey for diseases of livestock was conducted in Samoa in 1997, with the objective of determining the current animal health status of the country for selected diseases. The results are presented along with those of previous surveillance activities, notably in the 1970s. Both village livestock (pigs, poultry, horses) and commercial livestock (cattle, pigs, poultry) were covered in the survey.

Samoa is free of the contagious livestock diseases of serious socio-economic or public health significance (OIE list A diseases). It is also free of rabies. Appropriate importation and quarantine procedures must be maintained to retain this disease-free status. Other important livestock diseases which are not present in Samoa include porcine brucellosis, transmissible gastroenteritis of pigs, porcine reproductive and respiratory syndrome, bovine anaplasmosis and enzootic bovine leukosis. The serological evidence also points to freedom from bovine Johne's disease.

There are several diseases of animals present in Samoa that are transmissible to humans: bovine brucellosis and tuberculosis (both the subject of renewed control programmes), leptospirosis and trichinosis. The human viral infection Japanese B encephalitis is not present in Samoa.

There is serological evidence for the presence of infectious bovine rhinotracheitis, pestivirus, theileriosis and babesiosis in cattle; Aujeszky's disease in pigs; and infectious bronchitis, infectious bursal disease, infectious laryngotracheitis, avian encephalomyelitis and Marek's disease in poultry.

Ongoing surveillance is necessary to maintain or improve the country's animal health status.

Résumé

Une enquête sérologique portant sur les maladies affectant le bétail a été réalisée au Samoa en 1997, en vue de déterminer la situation actuelle du pays au regard de certaines affections. Les résultats sont assortis des données concernant les activités de surveillance menées dans les années 70 notamment. L'enquête concernait tant les animaux vivant en semi-liberté dans les villages (porcs, volailles, chevaux) que les bêtes d'élevage commercial (bovins, porcins, volailles).

Le Samoa est indemne des maladies animales contagieuses de grande importance sur le plan socio-économique ou de la santé publique (maladies de la liste A de l'OIE), ainsi que de la rage. Il importe de maintenir les presciptions phytosanitaires et les mesures à l'importation pour conserver ce statut. Les maladies ci-après sont également inexistantes au Samoa : brucellose du porc, gastro-entérite transmissible du porc, syndrome dysgénésique et respiratoire du porc, anaplasmose bovine et leucose bovine enzootique (LBE). Les résultats sérologiques montrent en outre que le pays est indemne de paratuberculose bovine.

Plusieurs zoonoses sont présentes au Samoa : brucellose bovine et tuberculose (qui font toutes deux l'objet de nouveaux programmes de lutte), leptospirose et trichinose. L'encéphalite japonaise B, infection virale chez l'homme, est inexistante au Samoa.

Les maladies suivantes ont été mises en évidence par les épreuves sérologiques : chez les bovins, rhinotrachéite infectieuse bovine, pestivirose, theilériose et babésiose; chez

les porcins, maladie d'Aujeszky et chez les volailles, bronchite infectieuse, bursite infectieuse, laryngotrach6ite infectieuse, enc6phalomy6lite aviaire et maladie de Marek.

Une surveillance continue est n6cessaire pour maintenir ou am6liorer la situation zoosanitaire du pays.

ACKNOWLEDGMENTS

This publication was produced and the survey conducted with funding from the Government of France.

The enthusiastic support of the staff of the Livestock Division of the Samoan Ministry of Agriculture, Forests, Fisheries and Meteorology is gratefully acknowledged. The assistance and cooperation of the following made this survey possible: Director of Agriculture Tuisugaletaua Ali'imalemanu Sofara Aveau; Assistant Director for Livestock Faleupolu Tevita; Chief Animal Health Officer Faafetai Fata; paraveterinarians Emile Fata, Uga Ioane, Leo Sooalo and Taisia Leituala; veterinary assistants Enoka, Evile Sa'u and Faalele Tiatia; and last but not least, driver Metuli Tiatia.

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

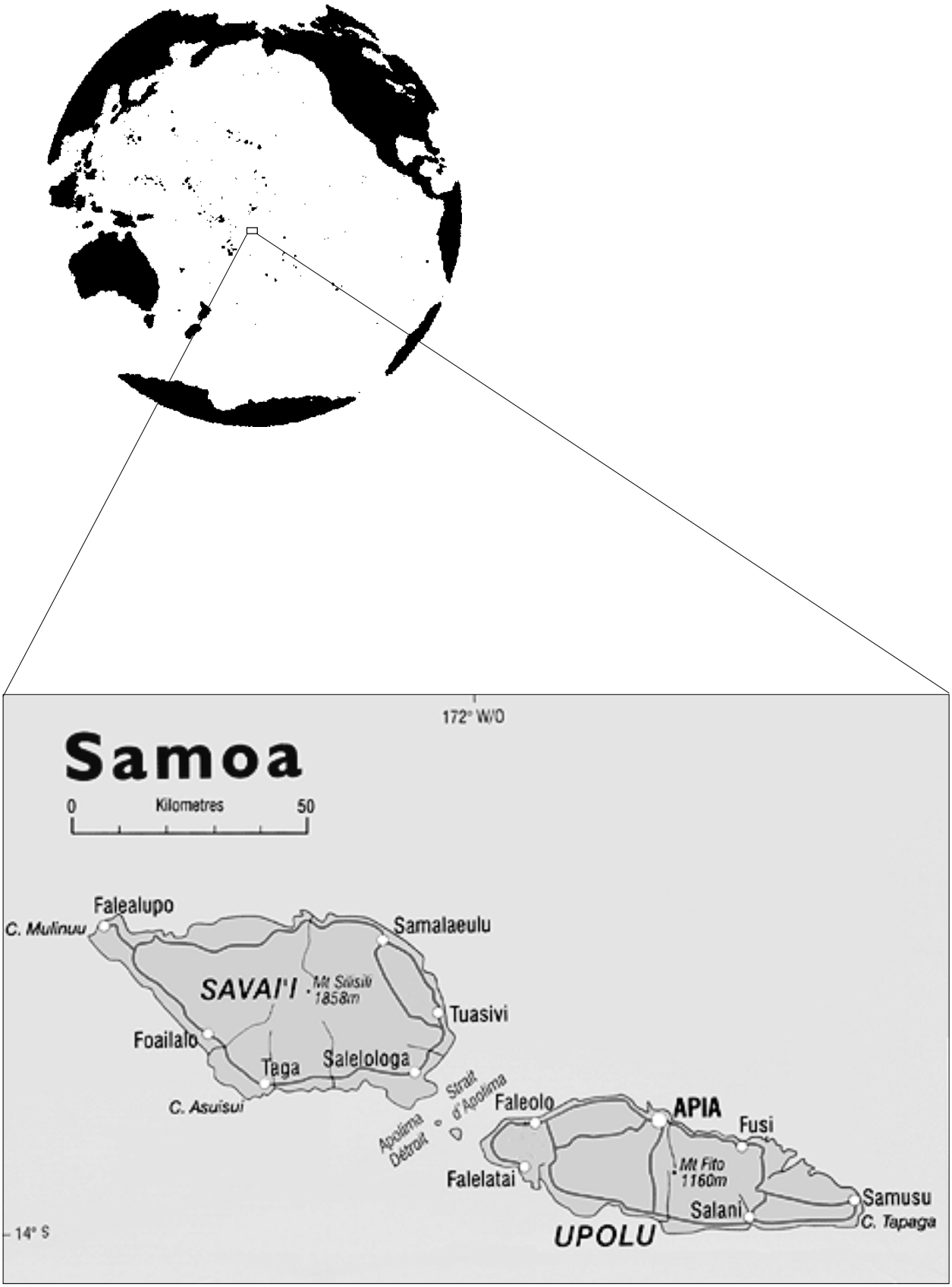
I am also grateful to Dr. Rob de Rooij for going to some lengths to provide historical information that was otherwise unavailable.

Table of Contents

Page

TABLE OF CONTENTS *(continued)*

Page


172° W/O
Samoa
0
Kilometres
50
Falealupo
C. Mulinuu
Samalaeulu
SAVAI'I
Mt Silisili
1858m
Tuasivi
Foailalo
Salelologa
Taga
C. Asuisui
Strait
d'Apolima
Apolima
Deboit
Faleolo
APIA
Fusi
Mt Fito
1160m
Falelatai
Salani
Samusu
C. Tapaga
UPOLU
14° S

Introduction

This report presents the findings of a serological survey of livestock diseases in Samoa. This survey was carried out in 1997–8, funded by the Veterinary Epidemiology project of the Secretariat of the Pacific Community (SPC), and carried out by the SPC veterinary epidemiologist and staff of the Livestock Division of the Samoan Ministry of Agriculture, Forests, Fisheries and Meteorology. 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 also for public health initiatives. 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

From 1972 to 1979 a series of animal health and production projects in Samoa were funded by the Food and Agriculture Organization of the United Nations. During this time a considerable amount of diagnostic work was done on all domestic species, and the results were summarised by de Rooij in 1979. For the 1980s and 1990s there are records of laboratory submissions and findings (mostly parasitology) and records of clinical findings and treatments for all species attended by the animal health service of the Livestock Division. All of these findings and reports are incorporated into this report. There are few records of meat inspection findings, although de Rooij gives a brief summary in his 1979 report.

Location and Topography

Samoa (formerly Western Samoa) comprises the 2 main islands Savaii and Upolu, and the small adjacent islets of Manono, Apolima, Nuutele, Nuulua, Namua and Fanuatapu. The population is approximately 160,000 who live in coastal villages on Savaii (45,000) and Upolu (115,000).

Upolu is a mountainous island of 1,108 km^2, with the capital city Apia on the north coast, at 13º50'S, 171º47'W.

Savaii is the larger island (1,695 km^2), 20km from the western end of Upolu. The land rises steadily from the coastal flats to the central volcanic peaks: Mt. Silisili is the highest point (1,858m; 13º37'S, 172º29'W).

Agriculture and livestock

Most agricultural production is for local consumption. Historically coconuts, bananas, taro and cocoa, have been the principal export crops.

Cattle, pigs and poultry are farmed commercially, although with all three local production does not satisfy demand, and meat is imported. There is a smallholder dairy industry, but most dairy products are imported. Village pigs and poultry form the bulk of Samoan livestock, and they are mostly free to roam, although pigs are penned in one or two villages. Horses are to be found in most villages, and they are generally tethered. Estimated livestock numbers are given in Table 2.

Cattle graze both in paddocks constructed specifically for them, and under coconuts in the extensive plantations on both islands.

SURVEY DESIGN

Livestock populations

Livestock were grouped into populations of animals with common exposure to disease. Each of these livestock populations 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. The list of separate livestock populations identified when designing the survey is shown in Table 1.

In Samoa both village pigs and village poultry are free to roam (except in one or two villages), so there is considerable mixing of both species among households. In general, villages are not separated by great distances, and both species also mix between adjacent villages. There is only occasional contact between livestock populations of the two islands. It is therefore reasonable to consider village pigs and village chickens to form single populations on each of the two islands.

Commercial laying hens were taken to be a separate population from the free range village birds, and the same was true of pigs in commercial piggeries.

Horses move around on each island, and we took each island to have a single population.

Most cattle are managed in separate, commercial herds. Commercial pigs, chickens and cattle are grouped in farms, each of which potentially has a different exposure to disease. Each farm was therefore considered separately for sampling purposes.

Table 1. Livestock populations* and survey sample sizes: Samoa 1997

Island	Species	Management System	Estimated Population	Desired no. of samples	Number Sampled
Savaii	Pig	Village	35,156	60	56
Savaii	Poultry	Village	28,688	60	64
Savaii	Cattle	Paddock	7,209		147
Savaii	Horse	Tethered/Paddock	1,500	30	38
Upolu	Pig	Commercial, housed	6,400	15 per herd	64
Upolu	Pig	Village	89,844	60	60
Upolu	Poultry	Commercial layers	28,000	10 per flock	74
Upolu	Poultry	Village	73,313	60	71
Upolu	Cattle	Paddock	12,957		169
Upolu	Horse	Tethered/Paddock	1,500	30	25

* Village livestock populations derived from 1991 census (human populations) and 1988 census (total livestock owning households). Village livestock numbers were then assumed to be distributed between the islands proportional to the human population. Cattle populations from 1997 survey (Anon 1997).

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 less than 1% for trichinosis in pigs to over 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 freedom from disease or estimation of prevalence of exposure to disease, the critical information needed is:

- Population size
- Likely prevalence[1]
- Acceptable error levels in the estimation
- Test sensitivity[2]
- Test specificity[3]

Apart from the acceptable error levels, all of the above vary from one infection to another for all populations, so for such a survey there is no correct sample size. 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 10 birds sampled. In these circumstances we considered that antibody prevalence would be very high if infections such as infectious bronchitis, Newcastle disease and others were present.

The figures 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 on both Savaii and Upolu, and many keep poultry. Households were selected based on convenience. Within each herd one to four adult pigs were selected, again by convenience. 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 on litter were selected based on convenience (the first 10 birds caught).

Cattle were selected for blood sampling and TB testing in 18 herds in early 1997, in a pilot study to assess the prevalence of these infections in the national cattle herd. Herds were selected to provide geographic representation and a range of herd sizes. Within large herds the first adults through the race (up to 88) were bled and tested. In small herds all adults were sampled. All sera were tested for brucellosis, and up to 20 sera per herd (selected randomly from herds with more than 20 stored) were used for the rest of the serological testing.

Within each poultry and pig population we attempted 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, although 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. Samoa does not export any livestock products, but does import layer chicks and occasional porcine and bovine breeding stock.

Diseases included in the serological testing in 1997 are listed in Appendix B.

---

1 The proportion of animals infected (prevalence of infection), or with antibodies to the infectious agent (antibody prevalence)
2 The proportion of those animals that have been infected with the disease agent that give positive results with the test
3 The proportion of those animals that have never been infected with the disease agent that give negative results with the test

Classical swine fever 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 Samoa. No vesicular disease has been seen in pigs or cattle in Samoa, and we did not include these infections in our serological testing. We did include classical swine fever, and for the poultry we included the two list A diseases: Newcastle disease and avian influenza. Cattle 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 adult pigs, goats, horses and cattle using evacuated 9ml tubes. Poultry were bled using 3ml syringes and 23g needles, and the blood was immediately transferred to a 5ml 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. Sera were then taken to Suva, Fiji for distribution to laboratories. The laboratories and tests used for all the serum samples are given in Appendix B.

Cattle were bled between late March and early May 1997; all other samples were collected in September 1997 except for 13 horses and 15 pigs bled in early November 1997.

Ten dogs were bled during 1997, and the frozen serum distributed to laboratories for testing as shown in Appendix B.

Analysis of results

Confidence levels for assertions of freedom from disease were arrived at using *FreeCalc*[4] .

Where prevalences in different populations are compared in the text, they are stated to be different when found to be so with a probability of 95% using the *chi-square* test. If they are stated not to be different, this means the probability of them being significantly different was less than 95%.

Questionnaires

A list of diseases of domestic animals was sent to each veterinarian working in Samoa in 1997 with a request that they should record on it whether they had seen clinical or other evidence of each disease. Two of the three were returned, and their contents is included in the discussion that follows.

---

[4] FreeCalc – Epidemiological software for surveys to detect disease (Cameron, 1996)

Results and discussion

Dogs

Parasites

Various common canine parasites were identified in the 1970s (de Rooij, 1979; Appendix C), and laboratory reports since then have frequently included parasite identifications. The following occur in Samoa:

Ancylostoma caninum (hookworm)
Toxocara canis (roundworm)
Trichuris vulpis (whipworm)
Dipylidium caninum (tapeworm)
Dirofilaria immitis (heartworm)
Ctenocephalides canis (dog flea)
Ctenocephalides felis (cat flea)
Demodex canis (mange mite)
Trichodectes canis (louse)
Rhipicephalus sanguineus (brown dog tick)
Giardia sp.
Coccidia

Serology

Ten canine sera were tested for antibodies to canine parvovirus, *Ehrlichia canis*, canine distemper virus, *Brucella canis* and Japanese encephalitis virus, with the following results:

	No. of samples	
Infection	**Tested**	**Positive**
Canine parvovirus	10	8
Ehrlichia canis	10	6
Canine distemper virus	7	0
Brucella canis	10	0
Japanese encephalitis virus	1	0

Ehrlichiosis (canine tropical pancytopaenia) is clearly present in Samoa. It is spread by the brown dog tick *Rhipicephalus sanguineus*, which has also been recorded.

Canine parvovirus is also present in Samoa.

The negative serology for brucellosis and canine distemper do not prove that these infections are not present, since not enough dogs were tested.

Rabies has never been recorded in Samoa.

Clinical Aujeszky's disease in dogs was reported by de Rooij (1979).

Cattle

Parasites

The following have been recorded in Samoa (de Rooij, 1979; MAFFM animal health reports).

Endoparasites	Ectoparasites
Ascaris vitulorum	*Amblyomma cyprium*
Bunostomum phlebotomum	*Haemaphysalis longicornis*
Cooperia sp.	
Dictyocaulus viviparus	
Echinococcus granulosus	
Fasciola hepatica[*]	
Haemonchus contortus	
Nematodirus spathiger	
Oesophagostomum radiatum	
Paramphistomum sp.	
Setaria digitata	
Strongyloides papillosus	
Trichostrongylus sp.	

[*] Only recorded in imported cattle; intermediate hosts not recorded in Samoa.

OIE list A diseases

Vesicular diseases have not been seen in Samoa, nor have rinderpest, pleuropneumonia or lumpy skin disease.

Bluetongue

All 316 sera tested for antibodies to BTV were negative. It appears unlikely that bluetongue virus is present in Samoa, although the sample numbers only allow 95% confidence that the prevalence of antibodies is less than 12% in any herd, in less than 10% of herds (AGID test performance taken from Ward, Gardner & Flanagan, 1995). In 1979 de Rooij also reported negative serology on 835 cattle from 16 herds.

Enzootic bovine leukosis

As with bluetongue, 316 sera were tested and all were negative, and we can be 95% confident that the prevalence of EBL infection is less than 10% in all herds tested (AGID test performance taken from KL; Kaneene JB; Miller JM, and Bull RW, 1985)”Jacobsen, Kaneene, Miller *et al.*, 1985). It is possible that EBL is present in one or more herds at a prevalence of less than 10%, in which case we would not necessarily have found it in this survey. EBL is more commonly found in dairy herds, largely because the cattle are in closer contact than in beef herds. Only beef cattle contributed to this survey.

Infectious bovine rhinotracheitis (IBR)

There are no records of clinical IBR, but 69% of 316 sera tested gave positive results for antibodies:

	No. of samples		Apparent
Population	**Tested**	**Positive**	**Prevalence %**
Savaii Total*	**147**	**99**	**67**
Herd 1	20	18	90
Herd 2	12	8	67
Herd 3	18	15	83
Herd 4	14	10	71
Herd 5	20	8	40
Herd 6	20	9	45
Herd 7	20	11	55
Herd 8	20	17	85
Upolu Total	**169**	**118**	**70**
Herd 9	20	11	55
Herd 10	20	18	90
Herd 11	20	20	100
Herd 12	9	0	0
Herd 13	20	14	70
Herd 14	20	19	95
Herd 15	20	12	60
Herd 16	9	3	33
Herd 17	20	10	50
Herd 18	11	11	100
Savaii + Upolu	**316**	**217**	**69**

* Includes 3 additional animals not in herds 1 – 8

Apart from one herd on Upolu where only 9 animals were tested, all 18 herds had 30 – 100% positive reactions. IBR is clearly endemic in Samoa.

Brucellosis

Clinical brucellosis (abortions) have been recorded in recent years, and in 1978, 193 positive and 47 suspicious reactions were found during serological testing of 1860 sera from 28 herds (de Rooij, 1979). S19 vaccination was routinely practised at that time, but vaccine has not been used in recent years. In 1986 records of the Animal Health and Production Service show that 11,073 cattle were bled and 297 (2.68%) reacted. In 1997 657 cattle were tested in 19 herds, and a total of 22 reactors were found in 2 herds, with 1 suspicious in a third herd:

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Savaii Total	**220**	**0**	**0**
Herd 1	21	0	0
Herd 2	12	0	0
Herd 3	18	0	0
Herd 4	14	0	0
Herd 5	22	0	0
Herd 6	23	0	0
Herd 7	34	0	0
Herd 8	76	0	0
Upolu Total	**437**	**23**	**5**
Herd 9	83	5	6
Herd 10	46	0	0
Herd 11	59	0	0
Herd 12	9	0	0
Herd 13	88	1	1
Herd 14	61	0	0
Herd 15	22	0	0
Herd 16	9	0	0
Herd 17	33	0	0
Herd 18	27	17	63
Savaii + Upolu	**657**	**23**	**4**

Bovine brucellosis is present in Samoa. All reactors were on Upolu, but given the relatively poor sensitivity of the RBPT (75% (Stemshorn, Forbes, Eaglesome *et al*., 1985)) it is still possible that brucellosis is present on Savaii at low prevalence in one or more herds.

Bovine pestivirus / bovine virus diarrhoea / mucosal disease

There have been no recent observations of clinical disease associated with pestivirus infection, although from the serological evidence the virus is clearly present throughout the Samoan cattle population. De Rooij (1979) reported 111 serological reactors of 156 animals tested from a single herd in 1978. In 1997 the 316 sera from 18 herds identified 143 animals with antibodies:

Population	No. of samples		Apparent
	Tested	Positive	Prevalence %
Savaii Total*	**147**	**61**	**41**
Herd 1	20	5	25
Herd 2	12	2	17
Herd 3	18	1	6
Herd 4	14	14	100
Herd 5	20	19	95
Herd 6	20	1	5
Herd 7	20	19	95
Herd 8	20	0	0
Upolu Total	**169**	**82**	**49**
Herd 9	20	0	0
Herd 10	20	20	100
Herd 11	20	14	70
Herd 12	9	1	11
Herd 13	20	17	85
Herd 14	20	1	5
Herd 15	20	14	70
Herd 16	9	0	0
Herd 17	20	6	30
Herd 18	11	9	82
Savaii + Upolu	**316**	**143**	**45**

* Includes 3 additional animals not in herds 1 – 8

This test is both sensitive and specific (Horner & Orr, 1993), and the lack of reactors in 3 herds suggests that these herds do not contain persistently infected animals as a source of infection.

Tuberculosis

De Rooij cited a report by Caldwell in 1953 that beef herds had 14–20% reactors to tuberculin testing, and dairy herds up to 80%. An eradication campaign based on testing and slaughter of reactors commenced in 1973, and the percentage of reactors decreased from 21% in 1971 to less than 1% in 1979. In 1979 85% of these reactors had visible lesions.

Intradermal tuberculin testing in 1997 was done at the same time as bloods were collected, with the following results:

	No. of animals		Reactor
Population	**Tested**	**Positive**	**Prevalence %**
Savaii Total	**220**	**0**	**0**
Herd 1	21	0	0
Herd 2	12	0	0
Herd 3	18	0	0
Herd 4	14	0	0
Herd 5	22	0	0
Herd 6	23	0	0
Herd 7	34	0	0
Herd 8	76	0	0
Upolu Total	**437**	**9**	**2**
Herd 9	83	8	10
Herd 10	46	0	0
Herd 11	59	0	0
Herd 12	9	0	0
Herd 13	88	1	1
Herd 14	61	0	0
Herd 15	22	0	0
Herd 16	9	0	0
Herd 17	33	0	0
Herd 18	27	0	0
Savaii + Upolu	**657**	**9**	**1**

The tuberculin test is fairly specific, but has very poor sensitivity, so these results do not rule out infection in herds with no reactors, and ongoing testing is necessary to monitor the tuberculosis status of Samoan cattle.

Actinobacillosis / wooden tongue & actinomycosis / lumpy jaw

De Rooij (1979) reported that 10% of the carcases submitted for meat inspection had the heads condemned for actinobacillosis. He also recorded the occurrence of actinomycosis (lumpy jaw). In 1997 both veterinarians responding to the questionnaire stated that they had seen neither actinobacillosis nor actinomycosis. Ongoing active surveillance is needed to establish whether these diseases are still present.

Johne's disease / paratuberculosis

In 1978 thirteen farms, a total of 1034 animals, were tested serologically for Johne's disease. The test used was probably the CFT, which has poor sensitivity and specificity. Five sera were classed as *suspect* and such a small number of weak positive reactions is very probably due to cross reactions. Both the sensitivity and the specificity of the ELISA used in 1997 are better, although the sensitivity of this test (its ability to detect infected animals) is still no more than 50%. In 1997 all 316 sera tested were negative. While it is likely that positive reactions would have been obtained if Johne's disease were well established in Samoa, the prevalence of infected animals in a herd can be low,

and it is possible that the disease is present and we failed to find infected animals because of the low sample numbers and the poor sensitivity of the test.

Anaplasmosis

There are no reports of clinical disease, and in 1978 1,028 animals from 13 herds all gave negative serological results (de Rooij, 1979). In 1997 there were 10 positive sera among 316 samples from 18 herds:

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Savaii Total*	**147**	**6**	**4**
Herd 1	20	2	10
Herd 2	12	1	8
Herd 3	18	0	0
Herd 4	14	1	7
Herd 5	20	1	5
Herd 6	20	0	0
Herd 7	20	0	0
Herd 8	20	1	5
Upolu Total	**169**	**4**	**2**
Herd 9	20	0	0
Herd 10	20	1	5
Herd 11	20	2	10
Herd 12	9	0	0
Herd 13	20	0	0
Herd 14	20	1	5
Herd 15	20	0	0
Herd 16	9	0	0
Herd 17	20	0	0
Herd 18	11	0	0
Savaii + Upolu	**316**	**10**	**3**

* Includes 3 additional animals not in herds 1 – 8

When cattle are exposed to ticks infected with *Anaplasma marginale* a high proportion of them are infected and develop antibodies. These are detected by the card agglutination test (sensitivity = 84%, specificity = 98% (Gonzalez, Long & Todorovic, 1978)). In endemic areas in the tropics one expects at least 60% of animals to be seropositive (Radostits, Blood & Gay, 1997). The results above are consistent with the country being free of anaplasmosis.

Babesiosis

There are no records of clinical babesiosis. In 1997 we tested 316 sera from 18 herds for *B.bovis* antibodies using the IFAT, with results as follows:

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Savaii Total*	**147**	**17**	**12**
Herd 1	20	0	0
Herd 2	12	0	0
Herd 3	18	1	6
Herd 4	14	8	57
Herd 5	20	3	15
Herd 6	20	3	15
Herd 7	20	2	10
Herd 8	20	0	0
Upolu Total	**169**	**10**	**6**
Herd 9	20	3	15
Herd 10	20	2	10
Herd 11	20	3	15
Herd 12	9	0	0
Herd 13	20	0	0
Herd 14	20	0	0
Herd 15	20	0	0
Herd 16	9	1	11
Herd 17	20	1	5
Herd 18	11	0	0
Savaii + Upolu	**316**	**27**	**9**

* Includes 3 additional animals not in herds 1 – 8

These results suggest the presence of *B.bovis* in Samoa, although the apparent prevalence of antibodies is lower than that expected in areas of active tick transmission; only one herd had a prevalence over 15%. *Haemaphysalis* ticks (recorded by de Rooij in 1979) are known to transmit babesiosis in some parts of the world. The specificity of the IFAT is not well quantified, and the conclusion to be drawn from these results is that further investigations are needed.

Theileriosis

Clinical disease has not been recorded. In 1997 we tested 316 sera from 18 herds using the IFAT, with the following results:

Population	No. of samples		Apparent
	Tested	Positive	Prevalence %
Savaii Total*	**147**	**115**	**78**
Herd 1	20	17	85
Herd 2	12	10	83
Herd 3	18	15	83
Herd 4	14	11	79
Herd 5	20	14	70
Herd 6	20	11	55
Herd 7	20	16	80
Herd 8	20	18	90
Upolu Total	**169**	**146**	**86**
Herd 9	20	13	65
Herd 10	20	15	75
Herd 11	20	19	95
Herd 12	9	9	100
Herd 13	20	18	90
Herd 14	20	12	60
Herd 15	20	20	100
Herd 16	9	9	100
Herd 17	20	20	100
Herd 18	11	11	100
Savaii + Upolu	**316**	**261**	**83**

* Includes 3 additional animals not in herds 1 – 8

The high rate of seropositivity is consistent with the presence of *Theileria* parasites in Samoa, and with active tick transmission. *Haemaphysalis longicornis* is a known vector of *Theileria buffeli* in Australia, and it is likely that the latter is the species of *Theileria* present in Samoa, since this is one of the many species of the parasite associated with benign theileriosis, and it is present in several surrounding countries.

Leptospirosis

Clinical bovine leptospirosis has been suspected in Samoa, but no culture or serology has been available to confirm the diagnosis. Serological testing was carried out in 1978 (de Rooij, 1979) and again in 1997. In 1978 414 of 629 sera tested reacted to one or more serovars. The serovars giving positive reactions were *hardjo*, *pomona*, *autumnalis*, *ballum*, *canicola*, and *australis*. There are no further details recorded for the testing or results.

The serology carried out in 1997 is summarised in Table 4 of Appendix D; 316 sera were tested in the MAT against each of 21 leptospiral serovars. The prevalence of animals reacting to one or more serovars was generally higher in Upolu herds than in Savaii herds: 26% of Savaii sera reacted, and 51% on Upolu. Few if any sera showed evidence of recent infection; titres of 800 were seen in 10 animals, to several serovars, and 1600 was seen once, to *australis* in herd 3.

Serovars of the *sejroe* serogroup (i.e. *hardjo* and *medanensis*) reacted with sera from Upolu (22% and 15% respectively) but with very few from Savaii; *szwajizak* was the commonest reaction on both islands (26% on Upolu, 12% on Savaii); and several sera also reacted to *australis* on both islands. The results suggest that *hardjo* is much more common on Upolu than on Savaii.

Leptospirosis is endemic in Samoa, and is probably more prevalent on Upolu.

Horses

Parasites

De Rooij reported only the pinworm *Oxyuris equi* and the tick *Haemaphysalis longicornis* from horses. *Strongyloides* was reported in one questionnaire, as were tapeworms. There are no other records of equine parasite identifications.

Clinical records

There are no records of clinical disease in horses.

Serology

Sixty three blood samples were collected in 1997 and tested for antibodies to equine rhinopneumonitis, equine infectious anaemia, equine influenza and leptospirosis.

Equine influenza

All sera were negative for antibodies to equine influenza type A.

Equine infectious anaemia

All sera were negative for antibodies to EIA.

Equine rhinopneumonitis

This infection is prevalent throughout Samoa, with similar results from each of the islands:

	No. of samples		Apparent
Population	**Tested**	**Positive**	**Prevalence %**
Savaii	38	13	34
Upolu	25	10	40
All : Savaii and Upolu	**63**	**23**	**37**

Leptospirosis

As with cattle, the proportion of sera reacting to the MAT was about twice as high on Upolu (60%) as on Savaii (34%). All 63 sera were tested against the same 21 serovars (see Appendix D, Table 6 for a summary of the results). Serovar *hardjo* reacted with Upolu equine sera, but not those from Savaii, and *canicola* also reacted with more Upolu sera (28%) than Savaii sera (8%). Reactions to *szwajizak* (10% overall) and *copenhageni* (19% overall) were also common on both islands.

Pigs

Parasites

Parasites listed by de Rooij in 1979 as occurring in Samoa were

Endoparasites	Ectoparasites
Ascaris suum	*Amblyomma cyprium*
Ascarops strongylina	*Haematopinus suis*
Globocephalus samoensis	*Sarcoptes scabei*
Gnathostoma hispidum	
Metastrongylus apri	
Oesophagostomum longicaudum	
Physocephalus sexalatus	
Stephanurus dentatus	
Strongyloides ransomi	
Trichuris suis	

Ascaris, *Strongyloides*, *Oesophagostomum* and *Stephanurus* were recorded in the questionnaires, as were lungworm and sarcoptic mange. Cysticercosis has not been recorded.

OIE List A diseases

Vesicular diseases have never been seen in Samoa. Neither classical swine fever (CSF) nor African swine fever has been recorded. In 1997 we tested 179 pigs for antibodies to classical swine fever, and found none (Appendix D, Table 1). This a highly contagious infection, and if it were present in Samoa we would expect to find at least 25% of village pigs with antibodies, and 50% of housed pigs. These results give us virtually 100% confidence that CSF is not present in any commercial herd or in the village population of either island.

Brucellosis

Three commercial piggeries were tested serologically for brucellosis in 1978, and all 108 sera tested were negative. Clinical brucellosis has been suspected in herds with weak and stillborn piglets and early abortions. One hundred and eighty sera collected in 1997 were tested for antibodies to *Brucella*, using the RBPT: all were negative. When brucellosis is present in a housed herd the prevalence of seropositive pigs can vary considerably, and a low prevalence is possible. The RBPT has a sensitivity of only 79% (Rogers, Cook, Ketterer *et al.*, 1989), and 15 pigs tested negative per herd allow us 95% confidence that the prevalence is no higher than 20%. To be sure that these herds do not have a lower prevalence of infected pigs further testing is needed.

Brucellosis spreads more easily in free range pigs than in housed pigs, and the negative results obtained for village pigs on each island allow us to be 95% confident that the prevalence of infection is no more than 4%.

Taken together the serological evidence from 1978 and 1997 is strongly suggestive that there is no porcine brucellosis in Samoa, but to be sure further testing (both for diagnosis and surveillance) is needed.

Aujeszky's disease / pseudorabies

This viral infection is present in Samoa. Clinical disease has not been recorded, but the serological evidence is strong. In 1978 sera from 164 pigs in 20 herds were tested, with 31 positive results and 7 suspicious. In 1997 we tested 179 sera from 5 commercial herds and village pigs for antibodies to AD, and found 41 positives:

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Savaii Total	**56**	**27**	**48**
Herd 1 housed	8	0	0
Village pigs	48	27	56
Upolu Total	**123**	**14**	**11**
Housed Total	63	3	5
Herd 2	15	0	0
Herd 3	15	2	13
Herd 4	15	0	0
Herd 5	15	0	0
Village pigs	60	11	18
Penned	15	4	27
Free range	45	7	16
Savaii + Upolu	**179**	**41**	**23**

AD infection is more prevalent on Savaii: on Savaii 56% of village pigs were seropositive, while on Upolu it was only 18% of village pigs. One of the commercial herds tested had 2 reactors (13%), while in the others all 15 pigs tested gave negative results.

Transmissible gastroenteritis

There have been no reports of clinical TGE, and the only serological testing performed (179 sera in 1997; see Appendix D, Table 1) was all negative. This is a highly contagious viral infection, and if it were present we would expect a high prevalence of antibodies in the pig population. It is almost certainly not present in Samoa.

Porcine reproductive and respiratory syndrome

As for TGE, the syndrome has not been seen clinically and the only serological testing performed (179 sera in 1997; see Appendix D, Table 1) was all negative. This is a highly contagious viral infection, and if it were present we would expect a high prevalence of antibodies in the pig population. It is almost certainly not present in Samoa.

Trichinosis

There have been no reports of this parasitic zoonosis, but in 1997 the serological results suggest that it is present in Samoa:

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Savaii Total	**56**	**10**	**18**
Herd 1 housed	8	1	13
Village pigs	48	9	19
Upolu Total	**123**	**2**	**2**
Housed Total	63	0	0
Herd 2	14	0	0
Herd 3	16	0	0
Herd 4	15	0	0
Herd 5	15	0	0
Village pigs	60	2	3
Penned	15	2	13
Free range	45	0	0
Savaii + Upolu	**179**	**12**	**7**

As with Aujeszky's disease, the apparent prevalence is higher in Savaii (19% of village pigs as opposed to 3% in Upolu). Three of the 10 Savaii pigs listed here as seropositive gave *suspicious* results with the ELISA. The 2 serologically positive pigs on Upolu both came from the same village, where they are kept in walled pens. On Savaii one serologically *suspicious* pig was identified in the one herd of housed, European breed pigs, while on Upolu all housed pigs tested gave negative results.

It appears that *Trichinella spiralis* is present in Samoa. The ELISA used is highly specific for *T.spiralis*, and all positive results were confirmed by immunoblot.

This parasitic disease deserves further investigation, particularly since most pigs are slaughtered with no opportunity for meat inspection. Serological evidence for the presence of *Trichinella spiralis* has been found in several PICTs, but cysts have proved difficult to find.

Leptospirosis

De Rooij reported the results of serological testing of 108 pigs from 3 herds, with 27 pigs showing antibodies to one or more of serovars *hardjo*, *pomona*, *autumnalis*, *ballum*, *canicola* and *australis*.

In 1997 we tested sera from 161 pigs against each of 21 serovars; a summary of the results is in Table 5 of Appendix D. The prevalence of seropositive animals for Savaii village pigs (33%) was the same as that for Upolu village pigs (24%). Seroprevalence varied considerably among commercial herds, from 0% of pigs sampled to 46%. The latter herd produced the highest titre in the survey (3200 to *copenhageni*). Titres over 400 suggest recent infection, and these were seen against serovars *australis* on both Savaii and Upolu (both in village pigs); *zanoni* on Upolu, and *szwajizak* on both Savaii and Upolu, again both in village pigs. One pig in a walled pen in western Upolu had titres over 100 against 10 serovars, the highest being 1600 against *szwajizak*.

The most frequent reactions were against *szwajizak*, with 28% of Savaii village pigs reacting and 12% of Upolu village pigs. Reactions to this serovar are more prevalent on Savaii. Amongst village pigs the next most common reactions were to *australis*, on both islands. The most striking feature of the housed pigs was an apparently recent outbreak of *copenhageni* infection in herd 4 (Upolu).

Serovars of the *sejroe* serogroup (*medanensis* and *hardjo*) which were common in the cattle, particularly on Savaii, were not that frequent in the pig populations.

Other infectious diseases

The following have been reported based on clinical observations (1997 questionnaires to veterinarians):

- swine dysentery
- enzootic pneumonia
- tetanus

De Rooij reported the following to be present, based on clinical evidence and/or isolation of the causative agent:

- erysipelas
- polyserositis
- tuberculosis (*Mycobacterium bovis*)
- disease caused by *Escherichia coli*

Poultry

Parasites

De Rooij (1979) reported positive identification of the following parasites of chickens in Samoa:

Endoparasites	Ectoparasites
Acuaria spiralis	*Cnemidocoptes mutans*
Ascaridia galli	*Goniocotes gallinae*
Capillaria contorta	*Lipeurus caponis*
Eimeria tenella	*Menopon gallinae*
Heterakis gallinarum	
Oxyspirura mansoni	
Syngamus trachea	
Tetrameres sp.	

Coccidiosis is commonly seen clinically in poultry, as are gastro-intestinal nematodes.

Serology

De Rooij reported results of testing for pullorum disease in 1978, and in 1997 both village chickens (64 on Savaii and 71 on Upolu) and housed layers (74 from 4 flocks on Upolu) were bled for viral serology. See Appendix D, Table 3 for the results.

There are no vaccines used in Samoan poultry, except for vaccination of day-old chicks imported from New Zealand against fowl pox, so serological titres are not due to vaccine response.

OIE list A diseases

The two avian diseases on list A were both the subject of serological testing in 1997 (see following paragraphs and Appendix D, Table 3).

Newcastle disease

This has not been diagnosed in Samoa, and in 1997 all 209 sera tested were negative for antibodies. This is a highly contagious group of viruses, and where ND is endemic one finds a high proportion of birds with antibodies. The total absence of HI titres for ND allows us to be virtually certain that ND is not present in any of the layer flocks tested, since despite the poor sensitivity of the test (79% (Miers, Bankowski & Zee, 1983)) we would expect at least 50% of birds to have titres if infection were present. Similarly, in village birds we would expect at least 25% seropositivity, and the negative results obtained give us almost 100% certainty that it is not present at this prevalence.

Neither velogenic disease nor any of the lentogenic strains found elsewhere in the region are present in Samoa.

Avian influenza

As for ND, this highly contagious viral infection has not been reported in Samoa, and all 209 sera tested in 1997 gave negative results. The same reasoning as for ND leads to a confident assertion that Samoa is free of AI.

Infectious bronchitis

Another highly contagious viral infection, clinical IB has been reported in Samoa. Ninety-seven percent of 209 sera tested in 1997 were positive for IB antibodies. Infectious bronchitis is endemic in Samoa.

Infectious bursal disease / Gumboro disease

Clinical IBD has not been recorded recently, but 1997 serology suggests that virus is present in Samoa:

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Savaii Total	**64**	**14**	**22**
Upolu Total	**145**	**33**	**23**
Housed layers	74	16	22
Flock 1	10	1	10
Flock 2	20	9	45
Flock 3	23	1	4
Flock 4	21	5	24
Village chicken	71	17	24
Savaii + Upolu	**209**	**47**	**22**

The prevalence of antibodies found was the same for both islands, and for housed and free range birds, although there was some variation among layer flocks.

The IBD antibody ELISA is intended primarily for assessment of flock immunity in commercial poultry, and its sensitivity and specificity for individual sera have not been published. For these samples all those giving positive reactions were subsequently tested with the AGID test for IBD antibody, and all but one gave a positive result. Based on the serological evidence it is highly likely that IBD is endemic in Samoa.

In his 1979 report de Rooij records the presence of Gumboro disease, citing *clinical evidence and/ or isolation of the causative agent*. Further investigations are needed if we wish to establish the strain(s) of virus present.

Infectious laryngotracheitis

There are no reports of clinical disease, but as with IBD, serological testing in 1997 suggests the virus is present in Samoa:

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Savaii Total	**64**	**8**	**13**
Upolu Total	**145**	**8**	**6**
Housed layers	74	0	0
Flock 1	10	0	0
Flock 2	20	0	0
Flock 3	23	0	0
Flock 4	21	0	0
Village chickens	71	8	11
Savaii + Upolu	**209**	**16**	**8**

Sera from housed layers were all negative, while those from free range village birds showed an antibody prevalence of just over 10% on both Savaii and Upolu. As for the IBD ELISA, the specificity of this ILT ELISA is unknown, so it is not certain that these results confirm infection with ILT virus. It appears likely that ILT is endemic amongst village poultry in Samoa.

Marek's disease

Serological results in 1997 were as follows:

Population	No. of samples		Apparent
	Tested	Positive	Prevalence %
Savaii Total	**63**	**15**	**24**
Upolu Total	**144**	**67**	**47**
Housed layers	73	49	67
Flock 1	10	10	100
Flock 2	20	9	45
Flock 3	22	15	68
Flock 4	21	15	71
Village chickens	71	18	25
Savaii + Upolu	**207**	**82**	**40**

There was a higher seroprevalence among housed layers than among free range birds. The commercial layers had all been vaccinated against MD. Prevalence among village chickens was the same on each of the two islands.

"Leukosis in chickens" was reported by de Rooij in 1979, but he did not distinguish between Marek's disease and avian leukosis virus.

Marek's disease is endemic in Samoan poultry.

Avian encephalomyelitis

This viral infection has not been diagnosed clinically, but based on the serological evidence it is clearly endemic in the Samoan poultry population. The results of serological testing in 1997 were:

Population	No. of samples		Apparent
	Tested	Positive	Prevalence %
Savaii Total	**63**	**60**	**95**
Upolu Total	**144**	**85**	**59**
Housed layers	73	50	68
Flock 1	10	7	70
Flock 2	20	17	85
Flock 3	22	8	36
Flock 4	21	18	86
Village chickens	71	35	49
Savaii + Upolu	**207**	**145**	**70**

The seroprevalence among village birds was higher on Savaii (95%) than on Upolu (49%). Also, grouping housed layers together, housed birds had a higher seroprevalence (68%) than free range village birds on Upolu.

Fowl pox

Clinical evidence of fowl pox was recorded by de Rooij in 1979, and also in the 1997 questionnaires to veterinarians. Day-old chicks imported from New Zealand are vaccinated against fowl pox.

Fowl cholera

This was also reported by de Rooij in 1979.

Pullorum disease

Two flocks were tested serologically for pullorum disease in 1978 (de Rooij, 1979). A total of 20 birds were tested, with one suspicious and no positive results. This is a test with only moderate specificity, and from these limited results it is not possible to determine whether pullorum disease occurs in Samoan chickens. No testing was done for this infection in 1997.

Japanese B encephalitis

In 1997 we tested sera from 59 horses, 161 pigs, 1 dog and 1 goat for antibodies to the human viral disease JE. This infection is transmitted by mosquitoes and causes a symptomless infection in several other species. The HI test was used on all these sera, and the pig sera were also tested using the ELISA.

Antibody was detected by HI in 6 horse sera, but neutralisation tests using specific viruses demonstrated that the antibodies were against one or more related flaviviruses with the highest titre against Murray Valley encephalitis (MVE) virus. The infecting virus in Samoan horses is probably closely related to MVE virus.

Continuing surveillance

If Samoa's animal health status is to be maintained and recognised internationally, ongoing surveillance comprising clinical monitoring, meat inspection and periodic serological surveys is necessary.

CONCLUSIONS

OIE List A diseases

Samoa is free of the diseases on the OIE's List A, i.e. "communicable diseases which have the potential for very serious and rapid spread, irrespective of national borders, which are of serious socio-economic or public health consequence and which are of major importance in the international trade of livestock and livestock products".

Public health and zoonoses

There are several zoonoses (diseases of animals transmissible to man) which are present in Samoan livestock, namely:

- bovine tuberculosis
- bovine brucellosis
- trichinosis
- leptospirosis

Of these, there are currently control programmes for both bovine brucellosis and tuberculosis. Trichinosis deserves further investigation, particularly since most pigs are slaughtered with no opportunity for meat inspection.

Leptospirosis is a common finding in the tropics, and is potentially an important public health problem in Samoa. Further investigations are needed to establish the detailed epidemiology of the serovars and mammalian hosts involved in Samoa.

Protecting imported livestock from local diseases

Day-old layer chicks imported from overseas will generally be exposed to infections present in village poultry, so for optimal health and productivity they should be vaccinated against infectious bronchitis, infectious bursal disease, infectious laryngotracheitis, avian encephalomyelitis and Marek's disease.

Both theileriosis and babesiosis are present in Samoa (although the *Theileria* strain may well be benign), and care should be taken when introducing cattle susceptible to tick-borne diseases.

Keeping exotic animal disease out of Samoa

Testing and quarantine procedures should be maintained to ensure imported livestock are free from exotic disease. Of particular importance in this respect are

- rabies
- vesicular diseases
- Newcastle disease and avian influenza
- tuberculosis and brucellosis
- classical swine fever and African swine fever
- ticks and tick-borne disease, especially anaplasmosis
- porcine transmissible gastroenteritis and porcine reproductive and respiratory syndrome

References

Anon. (1997). Report on output from livestock subsector marketing training; training personnel in livestock sector project. Ministry of Agriculture, Forests, Fisheries and Meteorology, Apia.

Cameron, A.R. (1996). FreeCalc – Epidemiological software for surveys to detect disease.

De Rooij, R.J. (1979). Animal health and production – Western Samoa; end of assignment report. FAO.

Gonzalez, E.F., R.F. Long & R.A. Todorovic. (1978). Comparisons of the complement-fixation, indirect fluorescent antibody, and card agglutination tests for the diagnosis of bovine anaplasmosis. Am. J. Vet. Res. 39(9): 1538-1541.

Horner, G.W. & D.M. Orr. (1993). An enzyme-linked immunosorbent assay for detection of antibodies against bovine pestivirus. N.Z. Vet. J. 41(3):123–125.

Jacobsen, K.L., J.B. Kaneene, J.M. Miller, & R.W. Bull. (1985). Comparison of the commercial agar-gel immunodiffusion test and radioimmunoprecipitation assay for detection of antibodies to bovine leukemia virus. Am. J. Vet. Res. 46(7):1430–1433.

Miers, L.A., R.A. Bankowski, & Y.C. Zee. (1983). Optimizing the enzyme-linked immunosorbent assay for evaluating immunity of chickens to Newcastle disease. Avian Diseases 27(4):1112–1125.

Radostits, O.M., D.C. Blood & C.C. Gay. (1997). Veterinary medicine. W.B. Saunders, London.

Rogers, R.J., D.R. Cook, P.J. Ketterer, F.C. Baldock, P.J. Blackall & R.W. Stewart. (1989). An evaluation of three serological tests for antibody to *Brucella suis* in pigs. Aust. Vet. J. 66(3):77–80.

Stemshorn, B.W., L.B. Forbes, M.D. Eaglesome, K.H. Nielsen, F.J. Robertson & B.S. Samagh. (1985). A comparison of standard serological tests for the diagnosis of bovine brucellosis in Canada. Can. J. Comp. Med. 49(4):391–394.

Ward, M.P., I.A. Gardner & M. Flanagan. (1995). Evaluation of an agar gel immunodiffusion test to detect infection of cattle with bluetongue viruses in Queensland, Australia. Vet. Micro. 45:27–34.

APPENDIX A – ABBREVIATIONS AND ACRONYMS

Laboratories

CAHL	Central Animal Health Laboratory MAF Quality Management Ward Street Upper Hutt New Zealand
EMAI	Elizabeth Macarthur Agricultural Institute New South Wales Agriculture Woodbridge Road Menangle New South Wales Australia
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
TFRC	Tick Fever Research Centre Queensland DPI 280 Grindle Road Wacol Queensland 4076 Australia

General

CPS	Secrétariat de la Communauté du Pacifique
FAO	Food and Agriculture Organisation of the United Nations
MAFFM	Ministry of Agriculture, Forests, Fisheries and Meteorology
OIE	Office International des Epizooties
PICT	Pacific Island Countries and Territories
SPC	Secretariat of the Pacific Community
WHO	World Health Organisation

Laboratory 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 Disease
IB	Infectious Bronchitis
IBD	Infectious Bursal Disease
IBR	Infectious Bovine Rhinotracheitis
ILT	Infectious Laryngotracheitis
JD	Johne's Disease
Lepto	Leptospirosis
MD	Marek's Disease
MVE	Murray Valley Encephalitis
ND	Newcastle Disease
PRRS	Porcine Reproductive and Respiratory Syndrome
SVD	Swine Vesicular Disease
TB	Tuberculosis
TGE	Transmissible GastroEnteritis
TS	Trichinosis / Trichinellosis

Appendix B : Diseases, laboratories and tests

Serological tests performed on Samoan livestock sera, 1997 - 1998

Species	Laboratory*	Infection*	Serological test*
Pig	CAHL	TGE	ELISA
		PRRS	ELISA
		Classical Swine Fever	ELISA
		Aujeszky's Disease	ELISA
		Trichinella spiralis	ELISA
	FVPL	Brucellosis	RBPT
	QHL	Leptospira panel	MAT
	QHA	Japanese Encephalitis	HI
			ELISA
Horse	LTDV†	Equine Infectious Anaemia	AGID
		Equine Rhinopneumonitis	CFT
		Equine Influenza A	CFT
	QHL	Leptospirosis	MAT
	QHA	Japanese Encephalitis	HI
Chicken	CAHL	Infectious Bronchitis	ELISA
		Infectious Bursal Disease	ELISA
			AGID
		Infectious Laryngotracheitis	ELISA
		Newcastle Disease	HI
		Avian Influenza	AGID
		Marek's Disease	AGID
		Avian Encephalomyelitis	AGID
Cattle	LTDV	IBR	ELISA
		Pestivirus	ELISA
		Johne's Disease	ELISA
		Anaplasmosis	CAT
		Babesiosis	IFAT
		Theileriosis	IFAT
		Bluetongue	AGID
		EBL	AGID
		Brucellosis	RBPT
	QHL	Leptospirosis	MAT
Dog	CAHL	*Brucella canis*	SAT
		Ehrlichia canis	IFAT
		Canine Distemper Virus	SNT
		Canine Parvovirus	HIT
	QHL	Leptospirosis	MAT
	QHA	Japanese Encephalitis	HI

* For explanation of abbreviations and acronyms, see Appendix A

† Equine infectious anaemia AGID performed at LTDV; the other tests carried out in Paris at l'Institut Pasteur.

APPENDIX C : PARASITES OF LIVESTOCK IN SAMOA

(Reproduced from de Rooij, 1979)

Host	Endoparasites	Ectoparasites
Cattle	*Ascaris vitulorum* *Bunostomum phlebotomum* *Cooperia sp.,* *Dictyocaulus viviparus* *Echinococcus granulosus* *Fasciola hepatica*[*] *Haemonchus contortus* *Nematodirus spathiger* *Oesophagostomum radiatum* *Paramphistomum sp.* *Setaria digitata* *Strongyloides papillosus* *Trichostrongylus sp.*	*Amblyomma cyprium* *Haemaphysalis longicornis*
Dog	*Ancylostoma caninum* *Dipylidium caninum* *Dirofilaria immitis* *Toxocara canis* *Trichuris vulpis*	*Ctenocephalides canis* *Ctenocephalides felis* *Demodex canis* *Rhipicephalus sanguineus* *Trichodectes canis*
Horse	*Oxyuris equi*	*Haemaphysalis longicornis*
Pig	*Ascaris suum* *Ascarops strongylina* *Globocephalus samoensis* *Gnathostoma hispidum* *Metastrongylus apri* *Oesophagostomum longicaudum* *Physocephalus sexalatus* *Stephanurus dentatus* *Strongyloides ransomi* *Trichuris suis*	*Amblyomma cyprium* *Haematopinus suis* *Sarcoptes scabei*
Poultry	*Acuaria spiralis* *Ascaridia galli* *Capillaria contorta* *Eimeria tenella* *Heterakis gallinarum* *Oxyspirura mansoni* *Syngamus trachea* *Tetrameres sp.*	*Cnemidocoptes mutans* *Goniocotes gallinae* *Lipeurus caponis* *Menopon gallinae*

[*] Only recorded in imported cattle; intermediate hosts not present in Samoa.

Appendix D : Serological results

Pigs

Table 1. Numbers of sera tested and numbers giving positive results in tests for antibodies to each of 7 infections of pigs in Samoa

Population	TGE†		PRRS†		Aujeszky's†		CSF†		*Trichinella*†		JE†		*Brucella*†	
	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive
Savaii Total	**56**	**0**	**56**	**0**	**56**	**27**	**56**	**0**	**56**	**10**	**54**	**0**	**56**	**0**
Herd 1 housed	8	0	8	0	8	0	8	0	8	1	8	0	8	0
Village pigs	48	0	48	0	48	27	48	0	48	9	46	0	48	0
Upolu Total	**123**	**0**	**123**	**0**	**123**	**14**	**123**	**0**	**123**	**2**	**107**	**0**	**124**	**0**
Housed Total	63	0	63	0	63	3	63	0	63	0	57	0	64	0
Herd 2	15	0	15	0	15	0	15	0	14	0	13	0	15	0
Herd 3	15	0	15	0	15	2	15	0	16	0	14	0	16	0
Herd 4	15	0	15	0	15	0	15	0	15	0	13	0	15	0
Herd 5	15	0	15	0	15	0	15	0	15	0	14	0	15	0
Village pigs	60	0	60	0	60	11	60	0	60	2	50	0	60	0
Penned	15	0	15	0	15	4	15	0	15	2	14	0	15	0
Free range	45	0	45	0	45	7	45	0	45	0	36	0	45	0
Savaii + Upolu	**179**	**0**	**179**	**0**	**179**	**41**	**179**	**0**	**179**	**12**	**161**	**0**	**180**	**0**

† See Appendix A for explanation of abbreviations

Cattle

Table 2. Numbers of sera tested and numbers giving positive results in tests for antibodies to each of 9 infections of cattle in 18 herds in Samoa

Population	EBL†		IBR†		BVD†		JD†		BTV†		*Theileria*†		*Anaplasma*†		*Babesia*†		*Brucella*†	
	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive
Savaii Total	**147***	**0**	**147***	**99**	**147***	**61**	**147***	**0**	**147***	**0**	**147***	**115**	**147***	**6**	**147***	**17**	**220**	**0**
Herd 1	20	0	20	18	20	5	20	0	20	0	20	17	20	2	20	0	21	0
Herd 2	12	0	12	8	12	2	12	0	12	0	12	10	12	1	12	0	12	0
Herd 3	18	0	18	15	18	1	18	0	18	0	18	15	18	0	18	1	18	0
Herd 4	14	0	14	10	14	14	14	0	14	0	14	11	14	1	14	8	14	0
Herd 5	20	0	20	8	20	19	20	0	20	0	20	14	20	1	20	3	22	0
Herd 6	20	0	20	9	20	1	20	0	20	0	20	11	20	0	20	3	23	0
Herd 7	20	0	20	11	20	19	20	0	20	0	20	16	20	0	20	2	34	0
Herd 8	20	0	20	17	20	0	20	0	20	0	20	18	20	1	20	0	76	0
Upolu Total	**169**	**0**	**169**	**118**	**169**	**82**	**169**	**0**	**169**	**0**	**169**	**146**	**169**	**4**	**169**	**10**	**437**	**23**
Herd 9	20	0	20	11	20	0	20	0	20	0	20	13	20	0	20	3	83	5
Herd 10	20	0	20	18	20	20	20	0	20	0	20	15	20	1	20	2	46	0
Herd 11	20	0	20	20	20	14	20	0	20	0	20	19	20	2	20	3	59	0
Herd 12	9	0	9	0	9	1	9	0	9	0	9	9	9	0	9	0	9	0
Herd 13	20	0	20	14	20	17	20	0	20	0	20	18	20	0	20	0	88	1
Herd 14	20	0	20	19	20	1	20	0	20	0	20	12	20	1	20	0	61	0
Herd 15	20	0	20	12	20	14	20	0	20	0	20	20	20	0	20	0	22	0
Herd 16	9	0	9	3	9	0	9	0	9	0	9	9	9	0	9	1	9	0
Herd 17	20	0	20	10	20	6	20	0	20	0	20	20	20	0	20	1	33	0
Herd 18	11	0	11	11	11	9	11	0	11	0	11	11	11	0	11	0	27	17
Savaii + Upolu	**316**	**0**	**316**	**217**	**316**	**143**	**316**	**0**	**316**	**0**	**316**	**261**	**316**	**10**	**316**	**27**	**657**	**23**

* Includes 3 additional animals not in herds 1 – 8

† See Appendix A for explanation of abbreviations

Poultry

Table 3. Numbers of sera tested and numbers giving positive results in tests for antibodies to each of 7 infections of poultry in Samoa

		ND†		AI†		IB†		IBD†		ILT†		AE†		MD†	
Population	**Housing**	**Total**	**Positive**	**Total**	**Positive**	**Total**	**Positive**	**Total**	**Positive**	**Total**	**Positive**	**Total**	**Positive**	**Total**	**Positive**
Savaii Total	**Free range**	**64**	**0**	**64**	**0**	**64**	**64**	**64**	**14**	**64**	**8**	**63**	**60**	**63**	**15**
Upolu Total		**145**	**0**	**145**	**0**	**145**	**138**	**145**	**33**	**145**	**8**	**144**	**85**	**144**	**67**
Housed layers	Housed	74	0	74	0	74	69	74	16	74	0	73	50	73	49
Flock 1	Caged	10	0	10	0	10	10	10	1	10	0	10	7	10	10
Flock 2	Housed*	20	0	20	0	20	19	20	9	20	0	20	17	20	9
Flock 3	Litter	23	0	23	0	23	19	23	1	23	0	22	8	22	15
Flock 4	Litter	21	0	21	0	21	21	21	5	21	0	21	18	21	15
Village chickens	Free range	71	0	71	0	71	69	71	17	71	8	71	35	71	18
Savaii + Upolu		**209**	**0**	**209**	**0**	**209**	**202**	**209**	**47**	**209**	**16**	**207**	**145**	**207**	**82**

† See Appendix A for explanation of abbreviations

* Flock 2 comprises 2 laying flocks, one caged and the other on deep litter

Cattle leptospirosis

Table 4. Numbers of sera reacting to 21 leptospiral serovars in the microscopic agglutination test, for each of 18 herds of cattle in Samoa, 1997.

Population	*pomona*	*hardjo*	*tarassovi*	*grippotyphosa*	*celledoni*	*copenhageni*	*australis*	*zanoni*	*robinsoni*	*canicola*	*kremastos*	*szwajizak*	*medanensis*	*bulgarica*	*cynopteri*	*ballum*	*bataviae*	*djasiman*	*javanica*	*panama*	*shermani*	*No. tested*	*No. positive (any serovar)*	*Apparent prevalence %*
Savaii Total	**0**	**7**	**2**	**0**	**0**	**2**	**12**	**2**	**0**	**3**	**2**	**18**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**147**	**38**	**26**
Herd 1	0	3	0	0	0	0	2	0	0	0	0	1	3	0	0	0	0	0	0	0	0	20	6	30
Herd 2	0	0	0	0	0	0	4	0	0	0	0	2	0	0	0	0	0	0	0	0	0	12	5	42
Herd 3	0	2	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	18	3	17
Herd 4	0	0	0	0	0	1	2	1	0	1	0	0	0	0	0	0	0	0	0	0	1	14	4	29
Herd 5	0	1	0	0	0	1	1	1	0	1	0	2	0	0	0	0	0	0	0	1	0	20	5	25
Herd 6	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	1	5
Herd 7	0	0	2	0	0	0	1	0	0	1	0	3	0	0	0	0	0	0	0	0	1	20	5	25
Herd 8	0	1	0	0	0	0	0	0	0	0	2	9	0	0	0	0	0	0	0	0	0	20	9	45
Upolu Total	**0**	**38**	**12**	**0**	**0**	**0**	**20**	**3**	**1**	**2**	**2**	**44**	**26**	**0**	**0**	**0**	**2**	**0**	**1**	**2**	**10**	**169**	**87**	**51**
Herd 9	0	11	2	0	0	0	0	0	0	0	1	10	5	0	0	0	0	0	0	0	2	20	12	60
Herd 10	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	20	4	20
Herd 11	0	5	0	0	0	0	4	2	1	1	0	6	3	0	0	0	0	0	1	0	0	20	9	45
Herd 12	0	7	0	0	0	0	0	0	0	0	0	9	6	0	0	0	0	0	0	0	0	9	9	100
Herd 13	0	0	2	0	0	0	8	1	0	0	0	2	0	0	0	0	0	0	0	0	2	20	13	65
Herd 14	0	8	1	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	1	1	20	9	45
Herd 15	0	5	6	0	0	0	0	0	0	1	0	5	6	0	0	0	2	0	0	0	5	20	15	75
Herd 16	0	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	1	0	9	5	56
Herd 17	0	2	0	0	0	0	5	0	0	0	0	2	2	0	0	0	0	0	0	0	0	20	8	40
Herd 18	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	11	3	27
Savaii + Upolu	**0**	**45**	**14**	**0**	**0**	**2**	**32**	**5**	**1**	**5**	**4**	**62**	**30**	**0**	**0**	**0**	**2**	**0**	**1**	**3**	**12**	**316**	**125**	**40**

Pig leptospirosis

Table 5. Numbers of sera reacting to 21 leptospiral serovars in the microscopic agglutination test; village and commercial pigs in Samoa, 1997.

Population	*pomona*	*hardjo*	*tarassovi*	*grippotyphosa*	*celledoni*	*copenhageni*	*australis*	*zanoni*	*robinsoni*	*canicola*	*kremastos*	*szwajizak*	*medanensis*	*bulgarica*	*cynopteri*	*ballum*	*bataviae*	*djasiman*	*javanica*	*panama*	*shermani*	*No. tested*	*No. positive (any serovar)*	*Apparent prevalence %*
Savaii Total	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**13**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**54**	**15**	**28**
Herd 1 housed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
Village pigs	0	0	0	0	0	0	4	0	0	0	0	13	3	0	0	0	0	0	0	0	0	46	15	33
Upolu Total	**0**	**1**	**1**	**0**	**0**	**7**	**5**	**7**	**0**	**5**	**0**	**8**	**1**	**0**	**3**	**1**	**2**	**1**	**0**	**0**	**0**	**107**	**22**	**21**
Housed Total	0	0	0	0	0	5	1	2	0	2	0	2	0	0	2	0	1	0	0	0	0	57	10	18
Herd 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0
Herd 3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	14	1	7
Herd 4	0	0	0	0	0	4	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	13	6	46
Herd 5	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	14	2	14
Village pigs	0	1	1	0	0	2	4	5	0	3	0	6	1	0	1	1	1	1	0	0	0	50	12	24
Penned	0	1	1	0	0	1	2	2	0	2	0	2	1	0	1	1	1	1	0	0	0	14	5	36
Free range	0	0	0	0	0	1	2	3	0	1	0	4	0	0	0	0	0	0	0	0	3	6	7	19
Savaii + Upolu	**0**	**1**	**1**	**0**	**0**	**7**	**9**	**7**	**0**	**5**	**0**	**21**	**4**	**0**	**3**	**1**	**2**	**1**	**0**	**0**	**0**	**161**	**37**	**23**

Horse leptospirosis

Table 6. Numbers of sera reacting to 21 leptospiral serovars in the microscopic agglutination test, for 63 horses in Samoa, 1997.

Population	*pomona*	*hardjo*	*tarassovi*	*grippotyphosa*	*celledoni*	*copenhageni*	*australis*	*zanoni*	*robinsoni*	*canicola*	*kremastos*	*szwajizak*	*medanensis*	*bulgarica*	*cynopteri*	*ballum*	*bataviae*	*djasiman*	*javanica*	*panama*	*shermani*	*No. tested*	*No .positive (any serovar)*	*Apparent prevalence %*
Savaii	2	0	0	0	0	6	0	1	0	3	0	4	0	0	1	0	1	0	0	0	0	38	13	34
Upolu	1	5	0	0	0	6	1	1	0	7	1	2	0	0	0	0	0	0	1	1	0	25	15	60
All : Savaii and Upolu	**3**	**5**	**0**	**0**	**0**	**12**	**1**	**2**	**0**	**10**	**1**	**6**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**63**	**28**	**44**