DISTRIBUTION AND ALTERNATIVE HOSTS OF TARO BACILLIFORM BADNAVIRUS IN SAMOA

Macanawai A.R.[1], Ebenebe A.A.[2], Hunter D.[3], Harding R.[4]

ABSTRACT

The distribution and alternate hosts of Taro bacilliform badnavirus was investigated through field surveys for infected taro plants on Upolu and Savaii islands in Samoa during 2001. Investigations into alternative hosts were carried out through field surveys for symptoms of infection on non-taro plants growing within or around taro farms on Upolu Island. In both cases, and in addition to visual observation for symptoms of infection by the virus, plant specimens were collected and subjected to PCR-based diagnostic tests for the virus. Results for the distribution of Taro bacilliform virus revealed that the virus occurs on both Upolu and Savaii Islands. The findings further showed that the virus is presently more widespread than was found by an earlier investigator. Alternative host studies revealed that Xanthosoma sp., Alocasia macrorrhiza, and Commelina benghalensis are natural hosts of the virus.

Key words: *Alocasia macrorrhiza,* alternative host, *Commelina benghalensis*, geographical distribution, Samoa, *Taro bacilliform virus, Xanthosoma* sp.

INTRODUCTION

Taro bacilliform badnavirus (TaBV) infects taro, causing slight stunting, chlorosis of marginal leaf veins, and downward curling of leaf blades (Yang *et al.* 2003). The virus is transmitted by mealybugs (Gollifer *et al.* 1977). Findings of recent investigations by the present authors have revealed that the virus is also seed- and pollen-transmitted (Macanawai *et al.* in press, 2005). According to Brunt *et al.* (1990), Taro (*Colocasia esculenta* L.) is the natural host of TaBV. There is no information in the literature to suggest that infection by TaBV alone has significant effect on the yield of taro. However, the virus is viewed as an important quarantine pest (Zettler *et al.* 1989), as concurrent infection of taro plants by TaBV and Colocasia bobone disease virus (CBDV) leads to the lethal 'alomae' disease complex (James *et al.* 1973; Rodoni 1995), severe cases of which can result in total crop loss (Jackson 1980; Onwueme 1999). Alomae disease is present in Papua New Guinea and the Solomon Islands (Gollifer *et al.* 1977; Jackson 1980).

TaBV was first reported in C. esculenta from the Solomon Islands (Kenten and Woods 1973). It has since been recorded, also in taro, in several pacific island countries; including Papua New Guinea, Fiji, Vanuatu (Gollifer *et al.* 1977), and Samoa (Jackson 1979).

In Samoa, TaBV was first recorded in 1978 (Jackson 1979), but during a survey that Jackson conducted on Upolu and Savaii islands in 1979, he found the virus only on Upolu Island, and only at one location at Tanumalala village, about 32 km south-west of Apia (Jackson 1979).

The first objective of the present investigation was to review the status of the geographical distribution of TaBV in taro in Samoa. The second objective was to determine whether TaBV has alternate and natural hosts in Samoa. Alternative hosts are important in the epidemiology of several plant diseases. For instance, weeds may act as reservoirs of pathogens (Duffus 1971; Aftab *et al.* 2001). Therefore, the identification of alternative hosts would facilitate the development of more effective disease management strategies.

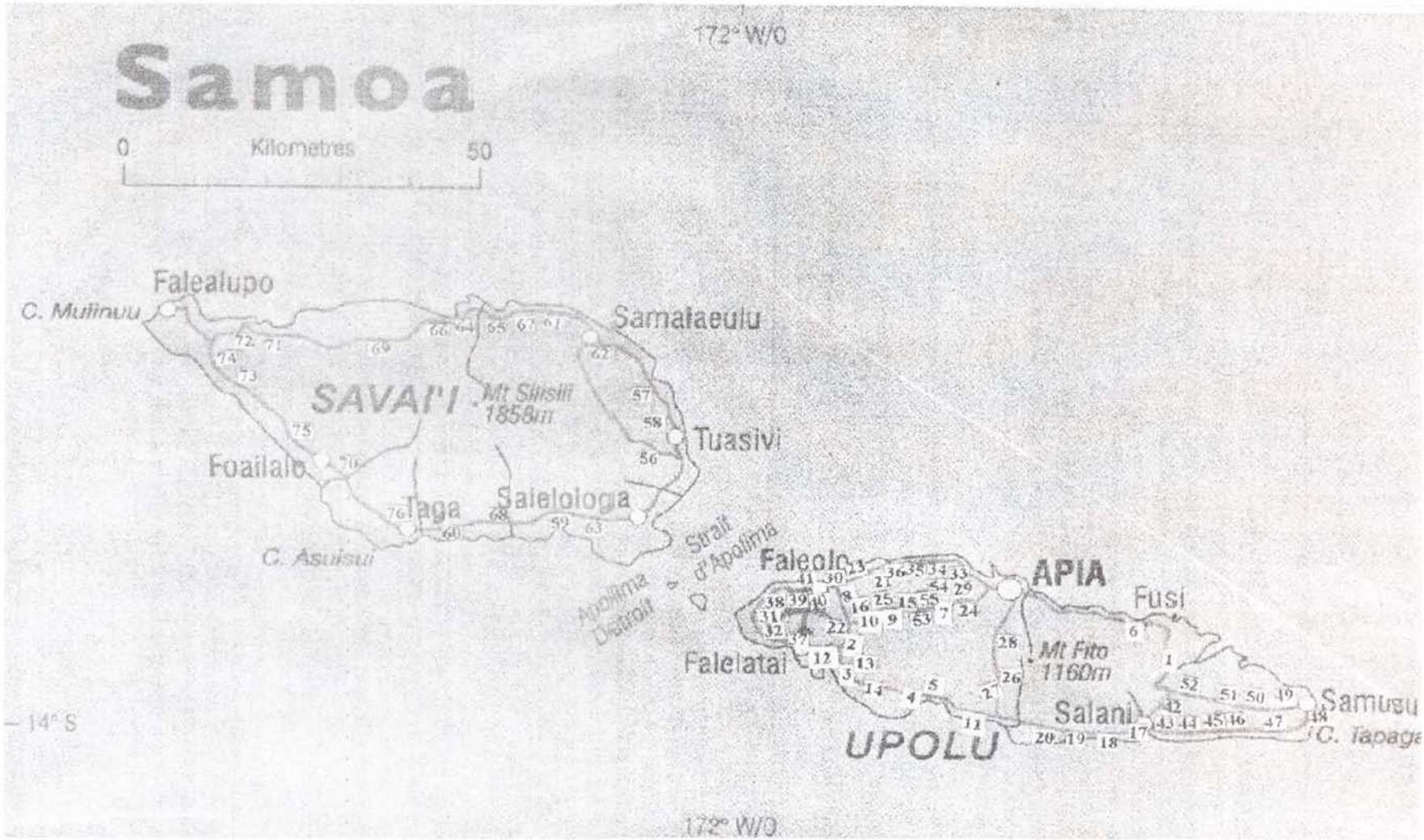
MATERIALS AND METHODS

Surveys for distribution of TaBV

Seventy-six taro farms (55 farms in 41 villages on Upolu Island and 21 farms in 21 villages on Savaii Island) were surveyed during 2001 (Fig. 1). Taro plots carrying three to four month old plants, mainly variety 'PSB-G2' (Philippine Seedboard-Gabbi 2), were selected at random and visually examined for plants exhibiting

[1]Plant Protection Section, Koronivia Research Station, Nausori, Fiji Islands.
[2]The University of the South Pacific, School of Agriculture, Alafua Campus, Samoa.
[3]Secretariat of the Pacific Community, Suva, Fiji.
[4]Plant Biotechnology Program, Science Research Centre, Queensland University of Technology, GPO Box 2434, Brisbane, 4001, Australia. Corresponding author e-mail: ebenebe_ad@samoa.usp.ac.fj

Fig. 1. **Map of Samoa showing numbered locations of taro farms surveyed for *Taro bacilliform virus* during 2001. (Source: Map adapted from Anonymous, 1997).**



symptoms of infection by TaBV. Between 75 and 500 randomly selected plants per plot were examined. Other taro cultivars ('Niue', 'Palau 4', 'Palau 10', 'Palau 20' and 'Pwetepwet'), which were present in the survey areas, were also sampled for TaBV symptoms. After visual examination, a 6 cm x 6 cm leaf section was removed for laboratory analysis from each plant that showed symptoms of infection. The leaf sections were cut into thin strips, dried under silica gel, and sent to Queensland University of Technology (QUT), Brisbane, Australia, where they were tested for TaBV by polymerase chain reaction (PCR) tests.

On Savaii Island, no taro plants showing symptoms were encountered during the survey. However, leaf specimens for diagnostic tests were randomly collected from symptomless taro plants.

Surveys for alternative hosts of TaBV

This investigation on alternate hosts of TaBV was conducted during 2001 on Upolu Island, around the villages of Falesiu-uta and Falesiu. Non-taro plants, such as small weeds, shrubs/trees, and crop plants, which were growing within or bordering each of six farms that were known to carry TaBV-infected taro plants (variety 'PSB-G2'), were visually examined for TaBV-like symptoms. In addition to visual examination, one to three youngest expanded leaves were collected from each species for laboratory analysis for TaBV, irrespective of whether the plants displayed symptoms of virus infection or not. Leaf samples were then prepared as described above for taro leaves, and sent to QUT for PCR analysis for the presence of TaBV.

RESULTS

Distribution of TaBV

Taro plants with TaBV-like symptoms were recorded on eight farms in four villages on Upolu Island (Table 1). Five of the eight farms were located around Falesiu-uta village, where the cultivars 'PSB-G2', 'Palau 4', Palau 20' and 'Pwetpwet', manifested the symptoms. In addition to 'PSB-G2', cultivar 'Palau 10' was found with TaBV-like symptoms in the village of Falesiu. Other observations of TaBV symptomatic plants were from Nuu and Manono on cultivar 'PSB-G2'. In all cases, leaf specimens from all symptomatic plants tested TaBV-positive by PCR-based tests.

No TaBV symptomatic taro plants were observed on any of the farms surveyed on Savaii Island. However, the virus was diagnosed by PCR tests in symptomless specimens collected from Paia village (cultivar 'PSB-G2') and Aopo village (cultivar 'Niue').

Alternative hosts of TaBV

Thirty-five plant species belonging to eighteen families were sampled and tested for TaBV. Of these, TaBV-like symptoms were observed on benghal dayflower (Commelina benghalensis L.), tannia (Xanthosoma sagittifolium (L.) Schott), and giant taro (Alocasia macrorrhiza Linnaeus). PCR tests confirmed all the symptomatic plants as TaBV-positive (Table 2).

DISCUSSION

The present study has recorded, for the first time, the occurrence of Taro bacilliform virus in the Samoan island of Savaii. In terms of overall distribution in Samoa, the investigation revealed that TaBV occurs in more locations than was observed in a 1979 survey by Jackson (1979). Furthermore, the detection of TaBV in symptomless taro plants from Savaii suggests the occurrence of latent infections. Yang *et al.* (2003) have indicated that many infections of TaBV appear to be latent. This suggests that the virus may be occurring in more areas than was recorded in the present study, especially on Upolu Island where specimens were collected only from symptomatic plants.

TaBV is a quarantine pest (Zettler *et al.* (1989), even though infection by the virus alone is not known to cause any significant yield loss in taro. Nevertheless, the virus could become extremely important because the lethal 'alomae' disease is thought to be caused by concurrent infection of taro by CBDV and TaBV (James *et al.* 1973; Rodoni 1995). Therefore, the presence and apparent increase in geographical spread of TaBV in Samoa constitutes a risk of alomae attack in this country. At present, CBDV has not yet been detected in Samoa, and efforts must be made to keep it away. Furthermore, precautions should be taken to curb further spread of TaBV within the country.

The presence of TaBV in C. benghalensis, A. macrorrhiza and X. sagittifolium in the field shows that the natural host range of this virus is not restricted to C. esculenta, as suggested by Brunt *et al.* (1990). This finding suggests that these, and possibly other non-taro plants may be potential reservoirs for the virus in the natural cropping environment. This information could be of significance in the management of TaBV.

ACKNOWLEDGEMENTS

We acknowledge the Australian Centre for International Agricultural Research (ACIAR) for funding the research, The University of the South Pacific's School of

Table 1. **Results from survey of taro farms for geographical distribution of Taro bacilliform virus (TaBV) in Samoa during 2001.**

Locations of taro farms surveyed on Upolu Island (villages)	Status of TaBV	Locations of taro farms surveyed on Upolu Island (villages)	Status of TaBV	Locations of taro farms surveyed on Savaii Island (villages)	Status of TaBV
Falevao (1)*	-	Valuu-tai (30)	-	Fusi (56)	-
Gagaifo (3)	-	Manono (31)	+	Asaga (57)	-
Saanapu (4, 14)	-	Siufaga (32)	-	Saasaai (58)	-
Lotofaga (5, 43, 52)	-	Vaitele-uta (33)	-	Palauli (59)	-
Fusi (6)	-	Puipa'a (34)	-	Gataivai (60)	-
Aleisa (7)	-	Afega (35, 45)	-	Safai (61)	-
Leulumoega (8, 16)	-	Saleimoalevi (36)	-	Samalaeulu (62)	-
Tanumalala (2, 10, 22)	-	Felelatai (37)	-	Salelologa (63)	-
		Manono-uta (38)	-	Sasina (64)	-
Tafitoala (11)	-	Satui Malufilufi (39)	-	Paia (65)	+
Safaatoa (12)	-	Fuaiolo'o (40)	-	Letui (66)	-
Tafagamanu (13)	-	Satapuala (41)	-	Avao (67)	-
Faleasiu-uta (9, 15, 25, 53, 55)	+	Lotofaga-uta (42)	-	Satufia-uta (68)	-
		Vavau (44)	-	Aopo (69)	+
Salani-tupai (17)	-	Saleapaga (46)	-	Salailua (70)	-
Vaovai (18)	-	Lalomanu (47)	-	Vaisala (71)	-
Saleilua (19)	-	Mutialele (48)	-	Papa (72)	-
Siumu (20, 26, 27)	-	Samusu-uta (49)	-	Falelima (73)	-
Siusega (24, 29)		Tiavea-uta (50)	-	Neiafu-uta (74)	-
Faleasiu (21)	+	Afulilo (51)	-	Samatau (75)	-
Nofoalii (23)	-	Nuu (54)	+	Taga (76)	-
Vailima (28)	-				

+ TaBV detected; - TaBV not detected

* Numbers in parenthesis represent the location of each farm surveyed in each village as shown in Fig. 1

Agriculture at Alafua Campus in Samoa, for providing research facilities, and the Ministry of Agriculture, Forests, Fisheries & Meteorology, Samoa, for providing support with the field surveys. We also thank Samoa taro farmers for allowing their farms to be surveyed, as well as Dr. G. Hafner and Mr. L. Devitt of QUT, for PCR-based diagnostic tests.

Table 2. **Result of field survey for alternative hosts of Taro bacilliform virus (TaBV) in Samoa.**

Scientific name	Common name	Virus-like symptom observed	TaBV status
Bidens pilosa	Spanish needle	Interveinal chlorosis	-
Hyptis pectinata	Comb bushmint	None	-
Mikania micrantha	Mile-a-minute	Interveinal chlorosis	-
Ageratum conyzoides	Goat weed	None	-
Emilia sonchifolia	Consumption weed	None	-
Crassocephalum crepidioides	Thick head	Interveinal chlorosis	-
Eleutheranthera ruderalis	Ogiera	Interveinal chlorosis	-
Synedrella nodiflora	Cinderella weed	Interveinal chlorosis	-
Paspalum conjugatum	Sour grass	None	-
Digitaria ciliaris	Bamboo grass	None	-
Digitaria setigera	Bristly crabgrass	Leaf chlorosis	-
Lantana camara	Lantana	Interveinal chlorosis	-
Cassia tora	Wild peanut	None	-
Stachytarpheta urticifolia	Blue rat's tail	None	-
Euphorbia hirta	Garden spurge	None	-
Phyllanthus amarus	Carry me seed	Interveinal chlorosis	-
Spermacoce assurgens	White broomweed	None	-
Oxalis barrellieri	Barrelier's woodsorrel	Interveinal chlorosis	-
Peperomia pellucida	Shiny bush	None	-
Alocasia macrorrhiza	Giant taro	Chlorosis of marginal veins	+
Xanthosoma sagittifolium	Tannia	Chlorosis of marginal veins	+
Momordica charantia	Bitter gourd	Interveinal chlorosis	-
Solanum nigrum	Black nightshade	None	-
Physalis angulata	Wild cape gooseberry	None	-
Cyperus rotundus	Nutgrass	None	-
Commelina benghalensis	Benghal dayflower	Leaf chlorosis	+
Passiflora foetida	Stinking passionflower	Interveinal chlorosis	-
Spathodea campanulata	African tulip tree	Interveinal chlorosis	-
Castilla elastica	Mexican rubber tree	Leaf chlorosis	-
Ficus elastica	Indian rubber tree	Leaf chlorosis	-
Macaranga harveyana	*Macaranga	None	-
Flueggea flexuosa	*Flueggea	Leaf chlorosis	-
Derris malaccensis	New Guinea creeper	None	-
Erythrina indica	Coral tree	None	-
Musa sapientum	Banana	Veinal chlorosis	-

+ TaBV-positive, - TaBV-negative, * No English common names available

REFERENCES

AFTAB, M.; FREEMAN, A. and MOERKERK, M. (2001). New records of weeds as alternative hosts for a number of common legume viruses and the role of weeds in pulse virus epidemiology and spread. pp. 148. In: Proceedings of the 13th Biennial Australasian Plant Pathology Society conference, Cairns-Australia, 24-27 September 2001.

ANONYMOUS (1997). The Pacific Island. AusAID and Pacific Community, Noumea, New Caledonia.

BRUNT, A.A.; CRABTREE, K. and GIBBS, A. (1990). Viruses of tropical plants. CAB International. Redwood Press. 707 pp.

DUFFUS, J.E. (1971). Role of weeds in the incidence of virus diseases. Annual Review of Phytopathology 5: 319-340.

GOLLIFER, D.E.; JACKSON, G.V.H.; DABEK, A.J; PLUMB, R.T. and MAY, Y.Y. (1977). The occurrence and transmission of viruses of edible aroids in the Solomon Islands and the South West Pacific. Pest Articles and News Summaries 23 (2): 171-177.

JACKSON, G.V.H. (1979). Taro virus diseases in W. Samoa. Report: South Pacific Commission. Agdex 171/637. 20 pp.

JACKSON, G.V.H. (1980). Diseases and pests of taro. South Pacific Commission. 50 pp.

JAMES, M.; KENTEN, R.H. and WOODS, R.D. (1973). Virus-like particles associated with two diseases of Colocasia esculenta (L.) Schott in the British Solomon Islands. Journal of General Virology 21: 145-155.

KENTEN, R.H. and WOODS, R.D. (1973). Viruses of Colocasia esculenta and Xanthosoma saggitifolium. Pest Articles and News Summaries 19: 38-41.

MACANAWAI, A.R., EBENEBE, A.A., HUNTER, D., HARDING, R. (2005, in press ... "Title of paper" ... *Australian Plant Pathology* ..... vol..... etc.

ONWUEME, I. (1999). Taro Cultivation in Asia and the Pacific. FAO RAP publication: 1999/16.

RODONI, B.C (1995). Alomae disease of taro. ACIAR Research Notes No. 15 12/95.

YANG, I.C., HAFNER, G.J., REVILL, P.A., DALE, J.L. and HARDING, R.M. (2003). Sequence diversity of South Pacific isolates of Taro bacilliform virus and the development of a PCR-based diagnostic test. Archives of Virology 148, 1957-1968.

ZETTLER, F.W., JACKSON, G.V.H. and FRISON, E.A. (eds.) (1989). FAO/IBPGR Technical Guidelines for the Safe Movement of Edible Aroid Germplasm. Food and Agriculture Organization of the United Nations, Rome/International Board for Plant Genetic Resources, Rome.