Abundance and distribution of West Indian sweet potato weevil, *Euscepes batatae* (Waterhouse) (Coleoptera: Curculionidae), in Samoa

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ABSTRACT

Surveys were conducted in the two main islands of Upolu and Savaii to determine the distribution and document the abundance of West Indian sweet potato weevil at different topographic areas in Samoa. A total of 28 farm localities were surveyed in August and October, 2016. Farm types, agronomic practices and farmer knowledge of the weevil were determined. About eighty percent of farmers were not aware of the presence of *E. batatae* because of the lack of interest in sweet potato cultivation. Those that were aware of *E. batatae* commonly observed this pest in vines and rarely in tubers. It was also discovered that *E. batatae* was present in all levels of topography but inland areas had a higher weevil population as compared to coastal and highland areas. This indicates the influence of altitude on weevil population; lower altitudes have warm temperatures which are suitable for weevil population growth. Furthermore, this survey was carried out during the dry season and most sweet potato plants thrive in such periods compared to the wet season. Information gathered from this study would enable agricultural extension officers and farmers to become aware of the presence of *E. batatae* and to initiate control measures for it, if necessary.

KEY WORDS: *Euscepes batatae*, West Indian sweet potato weevil, Abundance and distribution, Sweet potato

INTRODUCTION

About 75 % of Samoa's main land use is under agricultural crop production and of the 21, 798 major crop producing households, only 800 of them produce sweet potatoes (Samoa Agricultural Census, 2015). This is an indication of sweet potato's status as a subsistence crop and constraints to its production. Of importance is the absence of local and overseas markets, lack of high-yielding varieties, little or no farm inputs, inadequate agronomic practices and infestation of pests and diseases. Introduced and local varieties found in Samoa are available from the Centre for Pacific Crops and Trees (CePacT), Pacific Community (SPC) in Fiji and the Institute for Research and Extension in Tropical Agriculture (IRETA), Samoa. There is no written evidence of how long sweet potatoes have been in Samoa except for a series of contradicting theories reported by Woolfe (1992). Nevertheless, sweet potato has been in the country for many years and farmers are slowly

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diversifying their crop production due to climatic, nutritional and health conditions.

Unfortunately, there are important constraints associated with sweet potato production most importantly pests and diseases that have been reported from Fiji (Singh, 2004) and Tonga (Pole, 1988). The first major constraint reported from Fiji is leaf scab (*Elsinoe batatas*) a foliar disease caused by a fungus common in Fiji and other Pacific island countries which causes distortion in leaves and growing tips and evidently could lead to plant death. To reduce this constraint, it is advised to collect 30 cm vine tip cuttings for planting materials though if farmers cannot find vines without signs of leaf scab use fungicide to treat vine tips before planting.

The second major constraint and this is also a worldwide problem is sweet potato weevils (Chalfant *et al.*, 1990). There are two species of weevils attacking, sweet potato weevil *Cylas formicarius* (Fabricius) (Coleoptera: Curculionidae) which is more widely distributed and most damaging of the two, and West Indian sweet potato weevil *Euscepes batatae* (Waterhouse) (Coleoptera: Curculionidae) which is localised in the Pacific, some parts of Asia and America (Jackson, 2015). Both *E. batatae* and *C. formicarius* are reported in Samoa but only the latter species has been found in sweet potato farms (Jatala &Raman, 1988; Furlong *et al.*, 2015). The negative impact of sweet potato weevil is a major problem because it is not restricted to the field but also in storage sites. Weevil feeding causes sweet potatoes to produce chemicals (known as terpenes), which have an unpleasant odour and bitter taste making them unfit for human consumption (Mohamed, 2005). An estimated 60-100% production loss is caused by weevil infestations (Beyene, 2015). In PNG, yield losses of 51% stem and 34% tubers were observed in areas of low above-ground weevil incidence (Powell *et al.*, 2001).

There is limited literature on the incidence of sweet potato weevils in Samoa although Raman &Allyne (1991) have reported the distribution of this pest in the Carribean and the Pacific including Samoa. Some sources reported the presence of both *E. batatae* and *C. formicarius* in Samoa. Other reports from unpublished in Samoa works have found *Euscepes batatae* in sweet potato plots and in pheromone traps that were used to bait the more destructive counterpart *C. formicarius.* Evidently, information on the distribution of both weevils could have been misinterpreted by non-weevil specialists who reported both weevils in Samoa although only *E. batatae* has been reliably identified (Pole, 1988; Raman &Allyne, 1991).

This paper documented the abundance and distribution of the West Indian sweet potato weevil in Samoa through a farm field survey to (1) assess the abundance of *E. batatae* at different farm locations in Upolu and Savaii and (2) identify the life stages of *E. batatae* found within vines and tubers of sweet potato in Upolu and Savaii

MATERIALS AND METHODS

Study location

This study was carried out on both islands of Upolu and Savaii based on the list of sweet potato farmers provided by the Ministry of Agriculture and Fisheries (MAF) Crop Division at Nu'u. The 28 farms in both islands surveyed were located in 22 different villages.

The survey was carried out in Upolu shown in Figure 1 from August 23rd – August 25th, 2016. During these days the average temperature ranged between 26 – 32 °C with periods of heavy rainfall towards later in the afternoon. A total of nine farms were surveyed on the island of Savaii shown in Figure 2 and during the survey the average temperature ranged between 28 – 32 °C

(Fig. 2). The survey was done from the 26th until 27th October, 2016.

Figure 1: Locations of 13 villages surveyed during sweet potato weevil survey in Upolu, Samoa indicated by yellow ribbons. Source: http://www.google.com/earth/

Figure 2: Village locations where a total of 9 sweet potato weevil survey locations are found in Savaii, Samoa indicated by yellow ribbons. Source: http://www.google.com/earth/.

Survey questionnaire parameters

Questionnaires were used to gather information from farmers. The survey comprised questions of farm types, agronomic practices, duration of sweet potato cultivation, crop loss caused by the weevil and any method of control employed.

Data collected

At each farm, 10 percent of the entire sweet potato plot was sampled by collecting vines of about 80 cm long. Difficulties in tracing the main crown resulted in vine samples being cut and collected from different regions of the plot both in the interior and at the borders. Clear plastic bags were used to collect vine samples that were kept in an ice cooler to maintain sample freshness. Samples were then transported back to the laboratory for weevil observation and counting to obtain the following information:

1. Variety or type grown, number of varieties grown, age of plant and period of cultivation from when the sweet potatoes were obtained, damage of weevil, method of control and purpose of sweet potato cultivation
2. Number of *E. batatae* larva, pupa and adult found in vines

RESULTS

Farmers' insight on sweet potato farming and on *E. batatae*

In Table 1, several of the farmers interviewed had little or no knowledge of *E. batatae* nor observed this pest in their sweet potato gardens. The 17 % of farmers that were aware of the presence of the West Indian sweet potato weevil reported it in vines and sometimes tubers. However, observing damage mostly in the vines raised no concerns to farmers hence no control methods were used in any of the farm localities. Additionally, no reports of how much damage the weevils caused to vines or tubers were recorded in this survey. In Upolu, 63% of farms had only been growing sweet potatoes for 4 years, 26 % for a period of 5 – 10 years and the rest had been cultivating it for over 10 years. Similarly, in Savaii 67 % of farms had only grown sweet potatoes for 4 years and less, 22 % from 5 – 10 years and 11 % for more than 10 years. Despite having grown sweet potatoes for many years, more than half of the farmers depended on sweet potatoes for subsistence purposes only and not for sale.

Furthermore, the vast majority of farms were under mixed cropping cultivation with major staple crops such as taro, bananas, yam and vegetables. Due to high market demand for taro, yam, banana, coconut and vegetables, most of the farmers' times were devoted to managing those crops rather than sweet potato gardens. This was evident in some farms where sweet potatoes were

wildly growing below other crops and among weeds. Similarly, in other localities very small land areas approximately 2 m^2 were attributed to sweet potato gardens.

Table 1. Summary of farmer's insight on sweet potato farming and *Euscepes batatae* in Upolu and Savaii.

Island	No of Farms	Years Grown			Pest Knowledge		Control Method		Variety	
		<5	5 to 10	>10	Yes	No	No	Yes	Known	Unknown
Upolu	19	12	5	2	3	16	19	0	2	17
(%)		63	26	11	16	84	100	0	11	89
Savaii	9	6	2	1	1	8	9	0	3	6
(%)		67	22	11	11	89	100	0	33	67
Total	28	18	7	3	4	24	28	0	5	23
(%)		65	24	11	14	86	100	0	22	78

Furthermore, about 80% of farmers had very limited knowledge on the type and origin of sweet potato cultivars that were sampled. Based on the data collected, all weevils were found in vines. There were evidences to show the effect of weevil damage to vines on the yield since majority of farms were either in the early stages of planting or later stages of post-harvest. Comprehensively, there were more sweet potato growers in Upolu than in Savaii.

Distribution and abundance of *Euscepes batatae* in sweet potato farms

The morphological features of *Euscepes batatae* larva, pupa and adult distinguished it from other sweet potato weevil species such as *Cylas formicarius,* which has no record of being present in Samoa, and the ginger weevil, *Elytroteinus geophilus*. Based on the elevation data collected, a topographic scale was constructed into three different areas measured above sea level (ASL) in metres namely, coastal (elevation 0 – 125 m, inland (elevation 126 – 255 m) and highlands (elevation > 256 m). This survey revealed that *E. batatae* was distributed more in inland areas than in coastal areas and highlands for both Upolu and Savaii Islands as shown in Table 2.

Another larger weevil species, ginger weevil (*Elytroteinus geophilus)* as shown in Figure 3, was also present in some vines but was easily distinguished from *E. batatae* by its large size and was not recorded in the data collected and tabulated. The larva of *E. batatae* was easily identified from *Cylas formicarius* and *Elytroteinus geophilus* following the identification guide outlined by Reid (2015). On the other hand, differentiating between *E. batatae* pupa and adult from the other two weevil species was much simpler since *C. formicarius* physically appeared different while *E. geophilus* was extremely larger in size.

Table 2. Population of *Euscepes batatae* at different elevation/locations in Samoa.

Island	Location	Elevation (metres)	Larvae	Pupae	Adults	Total
Upolu	Coastal	0 - 125	10.8	2.2	0.4	13.4
	Inland	126 - 255	33.0	5.0	0	38.0
	Highland	> 255	9.0	2.9	0.3	12.1
Savaii	Coastal	0 - 125	1.0	0.9	0.7	2.6
	Inland	126 - 255	1.0	0.5	4.5	6.0

Moreover, Samoa's agricultural land areas could be classified into four different groups, namely AUA (Apia Urban Area), NWU (North West Upolu), ROU (Rest of Upolu) and SAVAII (Savaii Island). This classification is based on population densities in the respective areas. Using this information in relation to the average number of *E. batatae* weevils collected, more weevils were distributed in North Western Upolu (10 sweet potato farms) followed by Apia Urban Areas (5 sweet potato farms), Rest of Upolu (4 sweet potato farms) and Savaii (9 sweet potato farms) presented in Table 3.

Table 3. Distribution of *Euscepes batatae* in four population dense groups in Upolu and Savaii Islands.

Island	Group	Larvae	Pupae	Adult	Total	Average
Upolu	AUA	10.4	2.8	0	13.2	4.4
Upolu	NWU	13.8	2.7	0.3	16.8	5.6
Upolu	ROU	6.3	2.0	0.8	9.0	3.0
Savaii	SAVAII	1.0	0.8	1.6	3.3	1.1

Presence of *Euscepes batatae* in different sweet potato varieties

Although inadequate information was collected on the varieties of sweet potatoes in which weevils were collected, data were tabulated against flesh colour and a few known varieties to emphasise any varietal preference shown in Table 4. It appears that the IB-PH-03 and purple flesh-coloured varieties were more susceptible to *E. batatae* attack compared to red and white flesh-coloured cultivars. The white-flesh sweet potato appeared more resistant to weevil feeding. However, in one village of Sasina in Savaii tubers were found damaged due to weevil feeding by both larvae of *E. batatae* and *Elytroteinus geophylis*.

Table 4. Varietal preference of *Euscepes batatae* based on flesh colour of sweet potato.

Variety/Flesh Colour	Larvae	Pupae	Adult	Total
IB-PH-03/Orange	18.0	8.0	0	26.0
IB-PNG-45/White	0	0	0	0
IB-PNG-37/White	0	1.0	3.0	4.0
IB-PNG-44/White	1.0	0	0	1.0
IB-PNG-7/White	1.0	0	0	1.0
Purple	17.0	3.9	0.4	21.3
Red	4.2	1.6	0.6	6.4
White	5.8	1.1	1.0	8.0

Life stages of *E. batatae* in tubers and vines of sweet potato

Results show that the most common life stage of *E. batatae* found in vines and tubers of sweet potatoes was the larval stage. This holds true for Upolu but in Savaii, the adult stage was slightly more than the larval stage as shown in Figure 4.

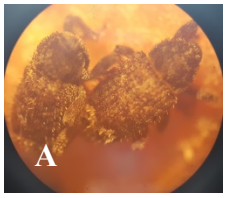
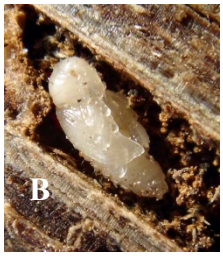
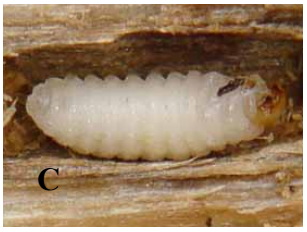
Weevil	Adult	Pupa	Larva
Euscepes batatae			
Cylas formicarius			
Elytroteinus geophilus			

Figure 3: Comparison of the adults, pupae and larvae of three sweet potato weevils (Image A taken by author, B & C source: http://www.boujo.net, D adapted from Vasquez (1990), E & H adapted from Reid (2010), F source: http://www.unwins.co.uk/nemasys-vine-we.

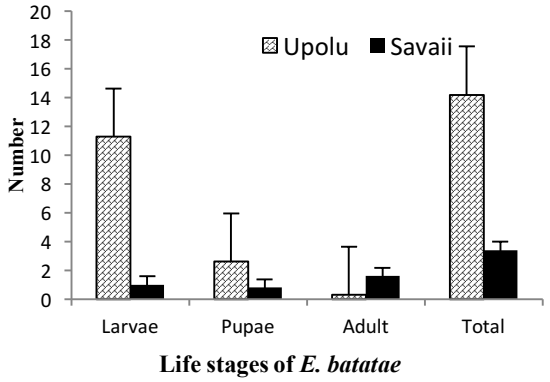


Figure 4: Abundance (±SE) of *Euscepes batatae* larval, pupal and adult stages in vines of sweet potatoes in Upolu and Savaii.

DISCUSSION

The findings of this study proved that the West Indian sweet potato weevil, *Euscepes batatae,* is present in Upolu and Savaii. However, its population was unevenly distributed between the two islands with more weevils found in Upolu than in Savaii. This is mainly attributed to the lower number of sweet potato growers in Savaii as compared to Upolu. Additionally, farmers were more interested in growing other staple crops such as taro, banana and breadfruit rather than sweet potato thus reducing host population for the weevils to multiply and expand. This reason also explains the lack of knowledge and awareness of farmers on the presence and impact of the sweet potato weevil in sweet potato gardens.

Moreover, the study showed that the population of *E. batatae* was higher in inland areas compared to coastal and highlands in both Upolu and Savaii. This suggests that almost all active agricultural lands are found in inland areas (Samoa Agricultural Census, 2015). Several researchers have found that weevil population is influenced by altitude. For instance, India experienced large weevil populations at high altitudes whereas in other countries, low altitudes (up to 1814 m ASL) recorded the highest number of weevils (Hue &Low, 2015). Furthermore, it has been reported that *E. batatae* is collected mainly at elevations less than 200 m above sea level (Bonfils &Bart, 1950). The latter holds true for Samoa where coastal and inland areas (0 – 215 m above sea level) had more weevils than highland areas. Adding on, weevil population was also affected by seasonal change where weevils prefer dry season over wet season. The survey was carried during the dry months of August and October but very few farms in Savaii had *E. batatae.* The incidence of infestation at these places could perhaps be linked to other factors such as the variety of sweet potato, time and method of planting and management of sweet potato gardens.

The survey tried to establish a link between variety and weevil incidence but there were limited records of the different varieties grown in Samoa. Nevertheless, the data were tabulated based on flesh colour just to highlight whether flesh colour could influence the preference of *E. batatae*. It was discovered that the orange flesh tubers were more susceptible to weevil feeding. Orange flesh sweet potato was reported to contain high levels of vitamin A and was ranked highest in consumer taste preference testing in Africa and Tanzania (Carey *et al.*, 1998; Kulembeka *et al.*, 2004). However, a direct correlation could not be established since weevil preference for sweet potatoes appeared to be controlled by several physical and chemical factors (Mao *et al.*, 2001).

Finally, in the survey the most common life stage of *E. batatae* collected was the larval stage. This was not surprising since the larva caused the most damage through its tunnelling habit in vines and tubers reducing market and consumption values (Okada *et al.*, 2014).

CONCLUSION

Euscepes batatae is definitely present in Samoa but it is unevenly distributed throughout the coastal, inland and highland areas of Samoa. Inland areas such as Aleisa recorded the highest population of *E. batatae* and highland areas such as Vaoala, Upolu and Tapueleele, Savaii had no record of weevils present. It is evident that *E. batatae* favours inland areas where temperatures are higher as compared to higher elevations.

Sweet potato varieties present in Samoa are not well documented. The current study found that variety IB-PH-03 is the most susceptible cultivar to *E. batatae* attack. Furthermore, the most damaging life stage of *E. batatae* is the larval stage and it is commonly found in vines and tubers of sweet potatoes in comparison to adults and pupae.

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