THE ECOLOGY OF *ELDANA SACCHARINA* WALKER, AND ASSOCIATED LOSS IN CANE YIELD AT ARUSHA-CHINI, MOSHI, TANZANIA

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ABSTRACT

Heavy losses in both plant cane and ratoon crops between 1966 and 1969, caused by *Eldana saccharina*, necessitated a thorough ecological study of the pest. Results showed that it is a ground borer, and causes more damage to plant cane than to ratoons. Larval populations maintained in stubble after harvest attacked the next crop. Each 1% infestation caused a decrease in brix value of 0,332%. A study of seasonal fluctuations showed that adults had 2 peaks of activity just before the rains. The moth was observed to be a good swimmer and may have spread within East Africa along rivers. Hot-water treatment of planting material using methoxyethyl mercuric chloride (6%) and dieldrin (50%) at 52 C for 20 minutes was effective. Improved harvesting methods were found to reduce borer populations. Lack of parasites makes *Eldana* a potential problem to sugarcane in many parts of Africa.

INTRODUCTION

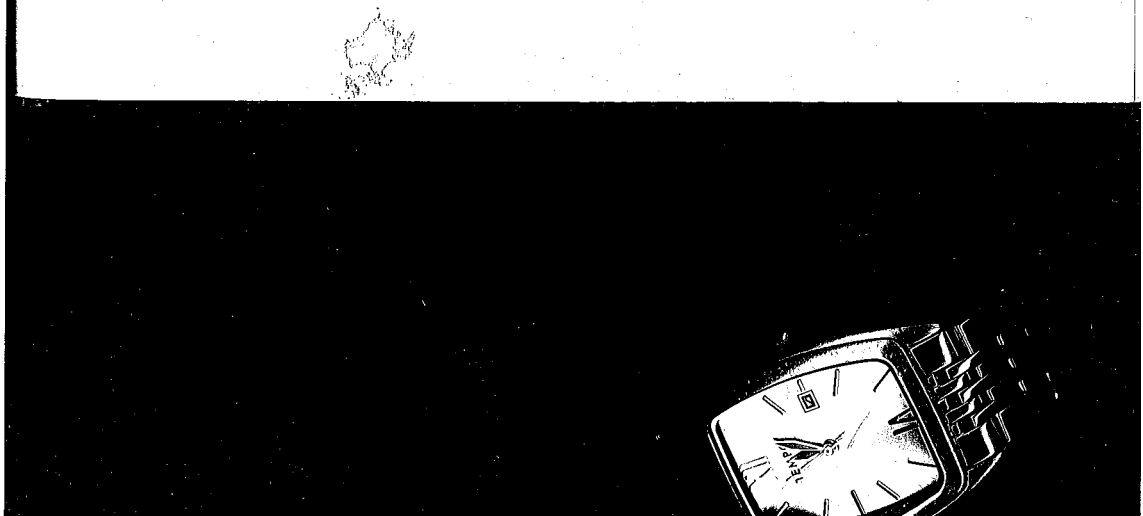
Studies on the distribution and biology of *Eldana saccharina* Walker (Lepidoptera, Pyralidae) have been reviewed by Girling.[3] The larva of this species does not attack young plant cane until it is about 6 months old. In mature plant cane the larvae enter the stalks through buds, cracks, or broken ends of lodged cane. In a ratoon crop, however, dead hearts can be found as soon as young shoots appear. In heavily infested cane *Eldana* eggs are found laid in batches on stalks where they are concealed by the leaf sheaths.

This pest was first observed in northern Tanzania in 1954 but it was not until 1956 that it was observed to be causing heavy damage at a jaggery estate 60 km north west of Arusha-chini. Since then it has been spreading in northern Tanzania where it reached pest status in February 1966. The main varieties of sugarcane grown at Arusha-chini during this period were CO 421, NCo 310, NCo 376 and H39 - 5803. All of these, except NCo 376, were highly susceptible to attack. *E. saccharina* is a serious pest of sugarcane mostly in eastern and southern Africa, Dick[1] and Carnegie.[2] In West Africa it is a minor pest of sugarcane but an important borer of maize, sorghum and millet.

STUBBLE/STALK DAMAGE RELATIONSHIP

The importance of stubble infestation was realised in this study since it is a reservoir of larval population which survives burning during harvest. Surviving larvae start attacking the next crop as soon as young shoots appear.

The relationship between percentage of stumps damaged and numbers of live borers found in stalks sampled at the same time was established and is shown in Table 1. This shows combined data of the crop harvested in the 1967 - 68 season for two varieties, CO 421 and NCo 376, part of which was



sprayed with dicrotophos. Observations suggest that initial attack occurs in the lower portion of the stem and that sprayed fields had fewer live borers in stalk material.

TABLE 1. Summary of the relationship between stumps damaged by *E. saccharina* and live borers found in cane stalks during 1967 - 68.

		Treated (dicrotophos)		Untreated	
% stumps damaged*	No. observed	Mean % stumps damaged	Mean living borers in stalks	Mean % stumps damaged	Mean living borers in stalks
5,0 – 9,9	3	7,3	4,7	8,0	8,5
10,0 – 14,9	6	12,8	4,8	13,2	11,0
15,0 – 19,9	2	16,1	6,0	17,7	12,4
20,0 – 24,9	5	22,6	12,4	22,5	15,5
25,0 – 29,9	1	29,4	11,0	28,2	23,5
Variety,					
Co 421		14,2	11,1	21,7	17,2
NCO 376		18,1	5,8	23,4	13,3

* in samples
† results for the entire crop.

Refractometer readings of 1 201 joints from mature stalks indicated that reduction in brix value occurs with the borer infestation as shown in Table 2.

TABLE 2. Summary of the effect of *E. saccharina* larvae upon brix value of 1201 mature stalks (variety 1 + 39-5803 ratoon 1).

Type of joints examined	Clean	Slightly damaged	Medium	Heavy
No. of joints examined	999	75	74	53
% of total	83,2	6,2	6,2	4,4
Mean brix value	15,1			

After harvest, 123 stumps were examined for the position of live borers above the soil surface. The number of larvae found in successive 5,0 cm intervals of stumps are shown in Table 3. From a sample of 180 stumps the mean length was found to be 15,42 cm. By substituting in the relationship $Y = mx + c$, the expected numbers of borers at different heights above soil level were calculated together with the expected reduction in residual borer population by cutting the stalks below the mean height, Table 4. An acceptable stubble length is 3,80 cm, and, if the mean could be reduced to this level instead of the present mean of 14,48 cm, each stalk reaching the factory would be increased by about 10,7 cm. The mean length of cane cut at harvest, measured from 2 000 stalks selected at random, was 2,8 metres. It was estimated that reducing the stump length to 3,80 cm above soil level should increase the sugar

yield by about 0,5 tons / hectare (Table 5). In the season following these observations an actual increase of 1,5 tons/hectare was recorded.

TABLE 3. The number of larvae found in cane stumps and estimated per cent reduction of borer larvae for different stump lengths as compared with the mean.

Height (cm) above soil level	Total no. of larvae	Length of stumps in cm	Frequency	Calculated height (cm) above soil level	Total larvae	% reduction of larvae
5	60	5,0	1	2,50	52,5	45,0
		7,5	10	3,75	56,2	41,2
10	92	10,0	21	5,00	61,7	35,4
		12,5	28	10,00	77,6	18,7
15	117	15,0	17	15,00	100,0	—
		17,5	13	20,00	128,0	—
20	123	20,0	3			
		22,5	12			
		25,0	3			
		27,5	2			
		30,0	1			
$\bar{X} \pm s_{\bar{X}} t_{0,5}$		14,20±0,90				

TABLE 4. Total larvae in cane stumps at various heights and estimated percentage reduction of larvae at different stump lengths.

Observed Height (cm) above soil level	No. of larvae	Length of stumps (cm)	Frequency	Calculated Height (cm) above soil level	calculated no. of larvae	% reduction of larvae
5,08	60	5,08	8	2,54	52,5	45,0
		7,62	10	3,81	56,2	41,2
10,16	92	10,16	21	5,08	61,7	35,4
		12,70	28	10,16	77,6	18,7
15,24	117	15,24	17	14,48*	95,5	—
		17,78	13	15,24	100,0	—
20,32	123	20,32	12	20,32	128,8	—
		22,83	3			
		25,40	2			
		27,94	1			
		30,48				
		Mean 14,48±0,91				

*Mean stump length in the field.

INTENSITY OF INFESTATION

The next step was to determine the intensity of infestation from the first to the last joint. Two thousand joints were examined in November 1969 and classified as clean, 25, 50, 75 and 100% damaged. Using the formula $Y = mx + c$, the y value was determined as $2,2 + 0,1354X$.

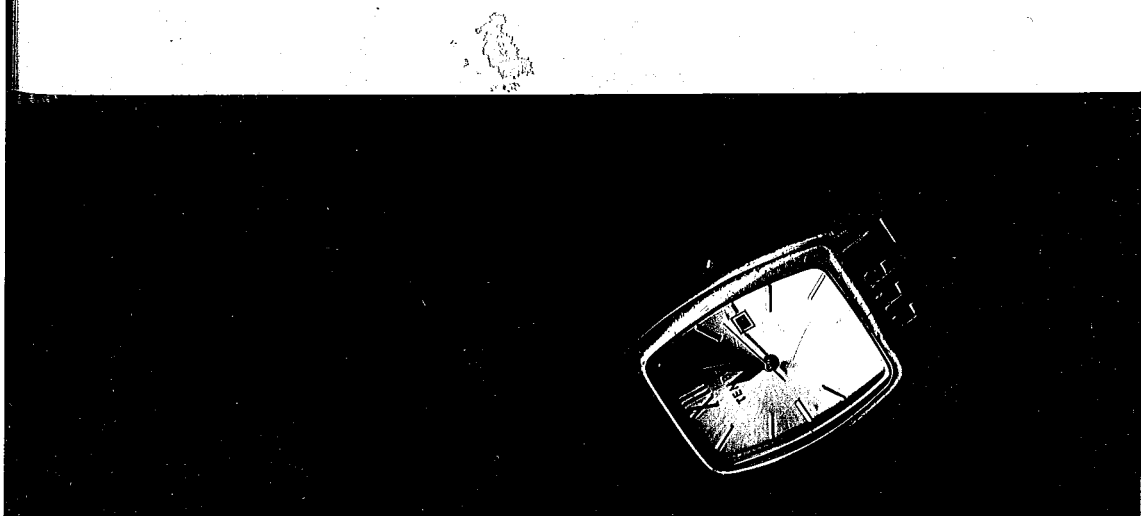


TABLE 5. Estimated increase in tons of sugar by cutting cane stalks at 3,8 cm, above soil level during harvesting of the total of 20 453 metric tons harvested in 1967 - 68 season.

Area harvested	=	1 566,3 hectares.
Estimated increase in yield	=	$\frac{20\,453 \times 3{,}8}{100}$ = 777,2 tons
Warning limit	=	$\frac{20\,453 \times 3{,}4}{100}$ = 695,4 tons
Action limit	=	$\frac{20\,453 \times 3{,}3}{100}$ = 674,9 tons
Estimated increase in sugar/hectare	i.e.	$\frac{777{,}2}{1\,566{,}3}$ & $\frac{695{,}4}{1\,566{,}3}$ or 0,496 and 0,444 tons*

*Actual increase recorded the following season 1,5 tons/hectare.

In known brix readings where Y = brix expected with X% joints bored, and using the formula:

$$\frac{P-Y}{P10\text{-}2}$$ where P = mean brix readings of damaged cane,

values were easily substituted since clean cane had a mean brix value reduced to 14,3. A decrease in brix value of 0,332% for each 1% increase in bored joints was calculated.

PARASITES AND PREDATORS

Between 1968 and 1969 a total of 11 350 eggs collected from the field was examined for parasites and predators. Only one species of Lelaptid mite and the red ant *Pheidole megacephala* (F) var. *strox*, were observed eating eggs. The mite which was identified at the Commonwealth Institute of Entomology, London, as belonging to the genus *Proctolaelaps* (Ascidae) is widespread at Arusha-chini. It was of interest to note that *P. megacephala* was unable to feed on the 4th, 5th and 6th instar larvae. Larvae in these 3 stadia produced a deep brown alkaline fluid that was highly toxic to the red ants. In this study not only were no larval parasites observed but any attempt to parasitise larvae in the laboratory with known parasites of Lepidoptera was unsuccessful.

A small nitidulid beetle *Carpophilus humeralis* (F) was found in tunnels made by *Eldana* larvae in cane stalks. The role of this beetle was not determined. Because ants were less and beetles more numerous in fields with a high borer incidence red ants and nitidulid beetles were trapped at Arusha-chini between April 1969 and April 1970. Trapping was carried out in two fields, one of which had been treated annually with 225 litres aldrex, while the other had received only one application of 140 litres aldrex in 1966. The insecticide was applied for control of white grub *Cochliotis melolonthoides* (Gerst). The results are shown in Table 6. Though based on only two fields these results confirm previous visual observation. From the table it is evident that where more aldrex was ap-

TABLE 6. Total number of *Pheidole megacephala* and *Carpophilus humeralis* trapped in two cane fields one of which had soil chemical treatment only in 1966 (Field I) and the other had yearly soil treatment (Field II) between 1961 and 1966.

Year	Month	Field I			Field II		
		P. megacephala	*C. humeralis*	% borer damage	*P. megacephala*	*C. humeralis*	% borer damage
1969	April	47	1 242	1965: 2,0	—	9 651	1965: 4,5
	May	138	821	1966: 3,2	—	7 401	1966: 8,0
	June	414	2 350	———	101	5 183	———
	July	—	203		—	227	
	August	—	94		—	96	
	September	10	12		—	10	
	October	26	16		10	25	
	November	15	204		9	1	
	December	13	530		—	64	
1970	January	11	1 121		—	5 281	
	February	34	85		—	6 426	
	March	39	786		—	657	
	April	122	1 246		—	7 430	
Total		869	8 710		120	42 452	

plied the red ant population was low. This may have accounted for the high borer incidence observed.

SEASONAL FLUCTUATIONS AND BEHAVIOUR OF ADULT MOTHS

Light-trapping of *E. saccharina* began in August, 1966 and continued until October 1970, using a Robinson trap. A 200/250 volt mercury vapour bulb, type MB/u was used for attracting adult moths. Tetrachloroethane was used as a killing agent. Out of 2 967 adults trapped 43% were males and 53% females, the remainder being undertermined. Seasonal peaks in moth populations were observed in the months of March and October. It is to be noted that these peaks occurred just before the onset of the long rains in northern Tanzania in April and the short rains in November.

THE ROLE OF THE PANGANI RIVER IN DISTRIBUTION OF ADULT MOTHS

Laboratory observations showed that the moths were very good swimmers and would remain alive in water beakers for more than 96 hours. Since this pest was first reported at a sugar estate in the Arusha region it is possible that the Pangani river, which passes both estates, might have played a major role in its distribution. In November 1969, 100 adult moths were released in the river at Arusha-chini a few minutes after 20 paper boats had been thrown into the water as indicators. The author, who released the moths, then drove to a point 8 kilometres down-stream. After 15 minutes the paper boats were noticed coming down the river and a team of 5 people lined up in 3 canoes, and recovered all the moths alive. When returned to the laboratory, the moths continued laying eggs normally.

CONCLUSION

Only three outbreaks of *E. saccharina* have been reported in East Africa. The first of these was at Karangai jaggery Estate in Arusha, the second at

Arusha-chini and the third in Uganda. In all these outbreaks plant cane was reported to suffer more damage than ratoons. This may be attributed to the fact that fields are well prepared before planting. Consequently, the cane is healthier and heavier and therefore prone to lodging. This in turn makes better oviposition sites available.

Although insecticides still remain the best method of controlling *E. saccharina*, this study revealed that better harvesting methods reduced borer populations considerably and increased cane yield. At Arusha-chini, cane is burnt before harvest and undoubtedly a good number of young borer larvae are destroyed then. An integrated control programme should therefore reduce the population to a non-economic level. At present no single method appears good enough for control of this very well adapted species.

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LA ECOLOGÍA DE *ELDANA SACCHARINA* WALKER Y PÉRDIDAS ASOCIADAS EN CAMPOS DE CAÑA EN MOSHI, TANZANIA

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RESUMEN

Las fuertes pérdidas informadas en caña, tanto hoja como socas, entre 1966 y 1969 causadas por *Eldana saccharina*, necesitaban un estudio ecológico completo de esta plaga. Los estudios mostraron que esta plaga es, en realidad, un barrenador subterráneo, causando mayor daño a la caña-hoja. Las poblaciones larvales se mantienen en las cepas después de la cosecha, atacando los subsecuentes cultivos. Se observó que cada 1% de infestación causa una merma valuada en 0,332% de brix. El estudio de las fluctuaciones estacionales mostró que los adultos tienen dos picos de actividad que ocurren precisamente antes de las lluvias. Se observó que esta plaga es un buen nadador y que puede dispersarse en el Africa Oriental a través de los ríos. Se encontró efectivo el tratamiento con agua caliente del material de plantación usando cloruro mercurial de Metoxietil (6%) y dieldrín (50%) a 52 C por 20 minutos. Se encontró que mejores métodos de cosecha de caña, reducen las poblaciones del barrenador. La ausencia de parásitos de esta plaga, hace de ella una plaga potencial de la caña de azúcar en muchas partes de Africa.