GETTING TO KNOW THE ASIAN CORN BORER, *Ostrinia furnacalis* (Guenee) AND ITS ALTERNATE HOST PLANTS

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Bt-Corn

- gaining local acceptance as alternative strategy vs. ACB
- esp. regions where high ACB populations have caused great yield loss
- requires appropriate management strategy to counter development of resistance of the pest to the transgenic plant (IRM)
- IRM requires sound knowledge of pest population dynamics
- Pest population dynamics requires good knowledge and understanding of alternate host plants

Whatever type of corn we plant – traditional, OP's, hybrids or Bt- **Corn .. …..**

regions where high ACB populations have caused great yield losses

- require appropriate insect pest management (IPM) measures
- or for Bt-corn, appropriate management strategy to counter development of resistance of the pest to the transgenic plant (IRM)
- both IPM & IRM require sound knowledge of pest population dynamics
- In turn, pest population dynamics requires good knowledge and understanding of pest biology and alternate host plants

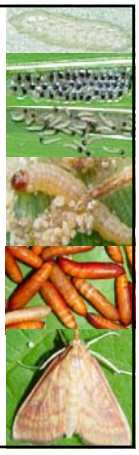
•Introduction
•Asian corn borer (ACB) Biology
- •Life cycle
- • Generation cycle
- • Behavior

•Alternate Host Plants

- • Survey – in 3 major corn growing area
- • Developmental studies- 8 hosts
- • Ovipositional preference – 8 hosts

ACB Biology, Alternate Hosts and IRM

- •The tropics and the temperate
- •ACB vs ECB
- •Basic questions
- •Tropical Refugia of ACB in the Philippines



- pest of corn in the Philippines (Banks 1906, Navarro 1911)
- ACB biology under laboratory conditions: Buligan (1929) Guerero (1965), Yunus and Hua (1969), Areekul (1964), Calora (1965) and Patanakamjorn (1975)
- Compared ACB reared on artificial diet and mungbean; stalks and whole plant in the field (Camarao 1984)

Life cycle (days) of the ACB
……..under laboratory conditions using corn stalk

Stages of Development	**Buligan (1929)**	**Guerero (1965)**	**Yunu& Hua (1969)**	**Areekul (1964)**
EGG				
Incubation period	4.3	3.8	3.0	3.7
LARVAL Instars				
First	3.6	1.7	3.0	3.3
Second	3.9	1.7	3.0	3.0
Third	3.8	1.8	2.0	3.5
Fourth	3.9	2.4	4.0	3.9
Fifth	4.6	2.4	6.0	3.3
Sixth	11.5	3.2	-	-
Total Larval Period	28.9	15.5	18.0	17.1
PUPAL Period	8.3	6.5	6.0	5.3
Egg to Adult	**41.5**	**26.5**	**27.0**	**26.1**

Life cycle (days) of the ACB

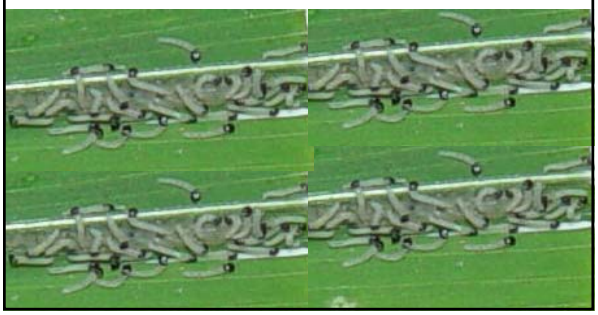
Stages of Development	Buligan (1929)	Guerero (1965)	Camarao (1984)			
			Laboratory		Field	
			Artifcial Diet	Bush sitao pods	Corn stalk	Corn plant
EGG						
Incubation pd	4.3	3.8	3.0	3.0	3.0	3.0
LARVAL Inst						
First	3.6	1.7	3.3	2.0	2.4	2.2
Second	3.9	1.7	2.2	1.7	2.1	2.2
Third	3.8	1.8	2.1	2.0	2.4	2.6
Fourth	3.9	2.4	2.2	1.6	2.6	2.4
Fifth	4.6	2.4	5.7	5.7	7.7	7.4
Sixth	11.5	3.2	-	-	-	-
Larval Period	28.9	15.5	15.5	13.1	17.1	16.3
PUPAL Period	8.3	6.5	7.0	6.5	6.5	7.1
Egg to Adult	**41.5**	**25.8**	**25.5**	**22.6**	**26.6**	**26.4**

EGG – laid in mass (“eggmass”) on underneath surface of leaf
- near the midrib; edge of leaf blade

Before hatching – black head, with black prothoracic plate

First instar – newly hatched larvae - grayish w/ head wider than body
– stationary for some time & slowly crawl to other parts

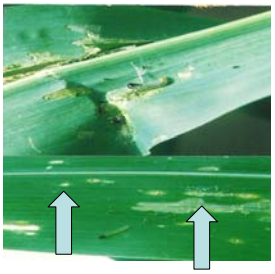
First and second instars – mostly migrate around the plant
– play “parachute” by exuding threads of silk



First instar LARVAE……. damage on leaves

at vegetative stage…. 2nd – 3rd INSTAR LARVAE

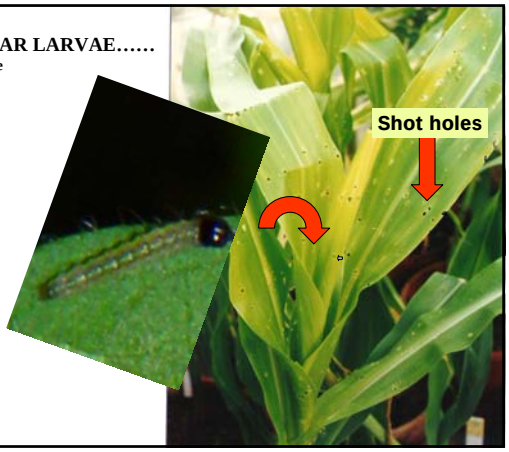
first and second instar-



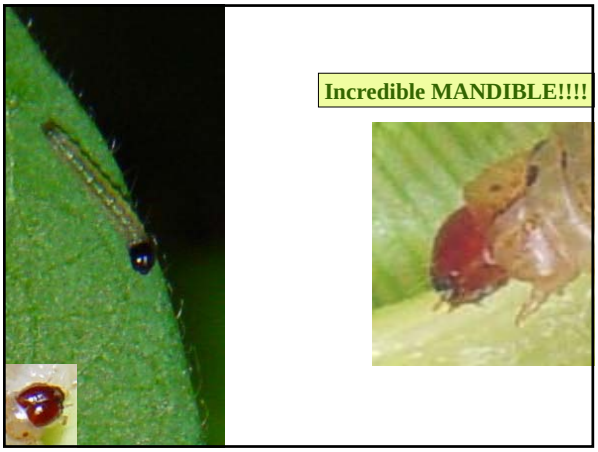
pin holes/ lesions

third instar – shot holes/ lesions

3RD INSTAR LARVAE……
starts to bore



- **BORES FIRST ON THE WHORL**



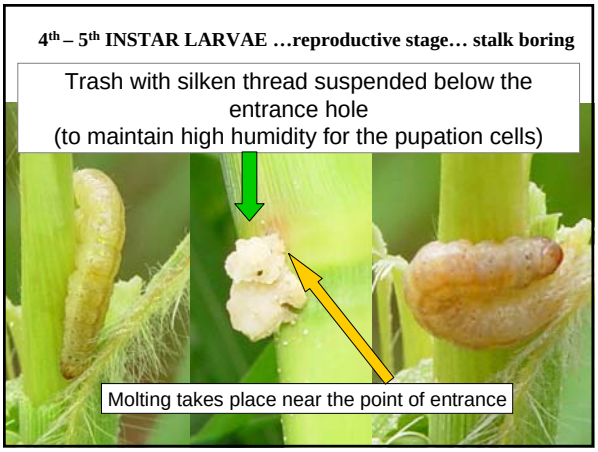
Incredible MANDIBLE

– LARVAE feed on the
LEAF
STALK
TASSEL
EARS
even ROOTS

ON ALL PARTS!

Larval boring behavior is effected because of these very powerful mandibles

4th – 5th INSTAR LARVAE …reproductive stage… stalk boring



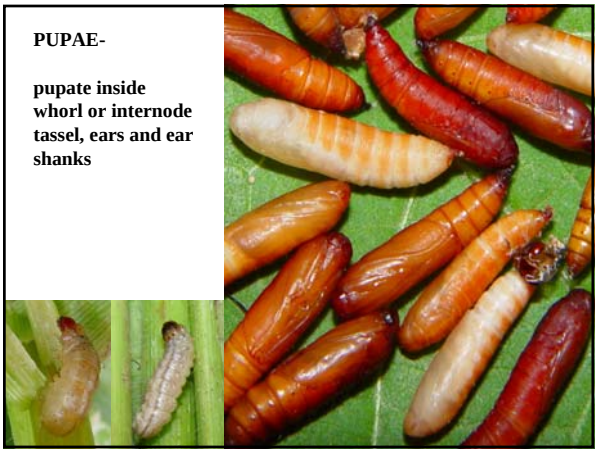
4th – 5th INSTAR LARVAE

Bore horizontal "chamber" (just above the node) then tunnel through the stalk (internodes forming two holes, entry and exit holes)

Larvae stop feeding before molting

PUPAE-

pupate inside whorl or internode tassel, ears and ear shanks



ADULTS- Upon emergence – they are free-living and mostly wander around.

MALE

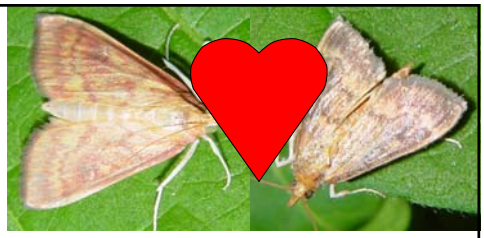
FEMALE

First night – courtship dance

- **Introduction**
- **Asian corn borer (ACB) Biology**
  - Life cycle
  - Generation cycle
  - Behavior
- **Alternate Host Plants**
  - Survey – in 3 major corn growing area
  - Developmental studies- 8 hosts
  - Ovipositional preference – 8 hosts

ACB Biology, Alternate Hosts and IRM

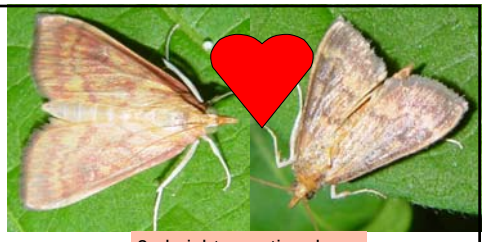
- The tropics and the temperate
- ACB vs ECB
- Basic questions
- Tropical Refugia of ACB in the Philippines



Adults active at night (sundown to 6 am)

(greatly affected by light and weather) –

photophovous and a state of catalepsy or torpor.



2nd night – mating dance

Adults active at night (sundown to 6 am)

(greatly affected by light and weather)

photophovous and a state of catalepsy or torpor.

Egg laying commenced one day after mating-

GENERATION CYCLE

FIRST GENERATION – VEGETATIVE-WHORL (30-60 DAT)

SECOND GENERATION – REPRODUCTIVE (60-90DAT)

•Alternate Host Plants

- Survey – in 3 major corn growing area
- Developmental studies- 8 hosts
- Ovipositional preference – 8 hosts

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High Plant Diversity

- in the Philippines (tropics!)
- Alternate hosts present, available for ACB
- Alternate hosts provide alternative resources for the pest
- Expected to help prevent development of pest resistance to the Bt-toxin (delay devt of resis)
- FEW studies done in Philippines
- Identifying alternate hosts in different regions to provide baseline info for developing IRM strategies appropriate for local conditions

BUKIDNON

- 7 crops reported to be alternate hosts observed being grown, sporadic and planted in home gardens as food or cash crops
- Sugarcane abundant; top crop next to corn. Some corn farmers shifting to sugarcane due to perennial problem of corn borer control.
- 7 non-crop hosts observed; aguingay (*Rottboellia cochinchinensis*) dominant in 5 municipalities; Job's tears (*Coix lachryma-jobi*) absent
- Aguingay was also observed to grow; in some instances, the dominant weed species inside and along the perimeters of cornfields.

SOUTH COTABATO

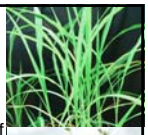
- 7-8 cultivated crops present in the field
- no single dominant crop noted
- however, mungbean, okra, string beans, sugarcane abundant in different municipalities
- other crops sporadically distributed
- tobacco and sorghum not very common in SCotabato
- Job's tears sporadically distributed in the 5 municipalities
- again, Itch grass dominant

- 3 crops dominant: tobacco, stringbeans, eggplant
- Eggplant, however, has yet to be established as a host -not previously reported
- No Guinea grass, Job's tears, Purple Napier grass
- Itch grass also the most abundant.

ACB Alternate Hosts - Bukidnon

- ACB larva on okra and tomato – new host records!
- Conduct developmental studies for verification
- mungbean and stringbeans –
  potential alternate host crops due to high number of larvae recovered
- more larvae and eggmasses from itch grass
- eggmasses also observed on wild sorghum and wild sugarcane






ACB Alternate Hosts- South Cotabato

stringbeans

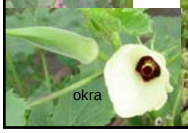
Larvae recovered:

750 cotton 23

550 mungbean 10
525 okra plants 7
800 stringbean damaged pods . . 15

mungbean

okra



cotton

ACB - Hosts South Cotabato

- non-crops: 11 larvae from 2,600 aguingay plants
  only eggmasses on Guinea grass, Napier grass and wild sorghum
- mungbean, okra, stringbeans and aguingay can serve as additional hosts
- other crops and non-crops yet to be established.

ACB - Hosts: Isabela

- out of 5, stringbeans – alternate host
- out of 2,160 damaged pods, 44 larvae
- non-crops: no borer from aguingay, paragrass, wild sorghum and wild sugarcane

POTENTIAL ALTERNATE CROP AND WEED HOST PLANTS OF THE ASIAN CORN BORER, *OSTRINIA FURNACALIS* FROM ACTUAL FIELD DISSECTION AND FARMER'S SURVEY, 2002-2004

PROVINCE	ACTUAL FIELD DISSECTION	FARMER'S SURVEY
BUKIDNON	Stringbeans	Stringbeans
	Okra	Tomato
	Mungbean	Eggplant
	Tomato	Sugarcane
	Itchgrass	Itchgrass
	Sugarcane	
	Napier	
	Guinea grass	
	Wild sorghum	
SOUTH COTABATO	Cotton	Spiny amaranth "Ovampong"
	Stringbeans	Cotton
	Mungbean	Tomato
	Okra	Eggplant
	Itchgrass	Stringbeans
	Guinea grass	Wild sugarcane
	Napier	Itchgrass
	Wild sorghum	Paragrass
		Tobacco
		Ampalaya
		Talahib/Bugang
		Napier
		Wild Sorghum
		Purple nutsedge
ISABELA	Stringbeans	Eggplant
		Stringbeans
		Tomato
		Okra

ACB Biology, Alternate Hosts and IRM

- •CORN cropping system
  tropics vs temperate
- •Corn borer
  ACB vs ECB
- •Basic questions
- •Tropical Refugia of ACB in the Philippines

LOOKING AT THE TROPICS

-very different from the temperate regions

PARAMETERS	TROPICS	TEMPERATE
Cropping systems	variable	uniform
Farm size per farmer	small (2-3 ha)	large (usually >20 acres)
Farming community pattern	Not contiguous	Contiguous
Cropping pattern	variable (1-3)	Uniform
Availability of buffer zones	More buffer zones (i.e. small farms usually bordered by weeds and other crops)	Less buffer zones (only around the periphery of big farms)
Corn varieties	Diverse (Native/OPs)	Uniform (Hybrids/Bt-corn)
Choice of seed or variety	Variable	Mostly for feeds
Date of Planting	asynchronous	Synchronous
Labor-machinery needs	Labor-intensive	mechanized
Associated flora and fauna	Highly diverse	Much less diverse
Climate	Rainy and sunny (wet and dry, often not really distinct in many subregions)	Distinct seasonal variation (four seasons)

LOOKING AT THE TROPICAL ACB

- very different from ECB

	Tropics *Ostrinia furnacalis* (Guenee)	Temperate *Ostrinia nubilalis* (Hubner)
Life cycle: egg-adult	shorter	longer
Life cycle break	virtually inexistent	pupae overwinter
Population growth break	during lag periods	winter and lag periods
Generation cycle/year	>8	>2
Generational succession	overlapping	first generation, second generation
Dispersal or migration flight distance record	unknown	¼ - ½ mi
Mating – flight pattern	unknown	adults fly a lot, mate outside field

ASIAN CORN BORER

ACB CHARACTERISTICS OVER DIFFERENT CROPPING SYSTEMS

NATURE OF ACB	CROPPING PATTERNS		
	Single Corn (one cropping)	Double Corn (two croppings)	Continuous (three or more)
Approx. number of life cycle completed	1	2	3
Behavior	-	moderate	Exposed to corn for most of the times
Generation cycle	2-4	4-6	6-8

ASIAN CORN BORER

OVERLAPPING GENERATION OF ACB POPULATION

Cropping Patterns	MONTHS											
	My	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Single												
Double												
Continuous												

BASIC REQUIREMENTS FOR AN UNSTRUCTURED "TROPICAL" REFUGIA

1. Quantitative data on the abundance and diversity of alternate weed hosts present in the different corn growing areas
2. Map (GIS) and situationer to locate the different alternate weed hosts present in the area
3. Proportion and kind of alternate weed hosts to be planted (when necessary) in (location) specific region
4. Regular monitoring of the abundance of ACB on different alternate weed hosts

SUMMARY

- ACB biology
- more alternate host crops and non-crops in Bukidnon and South Cotabato than in Isabela
- all areas: *Rottboellia* - common species, consistent alternate hosts; also the more abundant plants
- Corn cropping system/ IRM

IMPLICATIONS

- reflect differences in host utilization capabilities of local ACB populations
- level of variability or differences remains to be investigated: mainly genetic diversity or what?
- differences confirm IRM strategies for ACB should be region-specific

IMPLICATIONS

- presence of crops in corn-growing areas, together with non-Bt corn hybrids, OPV's and native cultivars can serve as natural refugia
- other crops and non-crops must be studied, being potential naturally occurring additional refugia for Bt-corn IRM

Considering the existence of alternate crop and weed hosts in the Philippines, how will these hosts affect the concept of "refugia" in a tropical setting?

This situation is further complicated by the very presence of some weeds like aguingay and napier inside the cornfields.

Implications

At present, ACB is perceived to be more or less mono- or oligophagous in the field. However, this study suggests that some alternate hosts can support the growth and development of ACB.

In fact, some not only enable complete life cycle but also apparently encourage or induce insect activities other mating and oviposition.

Will the introduction of Bt-corn trigger host-switching?

Will this scenario affect the population and behavior of ACB in the long period of time and its natural enemies in a Bt-corn dominated field?

RECOMMENDATIONS

- **The biology, especially growth and development, of ACB should be studied further on the other hosts enumerated in the survey.**
- **Quantitative survey of alternate hosts in other corn growing areas**

CONCLUSION & RECOMMENDATIONS

- presence of crops in corn-growing areas, together with non-Bt corn hybrids, OPV's & native cultivars can serve as natural refugia
- other crops & non-crops must be studied, being potential naturally occurring additional refugia for Bt-corn IRM

As the planting of Bt-corn had already intensified by the acceptance of farmers throughout the country, more extensive studies on the role of alternate hosts of ACB as susceptible refuge should be conducted. This is mainly in the context of plant biodiversity/alternate hosts in corn-based system in the Philippines and the ***underlying ecological implications*** of a tropical setting.

These pre-requisites are crucial in forwarding an appropriate "tropical refuge" for the ACB in the Philippines.

Thank you very much!

ADO TI SALAMAT APO!

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A MESSAGE TO ALL

To support studies on basic science along w/ technology development