FUNDAÇÃO DE AMPARO À PESQUISA DO ESTADO DE SÃO PAULO

WORKSHOP:

“Desafios da Pesquisa em Controle Biológico na Agricultura no Estado de São Paulo”

Bactérias entomopatogênicas – *Bacillus thuringiensis*

Ricardo Antônio Polanczyk
Prof. Adjunto 1 FCAV/UNESP

TOPICOS

1 – Introdução: Caracterizar o *Bt* como agente de controle biológico

2 – Modo de ação do *Bt* e sua relação com pesquisas básicas

3 – Diversidade de toxinas Cry x diversidade de *Bt* bioinseticidas

4 – Mercado dos *Bt* bioinseticidas: status, limitações e perspectivas

Professor Shigetane Ishiwata
(1868-1941)

大日本蠶絲會報第百拾四號

●論　說

●劇烈なる一種の軟化病（卒倒病）に就て（第一）

大日本蠶絲會技術委員農學士　石渡繁胤

來歴　去る明治三十一年春期西ケ原蠶業講習所試驗育中一區の蠶兒の劇に斃死せる者あり、其病の劇烈なる實に驚くべく、試に之れが爲めに斃れたる蠶兒の體液を桑葉に塗抹し健全なる蠶兒に與ふるに同樣の病狀を呈して斃る、と同じく劇烈なりし、よりて之れが體液の檢査を行ひ分離培養をなせしに一種の桿狀菌を得たり、其後蠶業家にして斯の如き劇烈なる病の爲めに蠶兒の害を蒙りたるものあるを聞くこと屢々なりし、又近時京都蠶業講習所試驗育蠶兒中にも病狀同一なる劇烈の病を發生せるを見たり、其體液の分離培養を行ひ、又前と同樣なる一種の桿狀菌を得種々なる試驗を行ひたるの結果其病原菌たることを確めるに至れり、病勢の劇烈なる病菌の體内に入るや直に全く食欲を止め數時にして斃死するを以て、假に卒倒病の稱を附し病菌は之れに卒倒病菌と命名したり。

此病原の何れより來るやは未だ不明に屬す、然れども常に一區の蠶兒の此病に罹るを見るに、傳染の度の強大なるにもよるべしと雖も抑も亦給與したる桑葉に附着せるか或は桑貯藏中に於ける腐敗による者にあらざるなきか疑なき能はざるなり、近頃東京農事試驗場技手野村喜太郎氏は桑葉の病菌を調査し其中一種の桿菌は蠶の病を起さしむるものなるとを發見されたり、而して其桿狀菌は予が病蠶より得たる卒倒病菌に類似せることを略しうるものあり、或は同一種なるやも知るべからず、現今之れが調査

第百拾四號　論說

Ishiwata, S., 1901. On a type of severe Xacherie (sotto disease). Dainihon Sanshi Kaiho 114, 1–5 [Original in Japonês].

Über die Schlaffsucht der Mehlmottenraupe (*Ephestia kühniella Zell.*) und ihren Erreger *Bacillus thuringiensis n. sp.*

Von

Ernst Berliner,
z. Zt. im Felde.

(Mit 7 Textabbildungen.)

1. Einleitung.

Im Jahre 1911 veröffentlichte ich in der „Zeitschrift für das gesamte Getreidewesen" unter dem Titel: „Über die Schlaffsucht der Mehlmottenraupe" eine vorläufige Mitteilung, in welcher ich eine Krankheit beschrieb, die unter günstigen Umständen unter den Raupen der als kosmopolitischen Schädling berüchtigten Mehlmotte (*Ephestia kühniella Zell.*) ausserordentliche Verheerungen anrichtete. Da ich durch meine Übersiedelung nach Halle gezwungen bin, die darauf bezüglichen Untersuchungen, welche in der „Versuchsanstalt für Getreideverarbeitung" ausgeführt wurden, zum Abschluss zu bringen, seien die gewonnenen Ergebnisse hier niedergelegt. Den Herren Direktoren der Versuchsanstalt in Berlin, Prof. Dr. Buchwald und Dr. M. P. Neumann, möchte ich auch an dieser Stelle meinen aufrichtigen Dank für das dieser Arbeit entgegengebrachte Interesse aussprechen.

Die von mir in Anlehnung an die Benennung ähnlicher Raupenkrankheiten als Schlaffsucht bezeichnete seuchenhafte Erkrankung trat im Sommer 1909 in einer Sendung von Mehlmottenraupen auf, die ich zum Studium der Parasiten dieser Tiere aus einer thüringischen Mühle erhalten hatte, breitete sich bald in der Versuchsanstalt für Getreideverarbeitung aus und bot mir so mehrere Jahre hindurch bequeme Gelegenheit zu ihrem Studium.

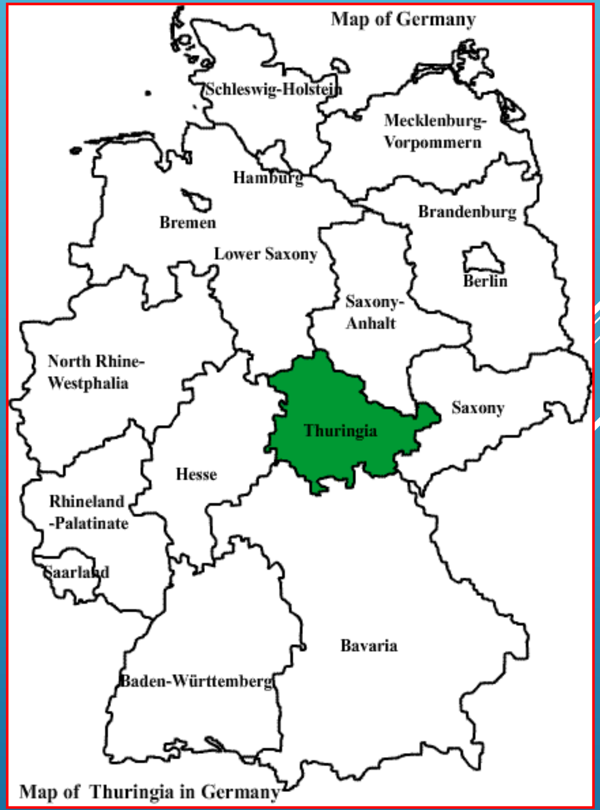
2. Das Krankheitsbild.

In ihren Anfangsstadien kann die Schlaffsucht mit Sicherheit nur durch die mikroskopische Untersuchung erkannt werden. Die befallenen Raupen unterscheiden sich äusserlich fast in nichts von den gesunden, nur dass sie meist ihren bisherigen Aufenthaltsort verlassen und gleich den vor der Verpuppung stehenden Larven sich auf die

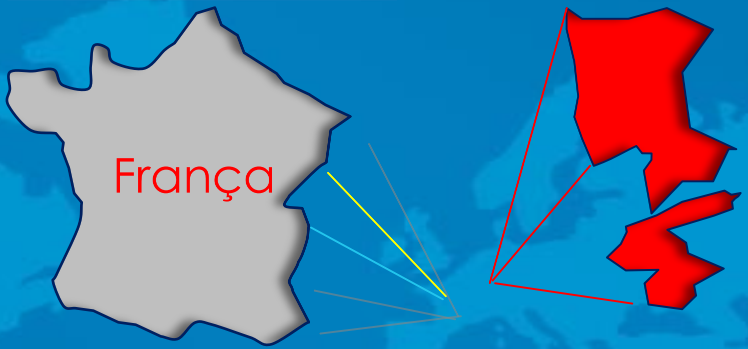
Berliner, E., 1915. Ueber die schlaffsucht der *Ephestia kuehniella und Bac. thuringiensis n. sp. Z. Angew. Entomol.* 2, 29–56.

Doença selvagem da traça-da-farinha (*Ephestia kuehniella* Zell.) e seu patógeno *Bacillus thuringiensis*

- Avaliação dos sintomas
- Morfologia e citologia
- Meios de cultura
- Bioensaios de suscetibilidade
- Experimentos de transmissão

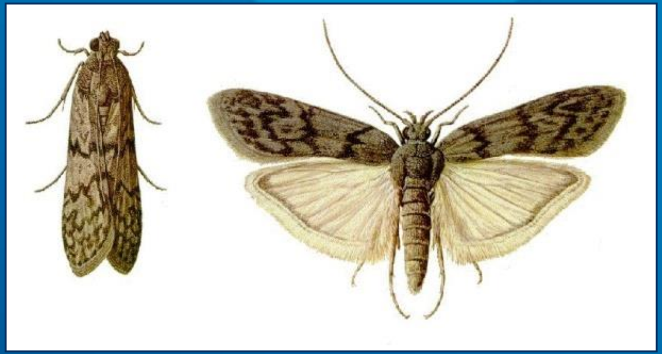


S P O R E I N E



Hungria e Iugoslávia

Ephestia kuehniella



Ostrinia nubilalis

A Bacterial Toxin paralysing Silkworm Larvæ

CERTAIN strains of *Bacillus cereus* are among the more virulent known bacterial pathogens of the silkworm, *Bombyx mori* L.[1]. Toumanoff and Vago[2,3] isolated a strain of *B. cereus* (*B. cereus* var. *alesti*) which causes toxæmia, a septicæmia and intermediate conditions in silkworm larvæ. Another strain of *B. cereus* (*B. cereus* var. *sotto*) was studied by Aoki and Chigasaki[4], who suggested that its effect was due to a toxin. A culture of *B. sotto* was kindly made available by Mr. Masatake Ono, of Tokyo, and the disease caused by it has been under investigation in this laboratory since early in 1953.

The work of Aoki and Chigasaki[4] has been confirmed. Two conditions have been observed in larvæ infected with *B. sotto*; a profound paralysis 2 or 3 hr. after ingestion of old cultures and a septicæmia without paralysis 12–24 hr. after injection of spores and cells into the body cavity. The rapid onset of paralysis, which took place without any discernible increase of the ingested bacteria, was suggestive of the presence of a pre-formed toxin; but no toxin could be demonstrated in culture media in which the bacteria had been grown.

It was found in our experiments that treatment of old cultures of *B. sotto* with clarified silkworm gut juice yielded a toxic extract. As silkworm gut juice is normally alkaline (pH 9·5–10·0), an old culture of *B. sotto* was treated with dilute alkali and filtered through a fritted glass filter. The sterile filtrate caused paralysis of silkworm larvæ. Hannay[5] has recently observed alkali-soluble crystalline inclusions in sporulating cells of strains of *B. cereus* known to be pathogenic for insect larvæ. Microscopical examination of *B. sotto* revealed similar crystals. Treatment of a suspension of spores, crystals, and vegetative debris with alkali resulted in the dissolution of the crystals without affecting the viability of the spores.

An experiment was done to test whether there might be any foundation to the speculation made by Hannay[5] that the crystals might be a toxic substance encouraging septicæmia of the insect larvæ. A suspension of crystals, spores and vegetative debris of *B. sotto* was well washed by centrifugation, resuspended in water, and divided into two parts. One part was diluted and tested against silkworm larvæ both by injecting a quantity of it into the body cavity and by feeding. The second part was treated with alkali until the crystals had dissolved, then the spores and debris were centrifuged out, well washed by centrifugation and resuspended in water. A portion of the supernatant was dialysed against water and another portion heated at 70° C. for 30 min. All four fractions were tested by feeding and injection. The results are given in the accompanying table.

THE EFFECT OF FEEDING AND INJECTING LARVÆ OF *Bombyx mori* L. WITH FRACTIONS OF AN ALKALI-TREATED CULTURE OF *B. sotto*

	Method of dosing larvæ	
	By feeding	By injection
Original culture Spores and crystals (1×10^7 spores per larva)	Paralysis within 4 hr., septicæmia within 12 hr.	Septicæmia within 12 hr. No paralysis
Alkali-treated culture 1. Spore fraction (1×10^7 spores per larva)	No effect	Septicæmia within 12 hr.
2. Supernatant	Paralysis within 4 hr. No septicæmia	No effect
3. Supernatant dialysed	Paralysis within 4 hr. No septicæmia	No effect
4. Supernatant heated at 70° C. for 30 min.	No effect	No effect

The results indicate that the septicæmia following feeding is dependent upon the presence of a toxic substance which is heat-labile and non-dialysable. The toxin had a paralytic effect when fed but was non-toxic when injected. The crystal-free spores, on the other hand, were pathogenic when injected but non-invasive when fed.

By differential centrifugation of a suspension of spores and crystals, two fractions were obtained which differed significantly in the ratio of spores to crystals. It was found by feeding various dilutions of the two fractions that toxicity varied as the crystal count and was independent of the number of spores present.

The results presented above indicate that the toxic component in old cultures of *Bacillus sotto* responsible for paralysis in silkworm larvæ is associated with the crystalline inclusions described by Hannay. The investigation of its nature and mode of action is being continued.

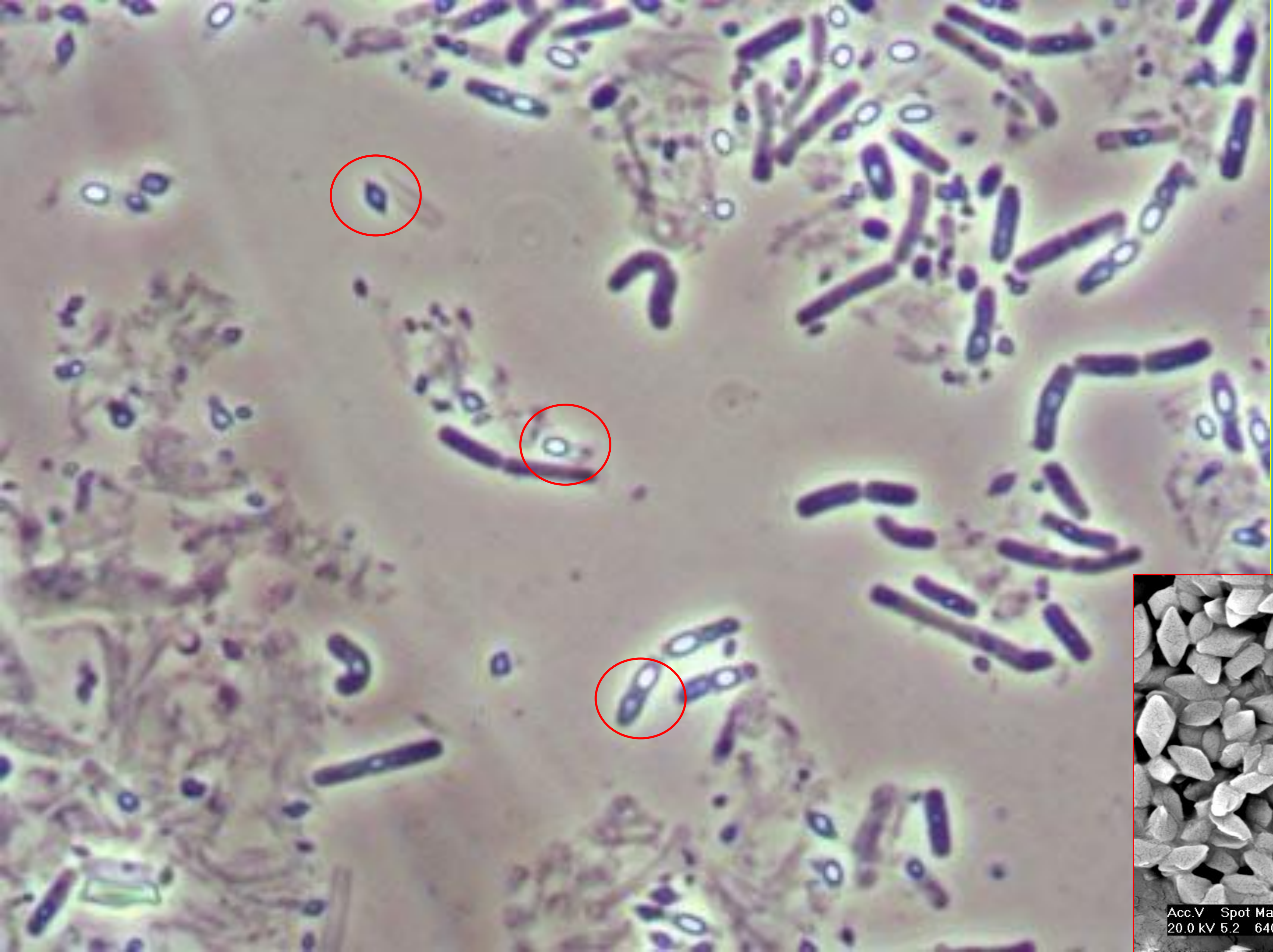
T. A. ANGUS

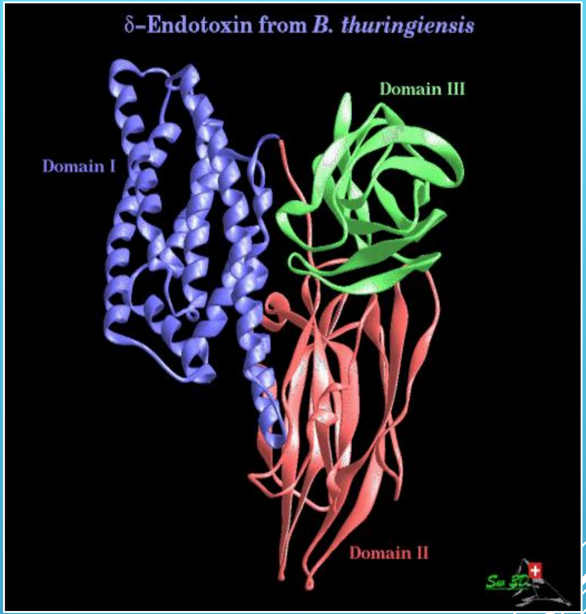
Laboratory of Insect Pathology,
Sault Ste. Marie,
Ontario.

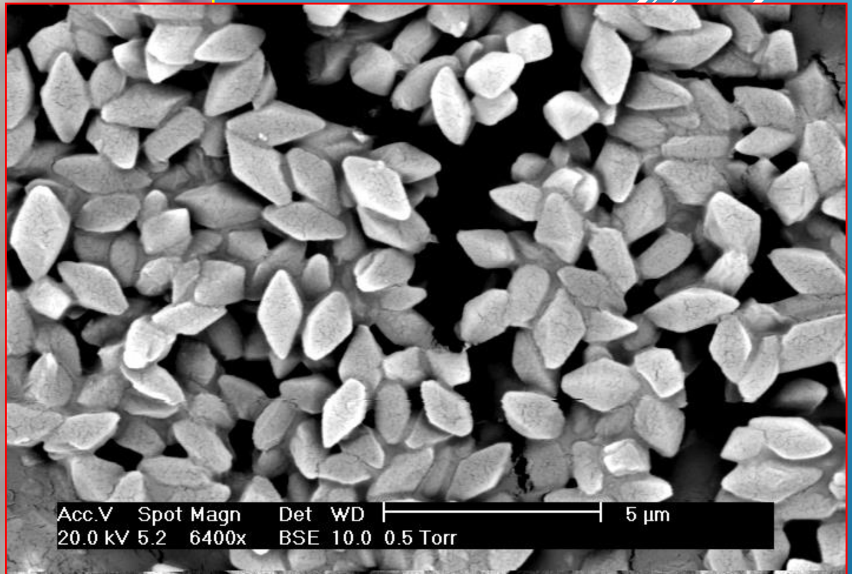
Nov. 27.

[1] Steinhaus, E. A., "Principles of Insect Pathology" (McGraw-Hill, N.Y., 1949).
[2] Toumanoff, C., and Vago, C., Ann. Inst. Pasteur, 81, 376 (1951).
[3] Toumanoff, C., and Vago, C., Ann. Inst. Pasteur, 82, 512 (1952).
[4] Aoki, K., and Chigasaki, Y., Mitt. Med. Fak. Kais. Univ. Tokyo, 14, 59 (1915).
[5] Hannay, C. L., Nature, 172, 1004 (1953).

Angus, T., 1954. A bacterial toxin paralyzing silkworm larvae. Nature, 173, 545.



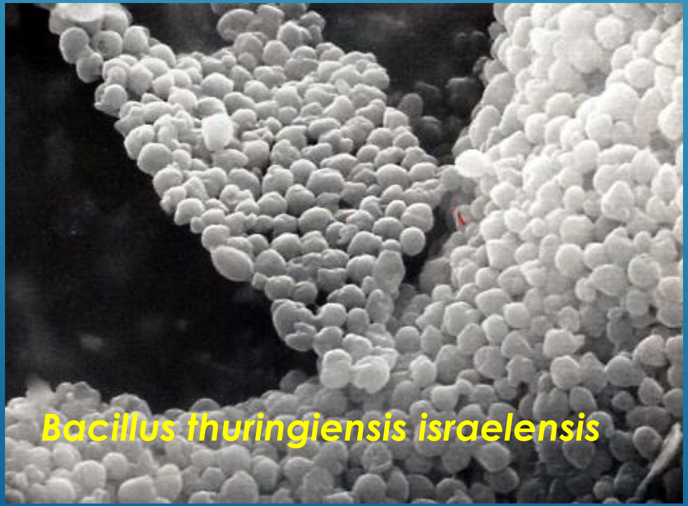

δ-Endotoxin from B. thuringiensis
Domain I
Domain III
Domain II


Acc.V Spot Magn Det WD 5 µm
20.0 kV 5.2 6400x BSE 10.0 0.5 Torr

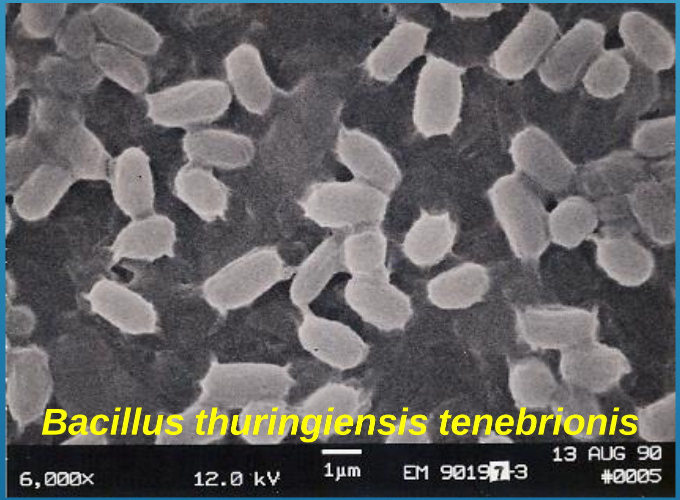
Formato dos cristais

Bacillus thuringiensis kurstaki

Bacillus thuringiensis aizawai

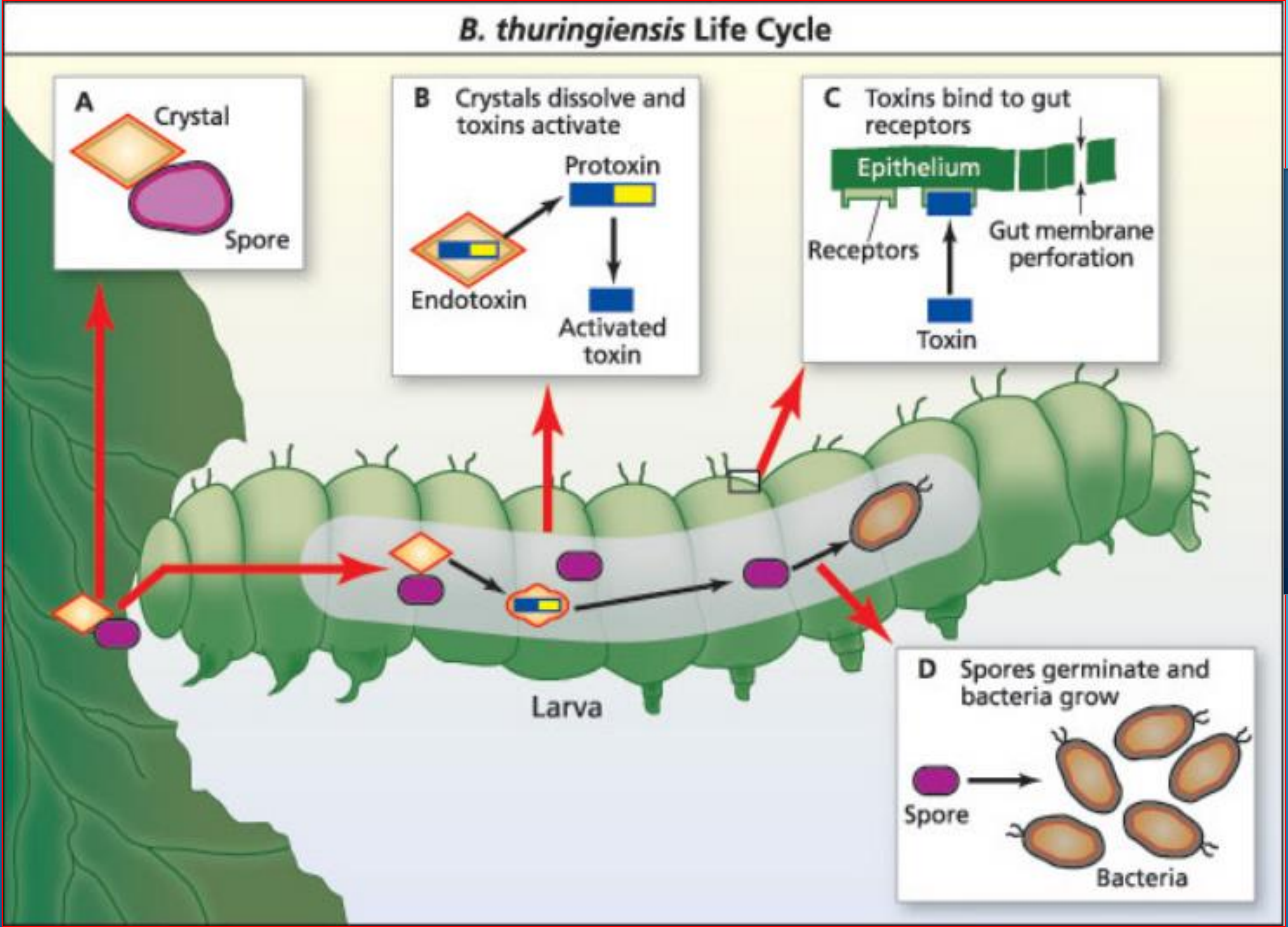


Bacillus thuringiensis israelensis

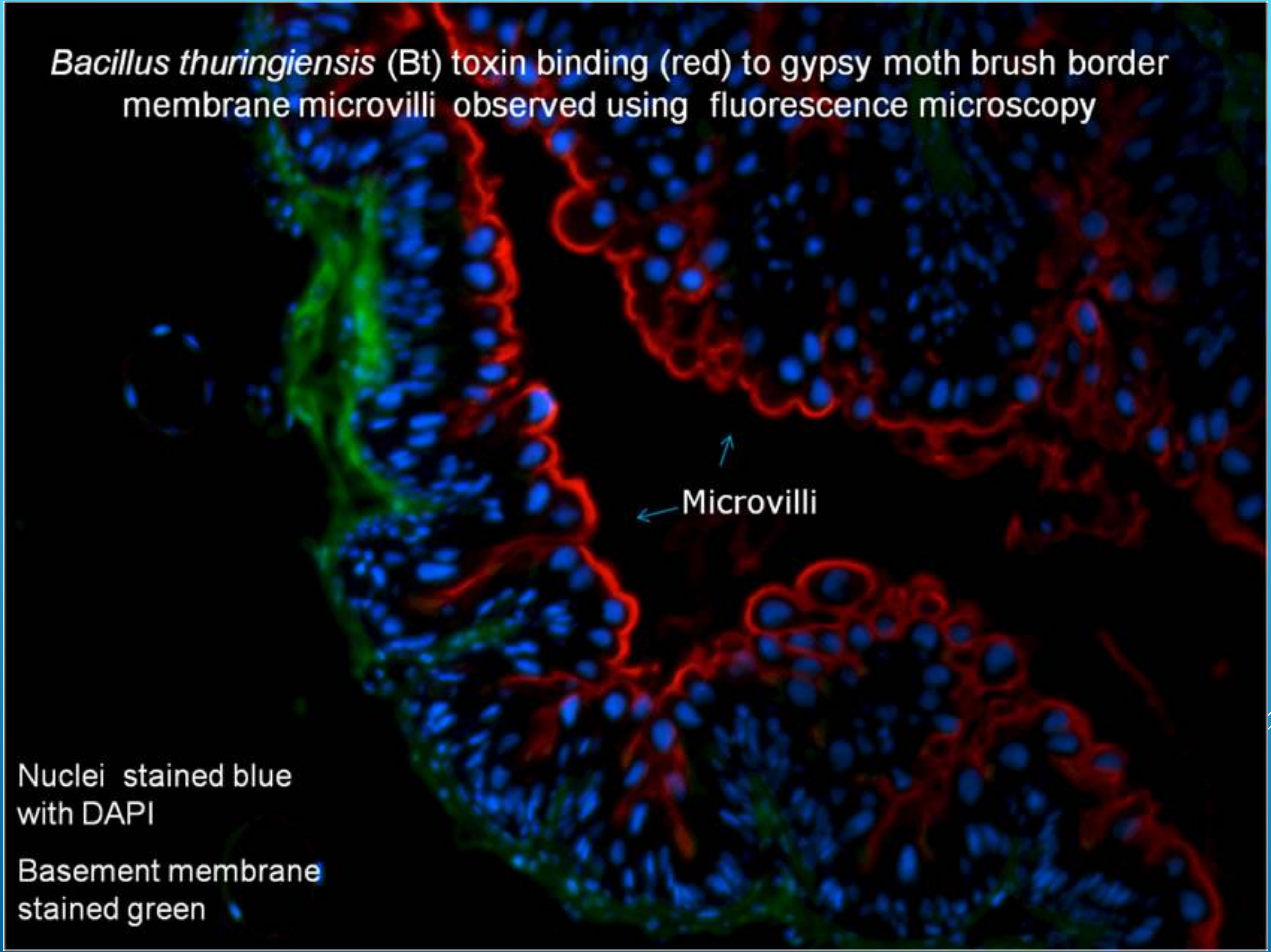


Bacillus thuringiensis tenebrionis

- Diversidade de formas
- Diversidade de toxinas
- Diversidade de numero



1) INGESTAO
2) DISSOLUCAO CRISTAL
3) ATIVACAO
4) LIGACAO
5) FORMACAO DO PORO
6) SEPTICEMIA
7) MORTE DO INSETO


Bacillus thuringiensis (Bt) toxin binding (red) to gypsy moth brush border membrane microvilli observed using fluorescence microscopy
Microvilli
Nuclei stained blue with DAPI
Basement membrane stained green

JOURNAL OF INVERTEBRATE PATHOLOGY **68**, 203–212 (1996)
ARTICLE NO. 0087

Interactions of *Bacillus thuringiensis* Crystal Proteins with the Midgut Epithelial Cells of *Spodoptera frugiperda* (Lepidoptera: Noctuidae)

EDUARDO ARANDA, JORGE SANCHEZ, MARNIX PEFEROEN,* LEOPOLDO GÜERECA, AND ALEJANDRA BRAVO[1]

*Instituto de Biotecnología Universidad Nacional Autónoma de México, Apdo. Postal 510-3, Cuernavaca 62250, Mor., Mexico; and *Plant Genetic Systems, J. Plasteaustraat 22-B, Gent 9000, Belgium*

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THE JOURNAL OF BIOLOGICAL CHEMISTRY VOL. 285, NO. 17, pp. 12497–12503, April 23, 2010

Role of Alkaline Phosphatase from *Manduca sexta* in the Mechanism of Action of *Bacillus thuringiensis* Cry1Ab Toxin*

Received for publication, November 14, 2009, and in revised form, January 14, 2010 Published, JBC Papers in Press, February 22, 2010, DOI 10.1074/jbc.M109.085266

Iván Arenas, Alejandra Bravo, Mario Soberón, and Isabel Gómez[1]

From the Departamento de Microbiología Molecular, Instituto de Biotecnología, Universidad Nacional Autónoma de México, Cuernavaca, Morelos 62250, México

APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Nov. 2006, p. 7029–7035 Vol. 72, No. 11
0099-2240/06/$08.00+0 doi:10.1128/AEM.01454-06

Genetic Variability of *Spodoptera frugiperda* Smith (Lepidoptera: Noctuidae) Populations from Latin America Is Associated with Variations in Susceptibility to *Bacillus thuringiensis* Cry Toxins▽

Rose Monnerat,[1] Erica Martins,[1] Paulo Queiroz,[1] Sergio Ordúz,[2] Gabriela Jaramillo,[2] Graciela Benintende,[3] Jorge Cozzi,[3] M. Dolores Real,[4] Amparo Martinez-Ramirez,[4] Carolina Rausell,[4] Jairo Cerón,[5] Jorge E. Ibarra,[6] M. Cristina Del Rincon-Castro,[6] Ana M. Espinoza,[7] Luis Meza-Basso,[8] Lizbeth Cabrera,[9] Jorge Sánchez,[9] Mario Soberon,[9] and Alejandra Bravo[9]*

APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Oct. 2001, p. 4610–4613 Vol. 67, No. 10
0099-2240/01/$04.00+0 DOI: 10.1128/AEM.67.10.4610–4613.2001

Variation in Susceptibility to *Bacillus thuringiensis* Toxins among Unselected Strains of *Plutella xylostella*

J. GONZÁLEZ-CABRERA,[1] S. HERRERO,[1] A. H. SAYYED,[2] B. ESCRICHE,[1] Y. B. LIU,[3] S. K. MEYER,[4] D. J. WRIGHT,[2] B. E. TABASHNIK,[4] AND J. FERRÉ[1]*

Departament de Genètica, Facultad de CC Biológicas, Universitat de València, 46100 Burjassot, Valencia, Spain[1]; Department of Biology, Imperial College of Science, Silwood Park, Ascot, Berkshire SL5 7PY, United Kingdom[2]; U.S. Agricultural Research Station, Agricultural Research Service, U.S. Department of Agriculture, Salinas, California 93905[3]; and Department of Entomology, University of Arizona, Tucson, Arizona 85721[4]

PROJETOS DESENVOLVIDOS PELO LCMAP COM *Bacillus thuringiensis*

Projeto 1: *Plutella xylostella*: variabilidade populacional e suscetibilidade a táticas de controle. (FAPESP 2010/12438-2)

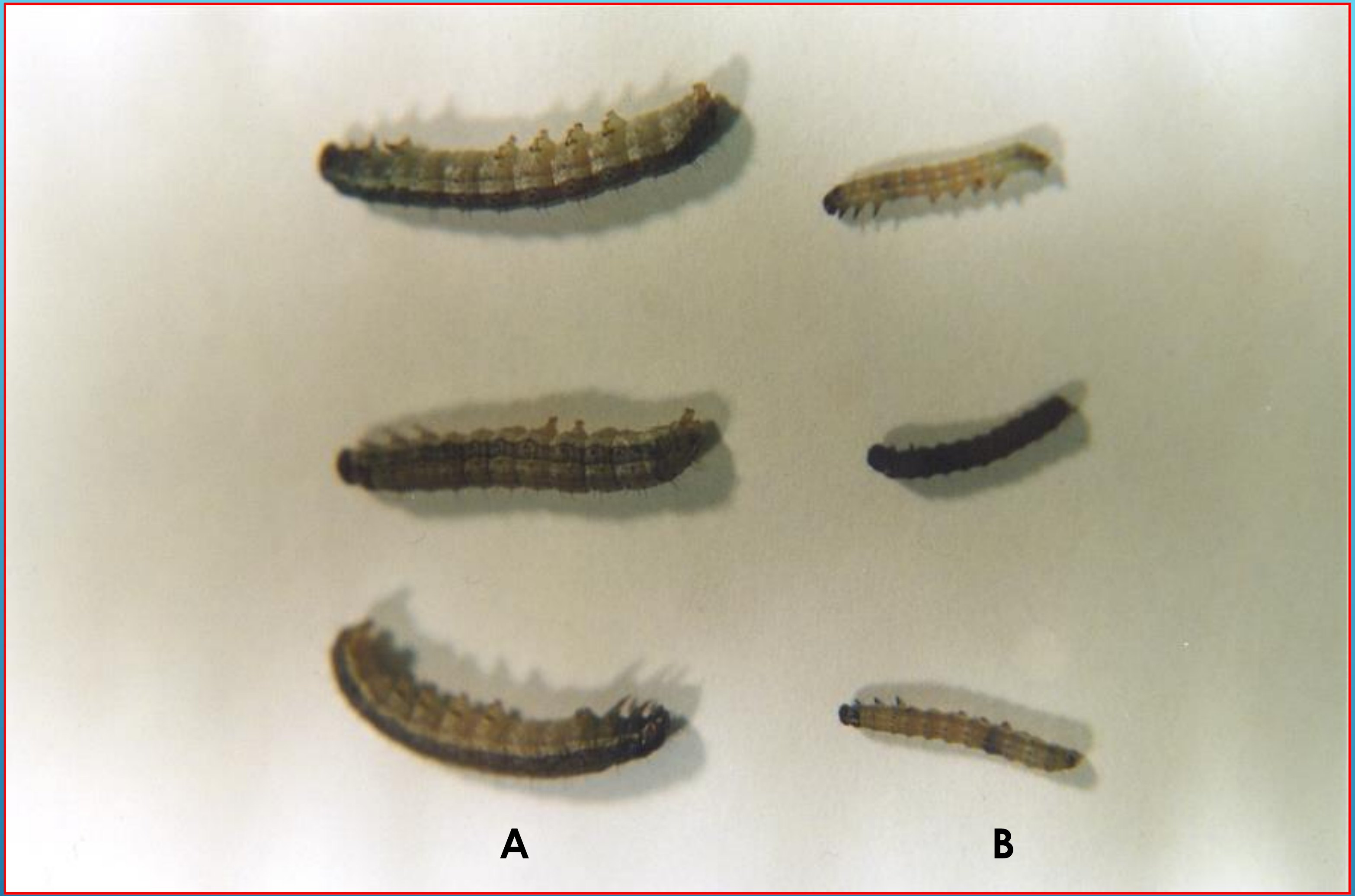
Projeto 2: Investigação de fatores envolvidos na resistência ao *Bacillus thuringiensis* Berliner em populações nativas de *Plutella xylostella* (L.,1758) (Lepidoptera: Plutellidae) (FAPESP 2015/05891-6)

Projeto 3: Interação da toxina Cry1Ac de *Bacillus thurigiensis* às microvilosidades apicais das células colunares (BBMVs) do intestino médio de diferentes instares larvais de *Helicoverpa armigera* (Lepidoptera:Noctuidae) (FAPESP 2015/24330-5)

Bacillus thuringiensis
X
Inseto praga

Bioensaios de patogenicidade

Bioensaios de virulência (Estimativa da CL_{50})



Lagartas de *Spodoptera frugiperda* da testemunha (A) e sobreviventes (B) ao *Bt*

OPEN ACCESS Freely available online

PLOS | ONE

Uptake and Transfer of a *Bt* Toxin by a Lepidoptera to Its Eggs and Effects on Its Offspring

Débora Pires Paula[1]*, David A. Andow[2], Renata Velozo Timbó[3], Edison R. Sujii[1], Carmen S. S. Pires[1], Eliana M. G. Fontes[1]

1 Department of Biological Control, Embrapa Genetic Resources and Biotechnology, Brasília, DF, Brazil, 2 Department of Entomology, University of Minnesota, St. Paul, Minnesota, United States of America, 3 Department of Molecular Biology, University of Brasilia, Brasília, DF, Brazil

Abstract

Research on non-target effects of transgenic crop plants has focused primarily on bitrophic, tritrophic and indirect effects of entomotoxins from *Bacillus thuringiensis*, but little work has considered intergenerational transfer of Cry proteins. This work reports a lepidopteran (*Chlosyne lacinia*) taking up a *Bt* entomotoxin when exposed to sublethal or low concentrations, transferring the entomotoxin to eggs, and having adverse effects on the first filial generation (F1) offspring. Two bioassays were conducted using a sublethal concentration of toxin (100.0 ng/µl Cry1Ac) for adults and a concentration equal to the LC10 (2.0 ng/µl Cry1Ac) for larvae. Cry1Ac is the most common entomotoxin expressed in *Bt* cotton in Brazil. In the adult diet bioassay there was no adverse effect on the parental generation (P0) adults, but the F1 larvae had higher mortality and longer development time compared to F1 larvae of parents that did not ingest Cry1Ac. For the 3rd instar larvae, there was no measurable effect on the P0 larvae, pupae and adults, but the F1 larvae had higher mortality and longer development time. Using chemiluminescent Western Blot, Cry1Ac was detected in F_1 eggs laid by P_0 butterflies from both bioassays. Our study indicates that, at least for this species and these experimental conditions, a ~65 kDa insecticidal protein can be taken up and transferred to descendants where it can increase mortality and development time.

Biological and Microbial Control

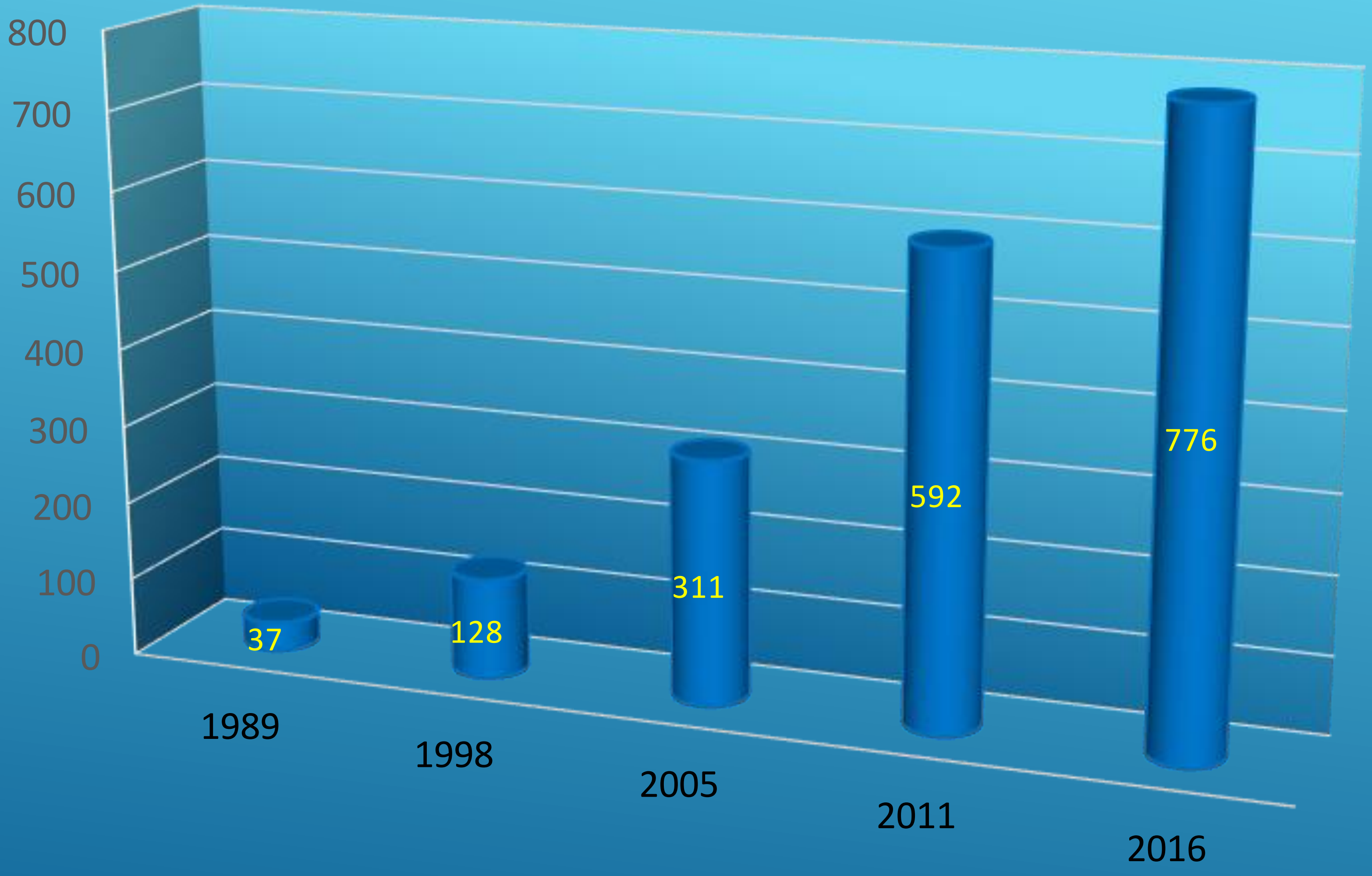
Bacillus thuringiensis Insecticidal Crystal Proteins Affect Lifespan and Reproductive Performance of *Helicoverpa armigera* and *Spodoptera exigua* Adults

Ying Zhang,[1] Yan Ma,[2] Pin-Jun Wan,[1] Li-Li Mu,[1] and Guo-Qing Li[1,3]

J. Econ. Entomol. 106(2): 614–621 (2013); DOI: http://dx.doi.org/10.1603/EC12413

Interação entre Bacillus *thuringiensis* e a fase jovem e adulta de *Helicoverpa armigera* (Lepidoptera: Noctuidae). Bolsa de Produtividade. Processo CNPq 312618/2014-0.

DIVERSIDADE DE TOXINAS Cry



Cry1Aa1 – Cry74Aa

Dr Neil Crickmore

Senior Lecturer in Molecular Genetics
Department of Biochemistry
School of Life Sciences
University of Sussex, Falmer, Brighton
BN1 9QG UK

Numero de toxinas Cry de *Bacillus thuringiensis* caracterizadas ao logo do tempo

Journal of Invertebrate Pathology 101 (2009) 1–16

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/yjipa

Minireview

Insecticidal activity of *Bacillus thuringiensis* crystal proteins

Kees van Frankenhuyzen *

Great Lakes Forestry Centre, Canadian Forest Service, Natural Resources Canada, 1219 Queen Street East, Sault Ste. Marie, Ontario, Canada P6A 2E5

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Delta-endotoxins
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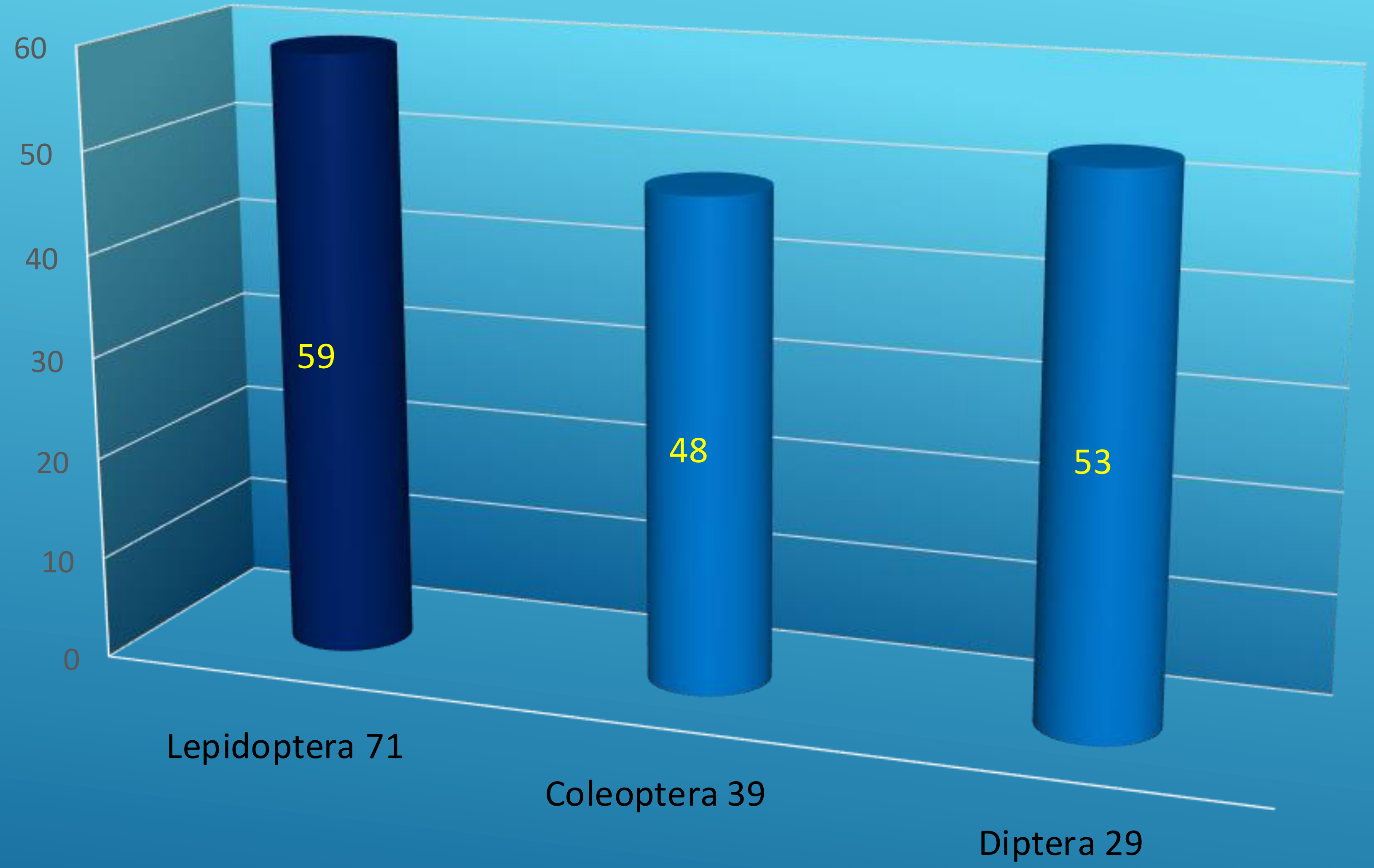
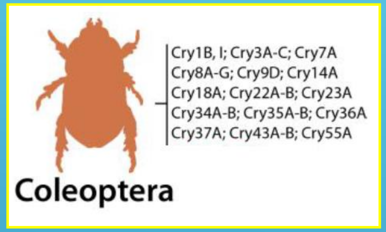
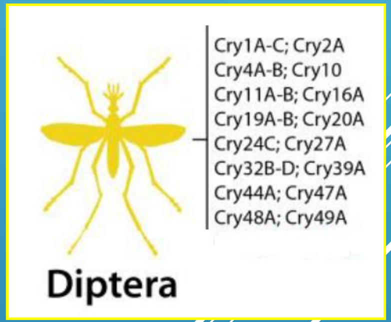
ABSTRACT

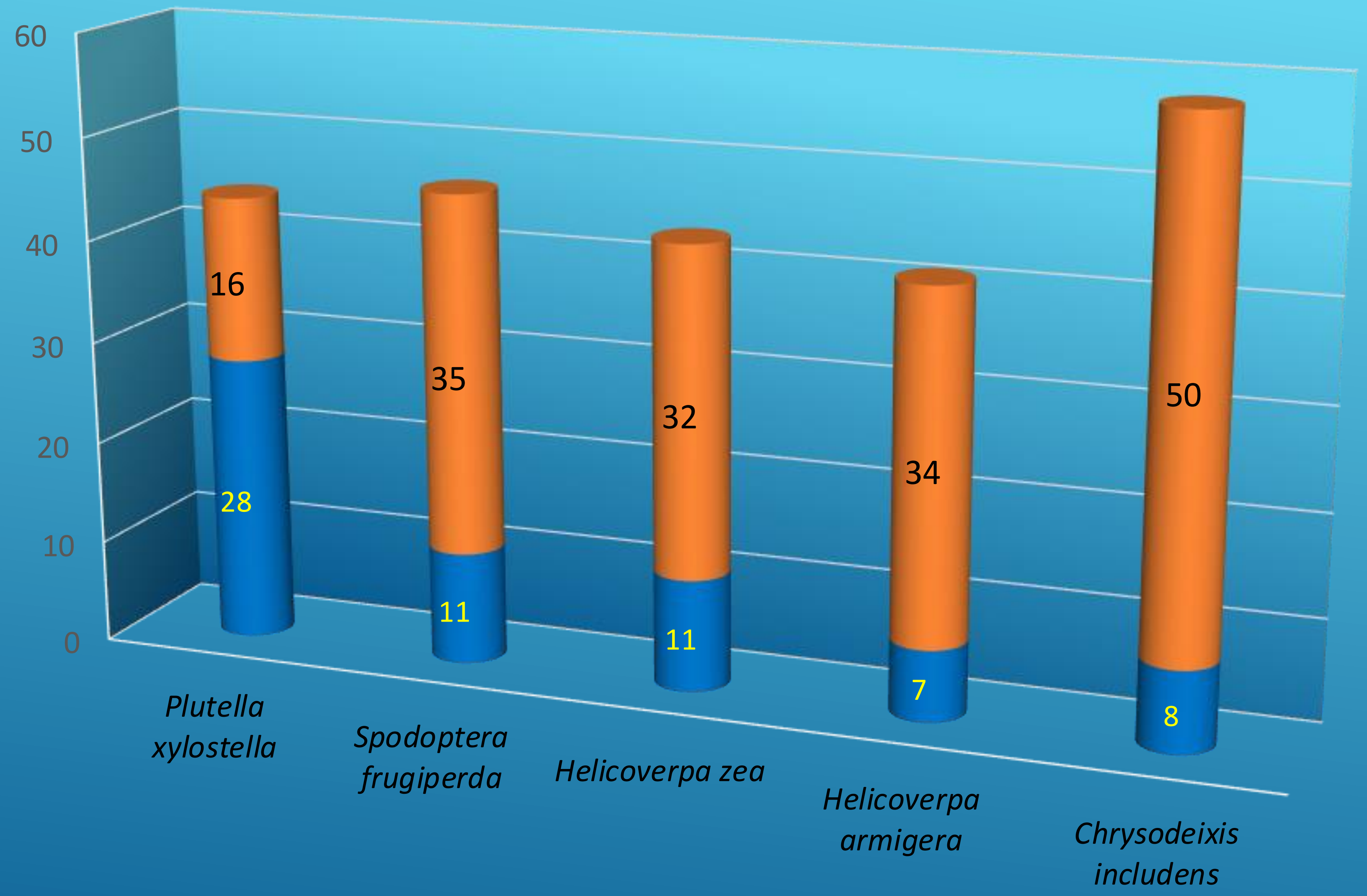
Published data on insecticidal activity of crystal proteins from *Bacillus thuringiensis* are incorporated into the Bt toxin specificity relational database. To date, 125 of the 174 holotype known toxins have been tested in ~1700 bioassays against 163 test species; 49 toxins have not been tested at all; 59 were tested against 71 Lepidoptera species in 1182 bioassays; 53 toxins were tested against 23 Diptera species in 233 bioassays; and 47 were tested against 39 Coleoptera species in 190 bioassays. Activity spectra of the tested toxins were summarized for each order. Comparisons of LC_{50} values are confounded by high variability of the estimates, mostly due to within-species variation in susceptibility, and errors associated with estimation of toxin protein content. Limited analyses suggest that crystal protein toxicity is not affected by quarternary toxin rank or host used for gene expression, but that pre-ingestion treatment by solubilization or enzymatic processing has a large effect. There is an increasing number of toxin families with cross-order activity, as 15 of the 87 families (secondary rank) that are pesticidal are active against more than one order. Cross-order activity does not threaten environmental safety of *B. thuringiensis*-based pest control because toxins tend to be much less toxic to taxa outside the family's primary specificity range.







Numero de toxinas Cry de *Bacillus thuringiensis* testadas contra insetos (Van Frankenhuyzen, 2009 – JIP)



Numero de toxinas Cry de *Bacillus thuringiensis* ativas e com atividade desconhecida para algumas pragas que ocorrem no Brasil

Cepas de *Bt* utilizadas na formulação de bioinseticidas

Cepa	Toxinas
Bacillus thuringiensis kurstaki HD-1	Cry1Aa, Cry1Ab, Cry1Ac, Cry2A e Cry2B
Bacillus thuringiensis kurstaki HD-73	Cry1Ac
Bacillus thuringiensis aizawai HD-112	Cry1Aa, Cry1Ab, Cry1C, Cry1D, Cry 1G e Cry2
Bacillus thuringiensis aizawai HD-113	Cry1Aa, Cry1Ab, Cry1C, e Cry1D
Bacillus thuringiensis thuringiensis HD-2	Cry1A e Cry1B
Bacillus thuringiensis tenebrionis	Cry3A

Bacillus thuringiensis aizawai HD-113

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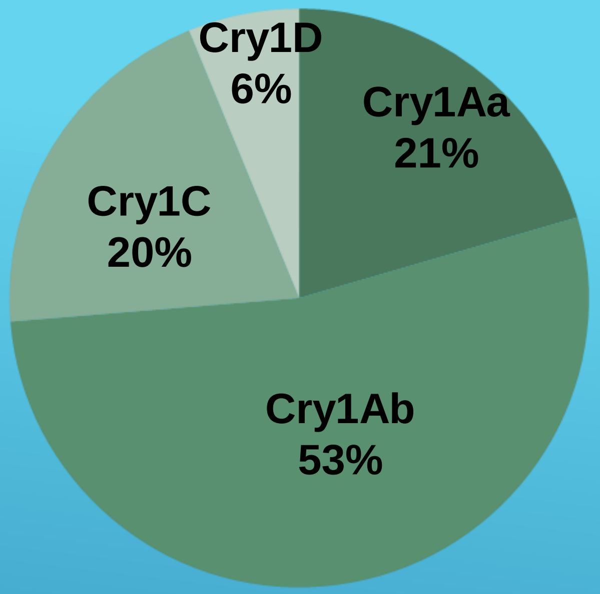
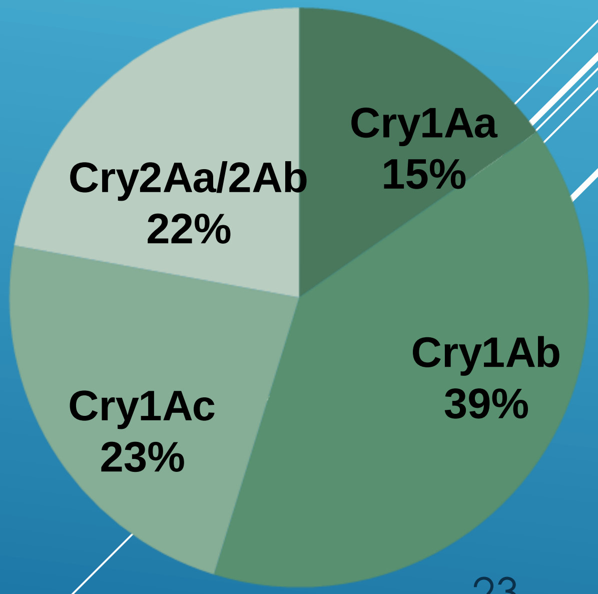
WETTABLE GRANULE



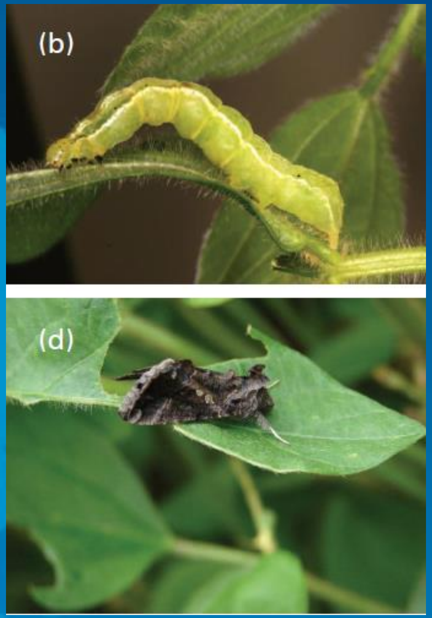
Bacillus thuringiensis kurstaki HD-1

DiPel®
BIOLOGICAL INSECTICIDE



MERCADO BRASILEIRO DE BIOINSETICIDAS A PARTIR DE 2010

Chrysodeixis includens



10 milhões de hectares

Able

Agree

Bac Control (EC e WP)

Bactur WP

Dipel (WP – WG)

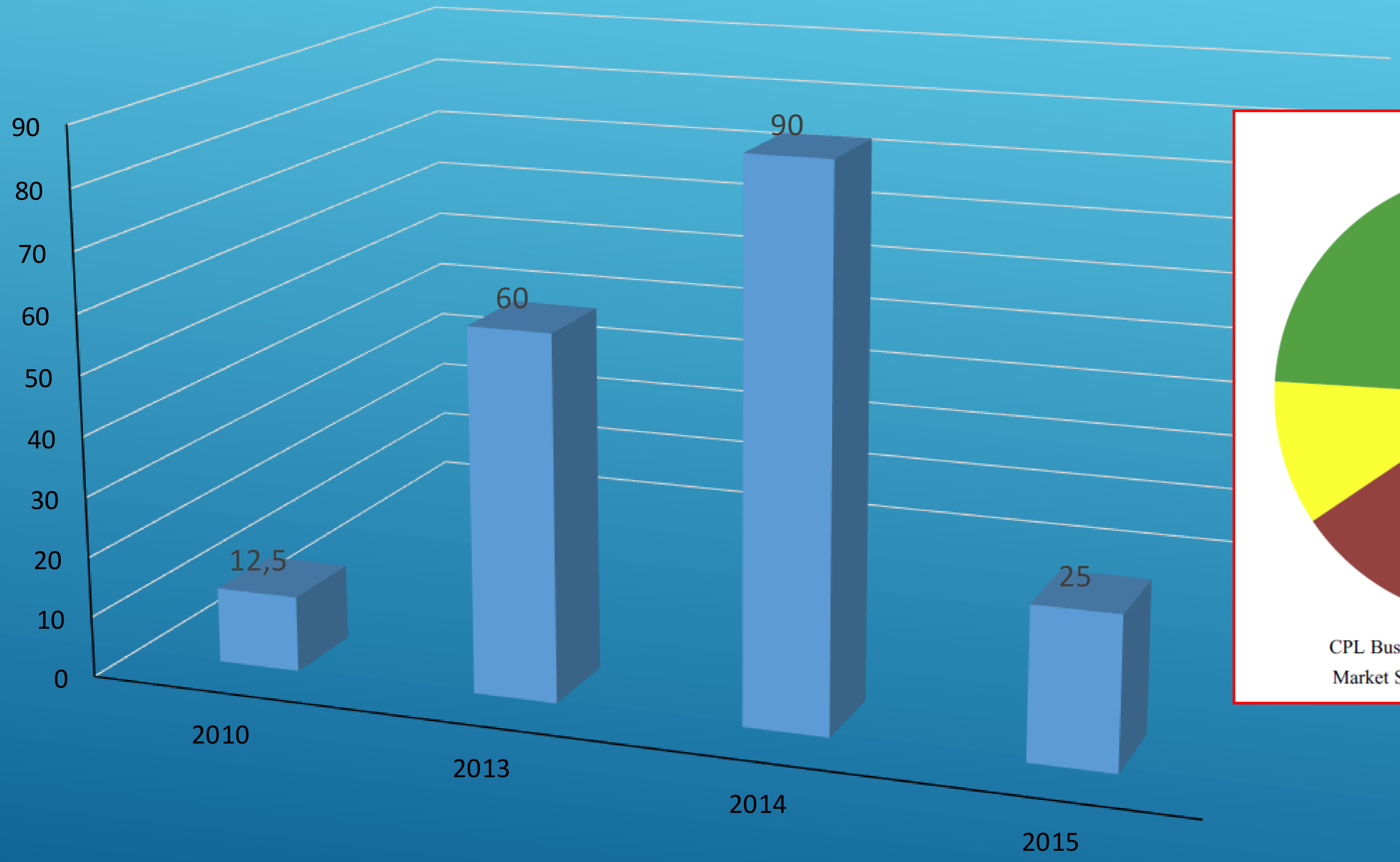
Thuricide

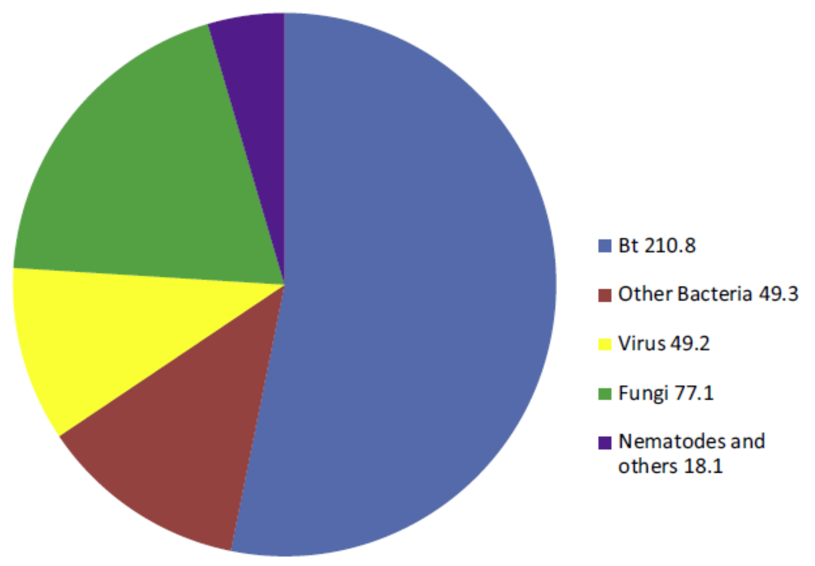
Ponto Final

Xentari

Helicoverpa armigera

ESTIMATIVA DO MERCADO BRASILEIRO DE BIOINSETICIDAS A PARTIR DE 2010 (milhoes de dolares)



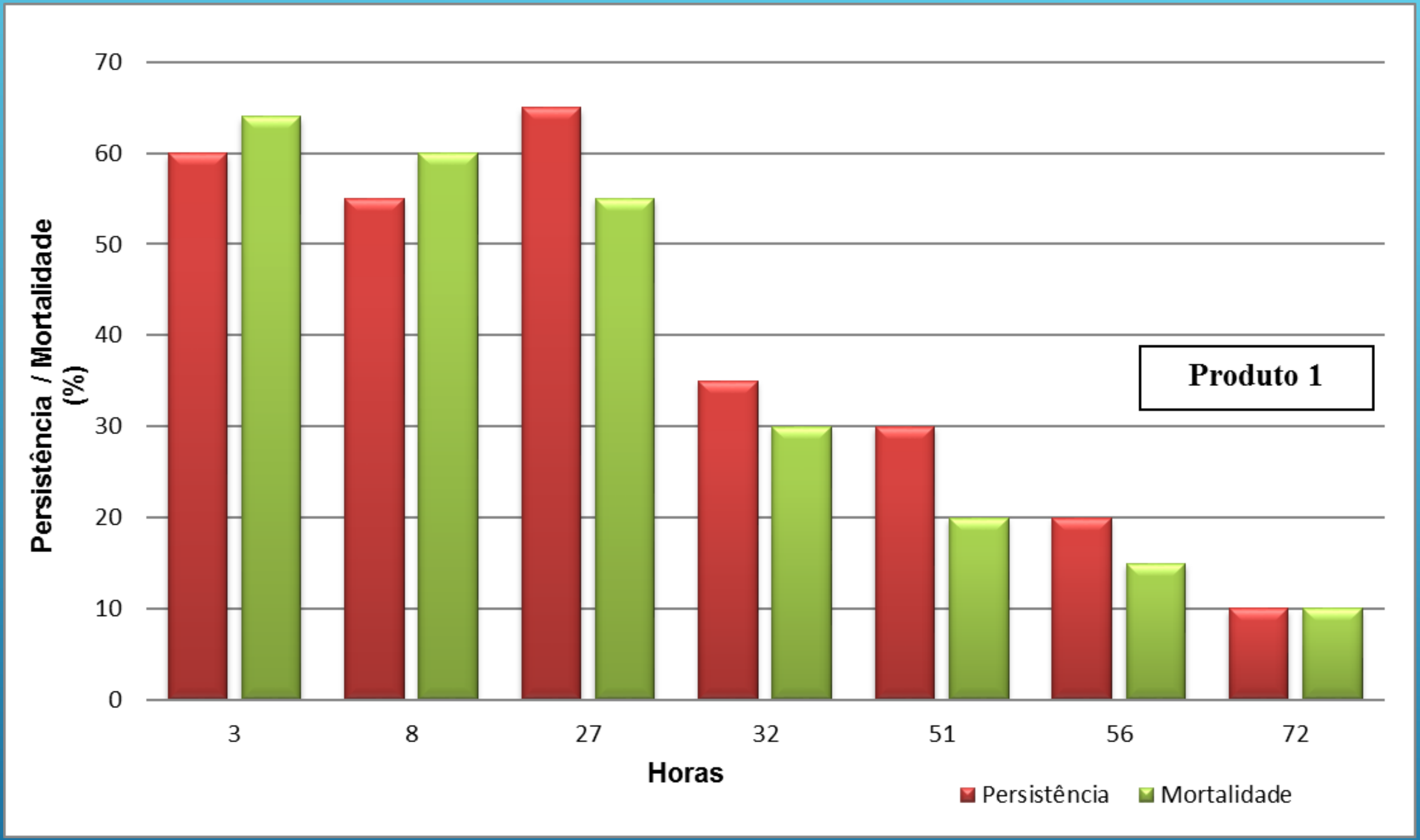


CPL Business Consultants (2010) The 2010 Worldwide Biopesticides Market Summary, (Vol. 1), CAB International Centre. Wallingford.

Razoes para a redução do mercado de *Bt* bioinseticidas

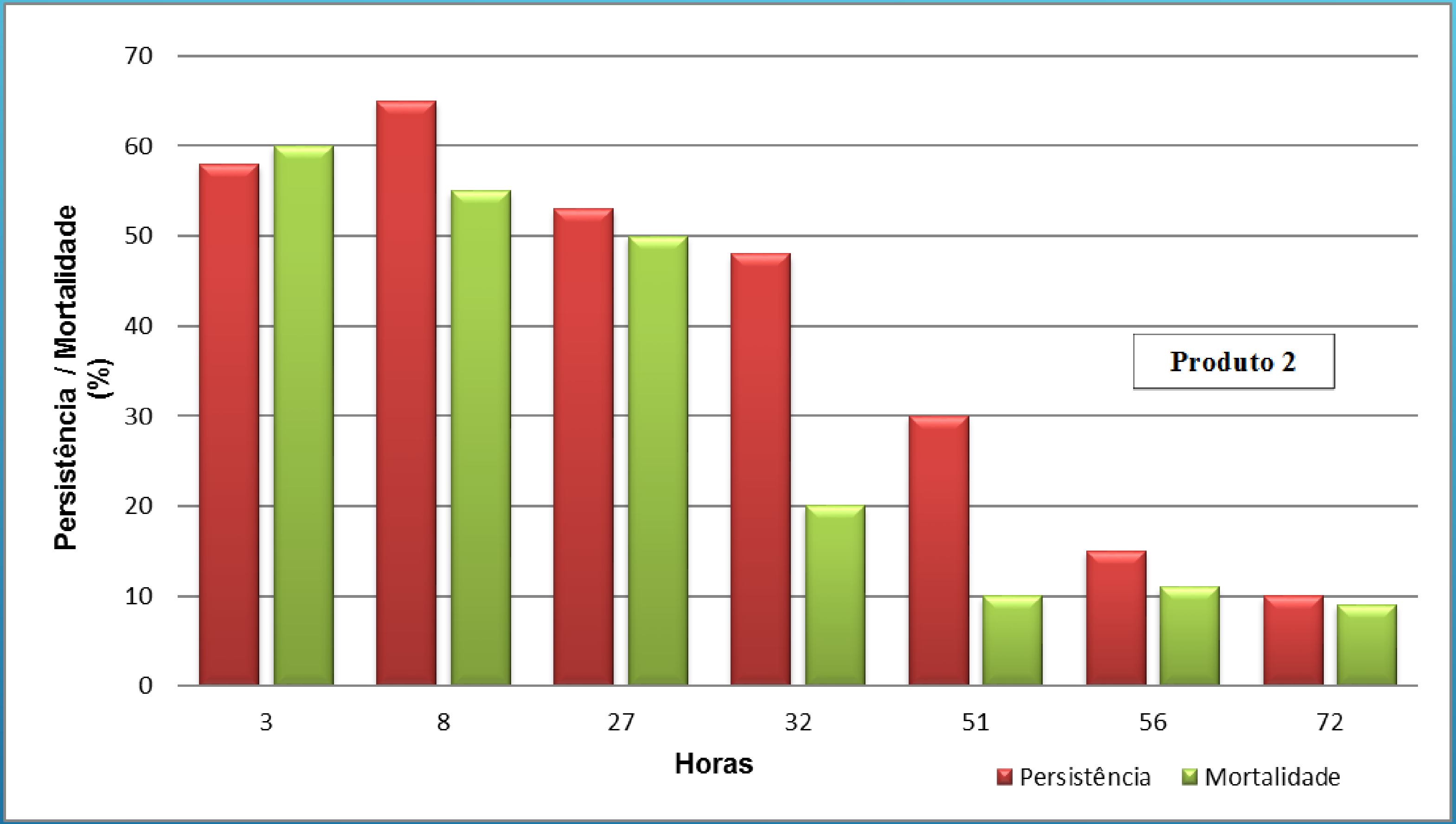
- Soja *Bt* Cry1Ac
- Condições climáticas (excesso de chuva)
- *Bt* "caseiro" (1000 L de água, 2 L de Dipel, 10 L de creme de milho e 8 kg de açúcar)
- Mistura de produtos
- Redução da ocorrência de *H. armigera*
- Importação benzoato
- Baixa persistência

Processo FAPESP 2014/23183-6



Persistência de bioinseticidas a base de *Bt* x mortalidade *Helicoverpa armigera* na cultura do milho

Processo FAPESP 2014/23183-6



Persistência de bioinseticidas a base de *Bt* x mortalidade *Helicoverpa armigera* na cultura do milho

Processo PIPE FAPESP 2015/15908-3

Desenvolvimento de microcápsulas de defensivos agrícolas orgânicos por spray dryer

Ecdytolopha aurantiana

Diatraea saccharalis

SAFRA 2011 - 2012				
CULTURA	ALGODÃO		CULTURA	ALGODÃO
PRODUTO	DOSE		PRODUTO	DOSE
CELEIRO	0,8		CERCOBIM	1
DIPEL	0,5		SUMILEX	0,8
KARATE	0,12		KRAFT	0,25
SAURUS	0,2		SAURUS	0,2
KRAFT	0,25		XENTARI	0,5
AUREO	0,2		AUREO	0,2
BOROMAG	1			

SAFRA 2011 - 2012				
CULTURA	ALGODÃO		CULTURA	ALGODÃO
PRODUTO	DOSE		PRODUTO	DOSE
LARVIM	0,4		POLO	0,6
DIPEL	0,5		MERTIM	0,5
SAURUS	0,2		BENDAZOL	1
KARATE	0,12		DIPEL	0,5
CERCOBIM	1		KARATE	0,12

Mistura de bioinseticidas a base de *Bt* com inseticidas em algodão. LEM (Bahia)

Perspectivas para o mercado de *Bt* bioinseticidas

- Alto custo dos produtos químicos clássicos de amplo espectro
- Alto impacto dos inseticidas convencionais sobre o meio ambiente

Ciência Rural, Santa Maria, v.42, n.10, p.1715-1721, out, 2012
ISSN 0103-8478

Risco de contaminação das águas de superfície e subterrâneas por agrotóxicos recomendados para a cultura do arroz irrigado

Risk assessment of surface and groundwater contamination by the rice pesticides

Luiz Fernando Dias Martini[I] Sergiane Souza Caldas[II] Catia Marian Bolzan[II] Angela Da Cas Bundt[I] Ednei Gilberto Primel[II] Luis Antonio de Avila[I*]

O controle biologico de pragas também e uma questão de saúde publica

Perspectivas para o mercado de *Bt* bioinseticidas

- Alto custo dos produtos químicos clássicos de amplo espectro
- Alto impacto dos inseticidas convencionais sobre o meio ambiente
- Grande diversidade de toxinas inexploradas

Potencial de uso de toxinas Cry de *Bt* para Lepidoptera e Coleoptera

Bioinseticidas

Lepidoptera	Coleoptera
Cry1 (A – G)	Cry1 (B e I)
Cry 2A	Cry 3 (A,B e C)
Cry 1H	Cry7A
Cry1J	Cry 8 (A e G)
Cry1 K	Cry 9D
Cry7B	Cry 14 A
Cry8D	Cry18A
Cry9 (A,B,C e E)	Cry 22 (A e B)
Cry15A	Cry 23 A
Cry22A	Cry 34 (A e B)
Cry32A	Cry 35 (A e B)
Cry51A	Cry 36 A
	Cry 37 A
	Cry 43 (A e B)
	Cry 55 A

Perspectivas para o mercado de *Bt* bioinseticidas

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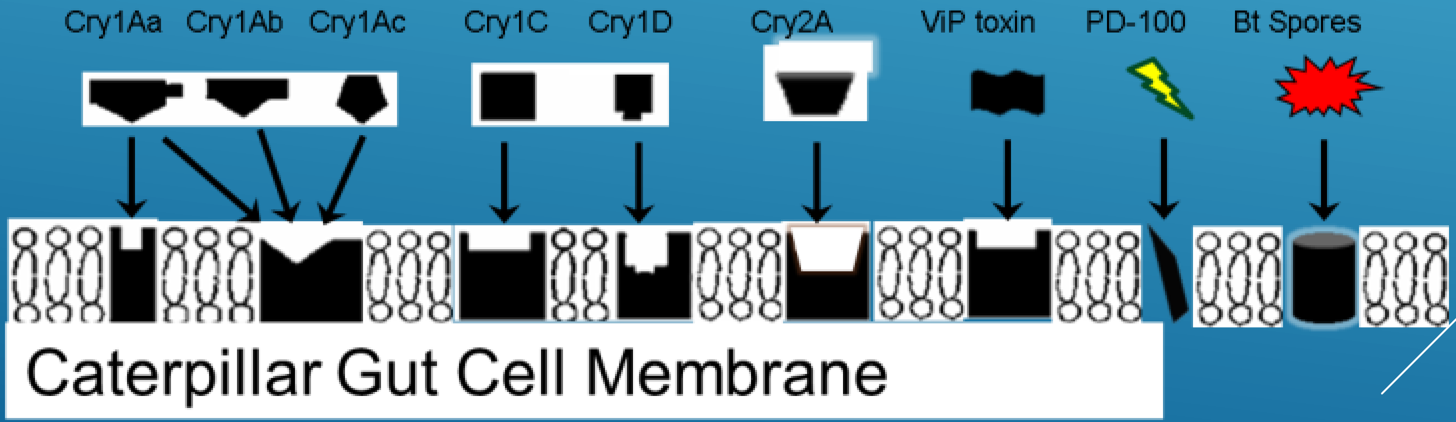
- Alto impacto dos inseticidas convencionais sobre o meio ambiente
- Grande diversidade de toxinas inexploradas
- Perspectiva de melhoria das formulações
- Durabilidade da tecnologia plantas *Bt*
- Mercado internacional extremamente ativo

Sympatico™

BIOLOGICAL INSECTICIDE

6 Cry Toxins – Broadest spectrum lepidopteran control



(Adapted from Ferré & van Rie, 2002)

Perspectivas para o mercado de *Bt* bioinseticidas

- Alto custo dos produtos químicos clássicos de amplo espectro
- Alto impacto dos inseticidas convencionais sobre o meio ambiente
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- Perspectiva de melhoria das formulações
- Durabilidade da tecnologia plantas *Bt*
- Mercado internacional extremamente ativo
- O *Bt* e um agente de controle biologico "multidisciplinar"

Rev Saúde Pública 2003;37(6):813-6
www.fsp.usp.br/rsp

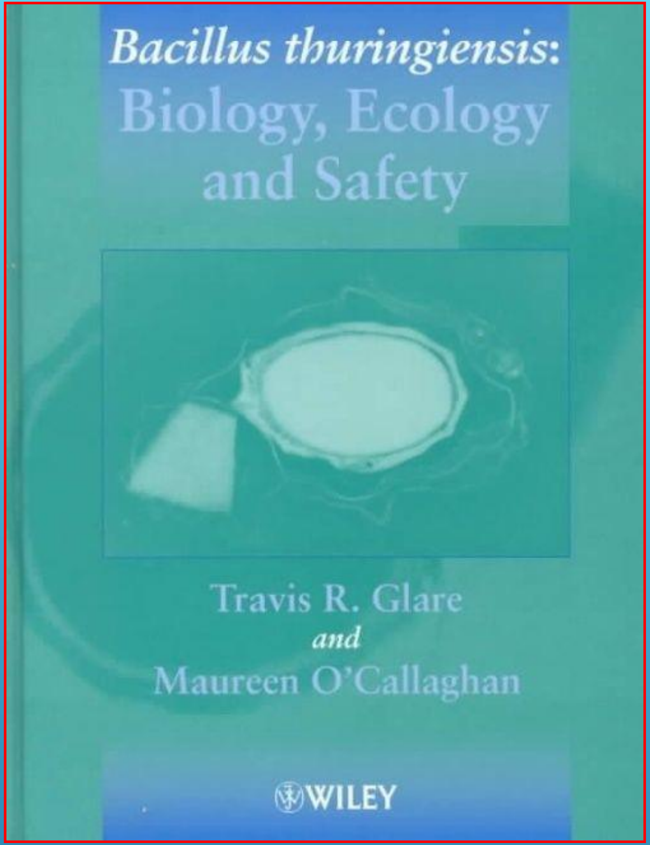
Atualização — *Current Comments*

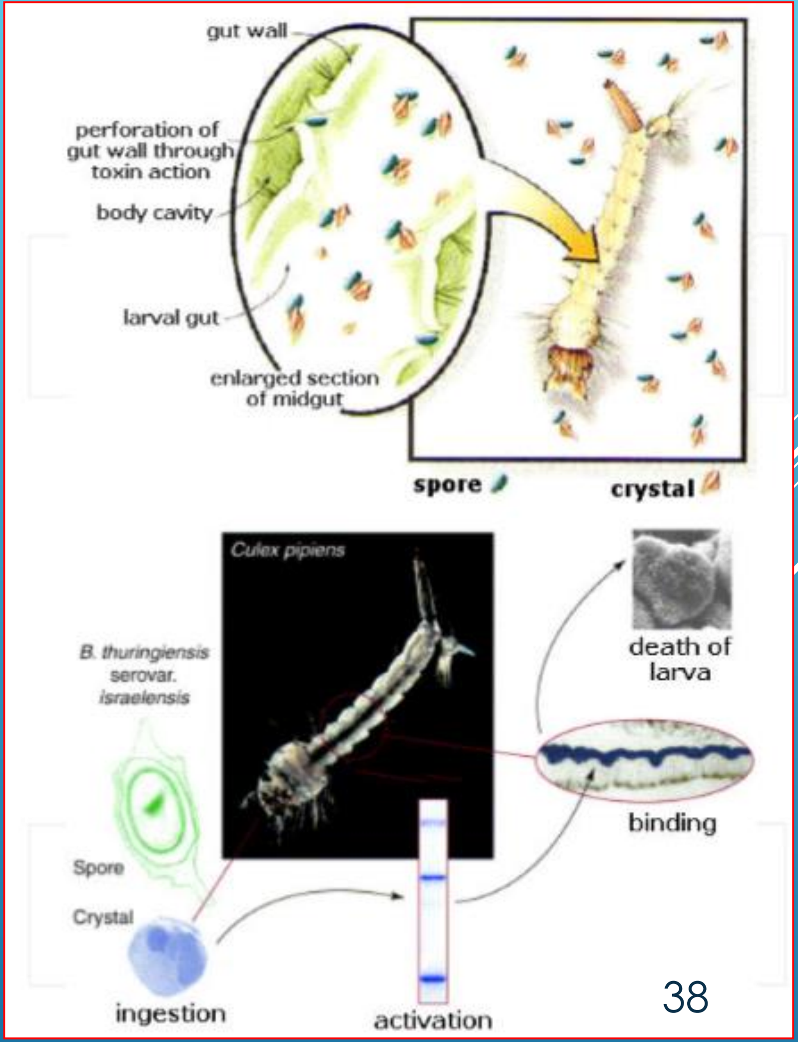
Potencial de *Bacillus thuringiensis israelensis* Berliner no controle de *Aedes aegypti*

Potential of *Bacillus thuringiensis israelensis* Berliner for controlling *Aedes aegypti*

Ricardo Antonio Polanczyk, Marcelo de Oliveira Garcia e Sérgio Batista Alves

Departamento de Entomologia, Fitopatologia e Zoologia Agrícola. Escola Superior de Agricultura "Luiz de Queiroz" da Universidade de São Paulo. São Paulo, SP, Brasil





Bt aizawai, Bt amagiensis, Bt canadensis, Bt darmstadiensis, Bt entomocidus, Bt fukuakensis, Bt galleriae, Bt jagathesan, Bt kenyae, Bt kurstaki, Bt kyushuensis, Bt malaysiensis, Bt medellin, Bt morrisoni, Bt pakistani, Bt thompsoni, Bt thuringiensis, Bt tochigiensis, Bt tolworthi.

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