Embrapa

Ministério da Agricultura e do Abastecimento - MA
Empresa Brasileira de Pesquisa Agropecuária - EMBRAPA
Centro de Pesquisa Agropecuária dos Cerrados - CPAC

RELATÓRIO DE VIAGEM AO JAPÃO

Período: 10/06/96 a 02/07/96

Maria Alice Santos Oliveira
Pesquisadora - Entomologia

EMBRAPA/CERRADOS

Embrapa

Ministério da Agricultura e do Abastecimento - MA
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PROCESSO DE SELEÇÃO: selecionada como bolsista para estudo do sistema de pesquisa na área de Entomologia no âmbito do projeto "Suporte Técnico Científico para o Desenvolvimento Agrícola Sustentável dos Cerrados" desenvolvido pela EMBRAPA/CERRADOS e JICA.

PROCESSO de Afastamento e Autorização do MAARA nº 21.000.000868/96-87, Seção 2, DOU nº 88 de 08/05/96 com ônus para a JICA.

LOCAL: Tsukuba/Kyushu- Japão

OBJETIVO: Intercâmbio científico e conhecimento de novas metodologias de controle de pragas no Japão.

ROTEIRO DA VIAGEM:

BRASÍLIA (DF)-SÃO PAULO (SP)-TÓQUIO (JAPÃO)
TSUKUBA (Província de Ibaraki)
KUKI (Província de Saitama)
HAKATA(Província de Fukuoka-Kyushu)
KUMAMOTO (Província de Kumamoto-Kyushu)
NAGOYA (Província de Aichi)
TSU (Província de Mie)
SHIMADA E KANAYA (Província de Shizuoka)

PROGRAMA DE TREINAMENTO
Bolsista: Maria Alice Santos Oliveira
Periodo: 12/06/96 a 02/07/96

DATA	CONTEÚDO
12/06/96 (QUA)	Chegada em Tokyo→ Tsukuba
13/06/96 (QUI)	Briefing
14/06/96 (SEX)	Visita de cortesia ao Ministério da Agricultura, Floresta e Pesca do Japão e à Matriz da JICA.
15/06/96 (SÁB)	
16/06/96 (DOM)	
17/06/96 (SEG)	Visita ao National Institute of Agro-Enviromental Sciences-NIAES-Controle de pragas- (Dr. Miyazaki).
18/06/96 (TER)	Visita ao National Institute of Sericultural and Entomological Science
19/06/96 (QUA)	Visita ao National Agriculture Research Center and Fruit Tree Research Station
20/06/96 (QUI)	Visita à Estação Experimental de Horticultura de Saitama
21/06/96 (SEX)	Visita à KUBOTA S/A.
22/06/96 (SÁB)	Translado Tsukuba→Hakata
23/06/96 (DOM)	
24/06/96 (SEG)	Visita à Universidade de Kyushu (Laboratório de Controle Biológico)
25/06/96 (TER)	Translado Hakata→Kumamoto e Visita à Kyushu National Agricultural Experiment Station.
26/06/96 (QUA)	Translado Kumamoto→Nagoya
27/06/96 (QUI)	Visita à National Research Institute of Vegetables, Ornamental Plants and Tea (NIVOT).
28/06/96 (SEX)	Continuação da visita anterior
29/06/96 (SÁB)	
30/06/96 (DOM)	
01/07/96 (SEG)	Avaliação do treinamento na JICA
02/07/96 (TER)	Retorno ao Brasil

10/06/96 - Saída de Brasília
11/06/96 - Em viagem
12/06/96 - Chegada ao Japão

13/06/96 - Briefing (orientações sobre o treinamento e outras informações a respeito da vida no Japão)- TSUKUBA (Dr. TANAKA, Dr.KOBAYASHI e Sra Coordenadora Wada HEIKO).

14/06/96 - Visita ao Ministério da Agricultura e JICA (Tokyo)

No Ministério da Agricultura fomos recebida pela Dra. Masako SAITO que nos fez um relato da agricultura no Japão, onde a produção agrícola corresponde a 10% em relação á Indústria (90%), fato este que faz do País um grande importador de alimentos. Em termos de área 68% do Japão é ocupado com florestas e áreas montanhosas; 14% área agricutável, deste total 60% são cultivados com arroz. A área média de produção é em torno de 1,3 ha com exceção da região de Hokaido onde a área é de aproximadamente 14 ha, área esta unsuficiente para a produção de alimentos para o país como um todo, quando em comparação com os Estados Unidos cuja área média é de 187 ha. No quadro anexo podemos observar a relação entre a produção doméstica e os principais produtos importados. Dentre as preocupações dos agricultores japoneses estão a continuação de seus esforços em reduzir custos, aumentar a qualidade e diversificar a produção.

Na JICA fomos recebida pelos Drs. Yoshitaka SUMI e Yoshikasu TACHIHARA que nos deram as boas vindas ao programa de treinamento no Japão, com um breve relato sobre o programa, com ênfase na transferência de tecnologia e aproveitamento da mesma em países em desenvolvimento, como o Brasil.

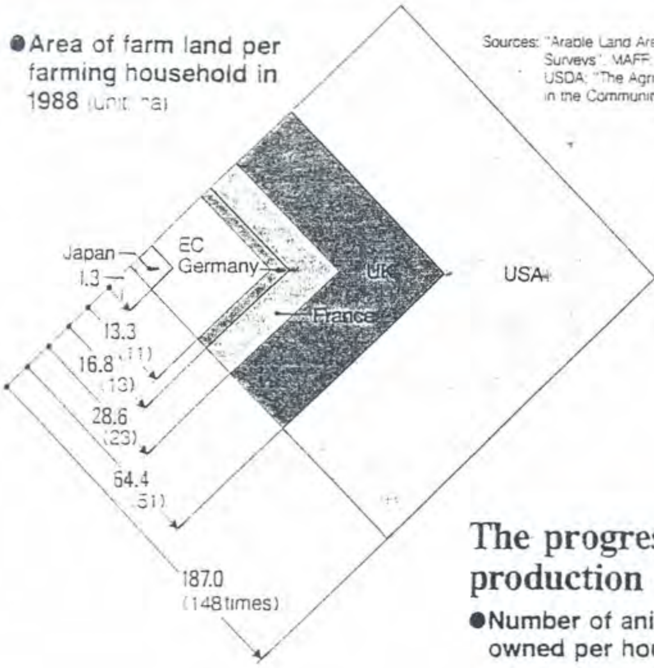
15/06/96 - Sábado

16/06/96 - Domingo

17/06/96

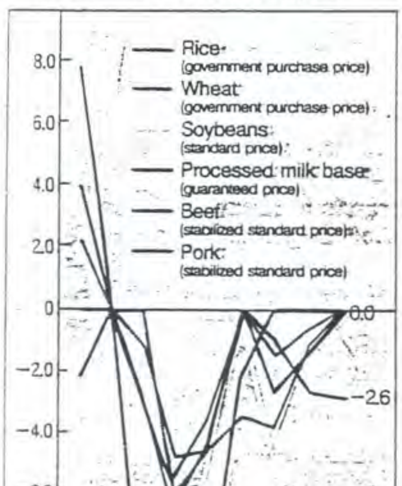
Visita ao National Institute of Agro-Enviromental Sciences - NIAES em Tsukuba, onde fomos recepcionada pelo Dr. Isamu NOUCHI, Chefe da Divisão de Ligação que nos apresentou a sistemática do Instituto e os trabalhos desenvolvidos, com apresentação de um vídeo sobre o título: "**PENSANDO NA AGRICULTURA DO FUTURO**". Após esta apresentação percorremos vários laboratórios acompanhada pelo Dr. M. MYAZAKI, Chefe da Seção de Entomologia deste Instituto. Iniciamos pelo laboratório de Sistemática de Insetos, onde os Drs.Takeshi MATSUMURA,(Chefe do laboratório), Kasuhito KONISHI e Yasuda KAJI nos aguardavam. Visitamos o Museu de Insetos, preparado à prova de fogo e à terremoto, onde tivemos a oportunidade de nos deparar com coleções especiais, de famosos entomologistas japoneses, tais como: KUROSAWA COLLECTION e SHIRAKI COLLECTION. Segundo Dr. MATSUMURA o Japão já coletou mais de 1 milhão de insetos e os mantém conservados por mais de 100 anos. Em seguida nos dirigimos para o laboratório de Comportamento de insetos, onde assistimos a uma excelente apresentação feita pelo Dr. Osamu SAITO sobre Bioquímicos, especialmente Feromônios. Neste laboratório desenvolve-se estudos sobre criação, ciclo de vida e reprodutivo além da

●Area of farm land per farming household in 1988 (unit: ha)



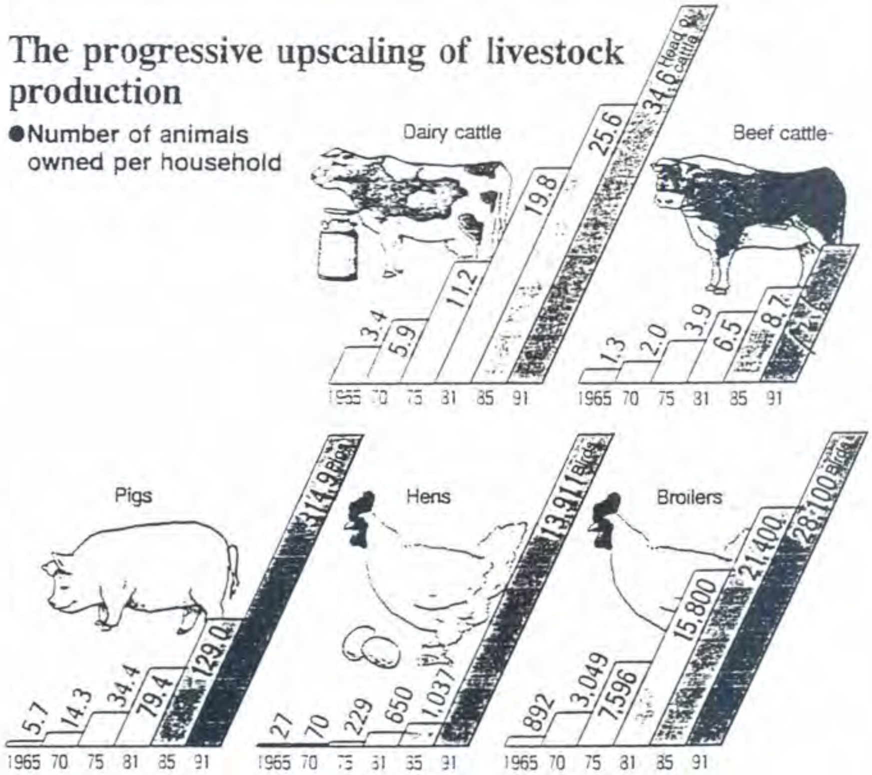
Sources: "Arable Land Area Statistics", "Agricultural Surveys", MAFF; "Agricultural Statistics", USDA; "The Agricultural Situation in the Community", EC

●Movements in official prices for farm produce (rate of increase or decrease from previous year)



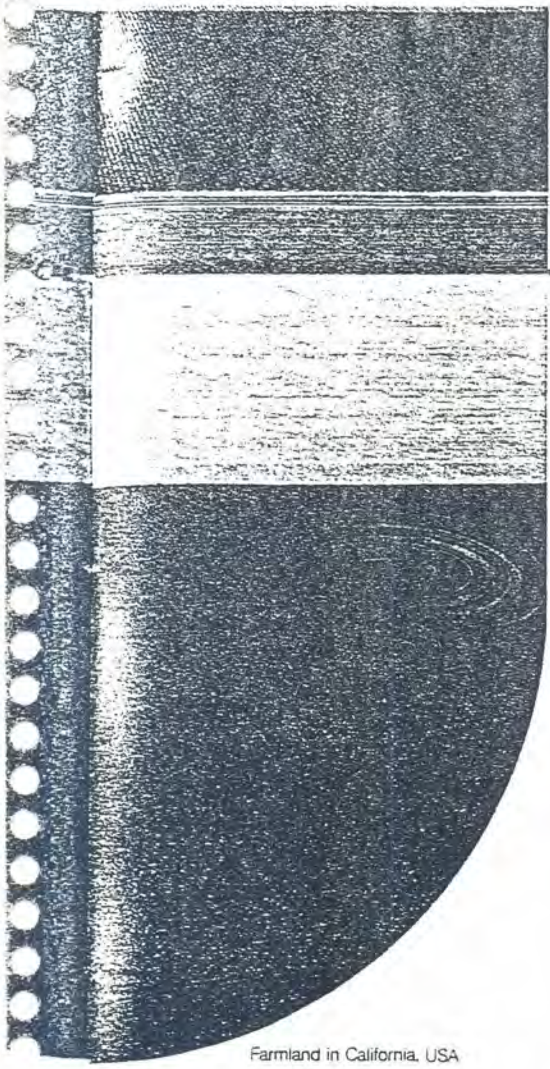
The progressive upscaling of livestock production

●Number of animals owned per household



●Movements in comprehensive prices of farm and fishery produce (fiscal 1990 = 100)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Agricultural product price index (all-inclusive)	94.4	97.1	95.0	97.1	97.5	97.5	92.5	91.1	93.9	96.5	100.0	104.4
Market wholesale price index for areas producing main types of fish (all-inclusive)	84.1	92.0	96.5	90.2	90.9	91.5	89.6	86.6	89.5	94.3	100.0	100.7
Consumer commodity price index (all-inclusive)	81.7	85.6	88.0	89.6	91.7	93.5	94.1	94.2	94.9	97.0	100.0	103.3



Farmland in California, USA

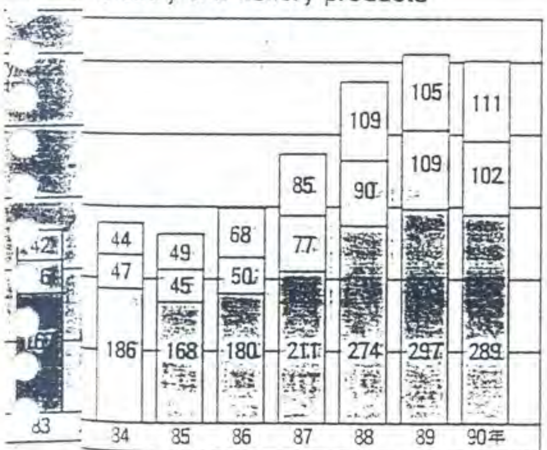
The relationship between domestic production and imports of main food items

●Food supply and demand in Japan in fiscal 1990 (unit: thousand tons)

ITEM	DOMESTIC PRODUCE	EXTERNAL TRADE		VOLUME DESTINED FOR DOMESTIC CONSUMPTION
		IMPORTS	EXPORTS	
Rice	10,499	50	0	10,484
Wheat	952	5,307	0	6,270
Soybean	220	4,681	0	4,821
Vegetables	15,739	1,551	2	17,288
Fruits	4,882	2,979	29	7,734
Beef	554	549	0	1,094
Pork	1,536	488	0	2,066
Milk and dairy products	8,203	2,237	3	10,583
Fish and shellfish	10,278	3,823	1,118	13,034
Alcoholic beverages(note)	9,095	263	46	9,405

…icu ltural, forestry, and fishery products

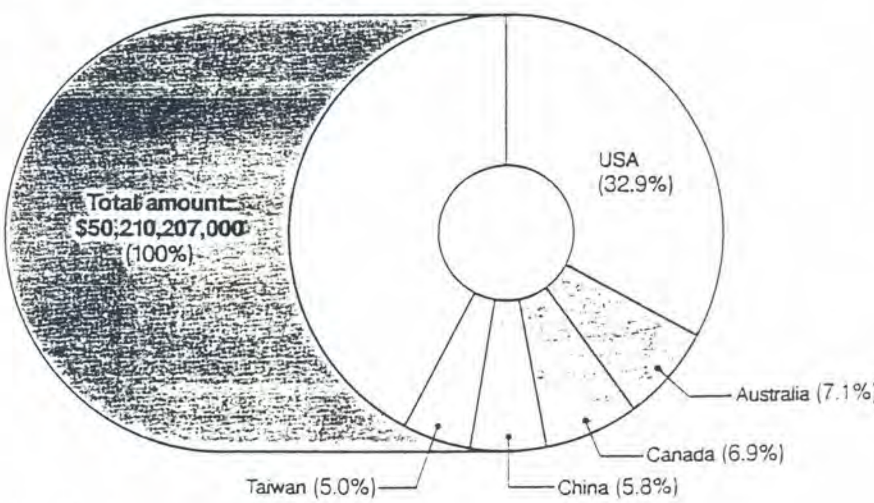
…ultural, forestry and fishery products



Source: Trade Statistics, Ministry of Finance

Japan is the biggest importer of agricultural, forestry, and fishery products from USA

●The top five sources of agricultural, forestry, and fishery products in 1990 (in parentheses: component ratio)



Source: Trade Statistics, Ministry of Finance

JICA

TSUTOMU TANAKA
SECOND TRAINING DIVISION

TSUKUBA INTERNATIONAL CENTRE (TBIC)
JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

No. 3-7, KOYADAI, TSUKUBA-SHI, IBARAKI-KEN, 305 JAPAN
TEL 0298-38-1715, 1775
FAX 0298-38-1776

MASATO KOBAYASHI
TRAINING COORDINATOR
TSUKUBA OFFICE
JAPAN INTERNATIONAL COOPERATION CENTER

C/O TSUKUBA INTERNATIONAL CENTER JICA
3-6 KOHYADAI TSUKUBA-SHI
IBARAKI-KEN 305
TEL : 0298-38-1 1 4 4
FAX : 0298-36-4 9 6 1

財団法人 日本国際協力センター
研修監理部 研修監理員

和 田 英 子
WADA EIKO

COORDENADORA
CENTRO DA COOPERAÇÃO INTERNACIONAL DO JAPÃO (JICE)

MASAKO SAITO

SECTION CHIEF (TRAINING)
INTERNATIONAL TECHNICAL CO-OPERATION DIVISION
ECONOMIC AFFAIRS BUREAU
MINISTRY OF AGRICULTURE, FORESTRY & FISHERIES

1-2-1, KASUMIGASEKI
CHIYODA-KU, TOKYO, JAPAN

TEL (03) 3501-7403
FAX (03) 3501-0581

JICA

Yoshitaka Sumi

DEPUTY DIRECTOR
AGRICULTURAL TECHNICAL COOPERATION DIVISION
AGRICULTURAL DEVELOPMENT COOPERATION DEPARTMENT
JAPAN INTERNATIONAL COOPERATION AGENCY
(J I C A)

SHINJUKU MAYNDS TOWER BLDG. 7TH FLOOR
1-1, YOYOGI, 2-CHOME
SHIBUYA-KU, TOKYO, 151, JAPAN

TEL: 81-3-5352-5262
FAX: 81-3-5352-5348

JICA

Yoshikazu TACHIHARA

AGRICULTURAL TECHNICAL COOPERATION DIVISION
AGRICULTURAL DEVELOPMENT COOPERATION DEPARTMENT
JAPAN INTERNATIONAL COOPERATION AGENCY
(J I C A)

SHINJUKU MAYNDS TOWER BLDG. 7TH FLOOR
1-1, YOYOGI, 2-CHOME
SHIBUYA-KU, TOKYO, 151, JAPAN

TEL: 81-3-5352-5263
FAX: 81-3-5352-5348

TOSHIAKI IMAGAWA Ph.D.

PHYSICAL GEOGRAPHER

CHIEF, LABORATORY OF LAND EVALUATION
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

NATIONAL INSTITUTE OF
AGRO-ENVIRONMENTAL SCIENCES
TEL. 81-298-38-8277

3-1-1, KANNONDAI, TSUKUBA,
305 JAPAN
FAX. 81-298-38-8199
e-mail : imagawa@niaes.affrc.go.jp

NIAES NATIONAL INSTITUTE OF AGRO-ENVIRONMENTAL SCIENCES

Dr. MICHIKAZU FUKUHARA

DIRECTOR
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

KANNONDAI 3-1-1, TSUKUBA-SHI, 305 JAPAN
(PHONE 81-298-38-8203, FAX 81-298-38-8199)

農業環境技術研究所
環境資源部土壌管理科長

Head, Division of Soil Science
National Institute of
Agro-Environmental Sciences
TSUKUBA, IBARAKI,305 JAPAN

岩　間　秀　矩
Dr HIDENORI IWAMA

[illegible]

Dr. Isamu NOUCHI

Head, International and Domestic Liaison Division
National Institute of Agro-Environmental Sciences
Kannon-dai 3-1-1, Tsukuba, Ibaraki 305, Japan
Phone: +81-298-38-8161 or 8145
Fax: +81-298-38-8199
E-Mail: nouchi@ss.niaes.affrc.go.jp

Dr. M. MIYAZAKI

DIVISION OF ENTOMOLOGY
DEPARTMENT OF ENVIRONMENTAL BIOLOGY
NATIONAL INSTITUTE OF AGRO-ENVIRONMENTAL SCIENCES

KANNONDAI 3-1-1,
TSUKUBA, IBARAKI, 305 JAPAN
PHONE(0298)38-8306
FAX (0298)38-8199
E-MAIL @mcailis.niaes.go.jp. affrc.

Takeshi MATSUMURA, D. Sc.

CHIEF (ENTOMOLOGIST)
LABORATORY OF INSECT SYSTEMATICS,
DIVISION OF ENTOMOLOGY,
NATIONAL INSTITUTE OF AGRO-ENVIRONMENTAL SCIENCES,
MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES

KANNONDAI, TSUKUBA,
IBARAKI 305, JAPAN
TEL:0298-38-8315
8348
FAX:0298-38-8199

Dr. Osamu SAITO

ENTOMOLOGIST

Laboratory of Insect Behavior
National Institute of Agro-Environmental Science

3-1-1, KANNONDAI, TSUKUBA, IBARAKI 305, JAPAN
PHONE: 0298-38-8434
F A X: 0298-38-8434

PHONE (0298) 38-8313
FAX (0298) 38-8199

OSAMU IMURA

Head of Population Ecology Laboratory

DIVISION OF ENTOMOLOGY
NATIONAL INSTITUTE OF AGRO-ENVIRONMENTAL SCIENCES
MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES
3-1-1 KANNONDAI TSUKUBA
IBARAKI 305, JAPAN

DR. EIZI YANO

DIVISION OF ENTOMOLOGY,
NATIONAL INSTITUTE OF AGRO-ENVIRONMENTAL SCIENCES, MAFF

3-1-1, KANNONDAI, TSUKUBA,
IBARAKI 305, JAPAN
TEL. 0298-38-8314
FAX. 0298-38-8199
E-mail yano@niaes.affrc.go.jp

Masahiko KUWAHARA Ph.D.
(INSECT TOXICOLOGIST)

CHIEF OF INSECTICIDE CHEMISTRY
DIVISION OF PESTICIDES
NATIONAL INSTITUTE OF AGRO-ENVIRONMENTAL SCIENCES(NIAES)

KANNONDAI 3-1-1, TSUKUBA, IBARAKI 305, JAPAN
PHONE:0298-38-8324 FAX:0298-38-8199

農林水産省農業環境技術研究所
環境生物部昆虫管理科昆虫分類研究室
Laboratory of Insect Systematics, NIAES

小 西 和 彦
Kazuhiko Konishi

勤務先 305 茨城県つくば市観音台3-1-1
電話 0298-38-8348
自 宅 305 茨城県つくば市吾妻1丁目403-909
電話 0298-58-1989
E-mail Konishi@niaes.affrc.go.jp

National Institute of Agro-Environmental Sciences
Division of Entomology
Laboratory of Insect Systematics

Dr. YASUDA Koji
Senior researcher

Kannondai 3-1-1, Tsukuba, Ibaraki 305
JAPAN
Tel 0298-38-8348
Fax 0298-38-8199

Dr Hiroshi YAEGASHI
Plant Pathologist

NATIONAL INSTITUTE OF AGRO-ENVIRONMENTAL SCIENSES
KANNONDAI, TSUKUBA, IBARAKI 305, JAPAN
TEL (0298) 38-8295
FAX (0298) 38-8199

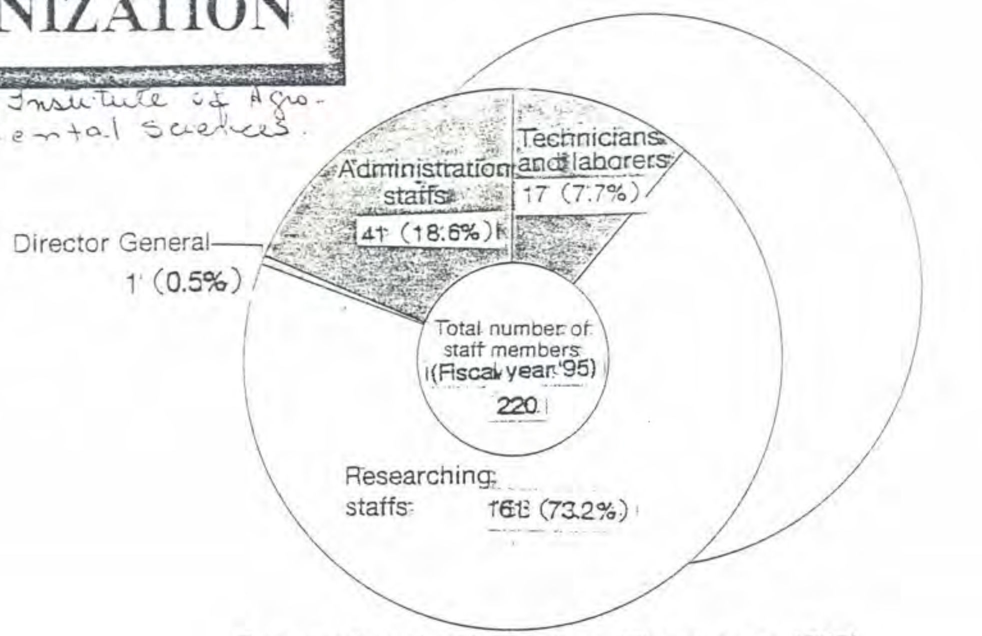
Dr. MASAYUKI NEMOTO

CHIEF VEGETATION CONSERVATION LAB.
NATIONAL INSTITUTE OF AGRO-ENVIRONMENTAL SCIENCES

3-1-1 KANNONDAI, TSUKUBA-SHI
IBARAKI-KEN 305, JAPAN
TEL 0298-38-8327

ORGANIZATION

National Institute of Agro-Environmental Sciences.



Total number of staff members (Fiscal year 1995)

Director General

Department of Research Planning and Coordination
- Research Planning Division
- International and Domestic Liaison Division
- Research Information Coordinator
- Documentation and Information Division
- Division of Experimental Farm
- Division of Changing Earth and Agro-Environment

Environmental Research Coordinator

Administration Department
- General Affairs Section
- Accounts Section

Department of Environmental Management
- Division of Environmental Planning
  - (Laboratory of)
  - Land Evaluation
  - Resource Dynamics
  - Impact Assessment
  - Rural Landscape
  - Vegetation Dynamics
- Division of Information Analysis
  - (Laboratory of)
  - Remote Sensing
  - Agrobiological Measurements
  - Isotope Technology
  - Biometrics
  - Statistics
  - Data Analysis and system

Department of Natural Resources
- Division of Agrometeorology
  - (Laboratory of)
  - Climatic Resources
  - Micrometeorology
  - Bioclimatology
  - Air Quality Conservation
- Division of Soil Science
  - (Laboratory of)
  - Soil Survey and Classification
  - Soil Genesis
  - Soil Inorganic Chemistry
  - Soil Physics
  - Soil Biochemistry
  - Soil Organic Chemistry
  - Soil Conservation
- Division of Water Quality Science
  - (Laboratory of)
  - Water Quality Assessment
  - Water Quality Dynamics
  - Water Quality Conservation

Department of Environmental Biology
- Division of Vegetation Science
  - (Laboratory of)
  - Plant Sociology
  - Vegetational Ecosystem Conservation
  - Allelopathy
- Division of Microbiology
  - (Laboratory of)
  - Microbial Systematics
  - Pathology
  - Soil Microbial Systematics
  - Soil Microbial Ecology
  - Soil General Microbiology
  - Nematology and Soil Zoology
- Division of Entomology
  - (Laboratory of)
  - Insect Systematics
  - Insect Behavior
  - Biological Control Agents
  - Population Ecology

Department of Farm Chemicals
- Division of Pesticides
  - (Laboratory of)
  - Fungicide Chemistry
  - Insecticide Chemistry
  - Herbicide Chemistry
  - Pesticide Resistance
  - Environmental Pesticide Assessment
- Division of Fertilizers
  - (Laboratory of)
  - Macro-components
  - Micro-components
  - Waste Resources

RESEARCH OBJECTIVES

1. **Agro-environmental resources**
   Characteristics and functions of non-biological and biological resources and of farm chemicals
2. **Agro-ecosystems**
   Mechanisms and functions of the matter-energy cycle and interrelations among elements
3. **Environmental control**
   Planning and coordination of surveys, determinations, analyses, information systems as well as evaluation and forecasting activities
4. **Global ecosystems**
   Dynamics of components, impact of agro-environmental changes on agro-ecosystems, preservation of global ecosystems

昆虫管理科長

ORGANIZATION

2.6.18

農業環境技術研究所

- 所長
  - 企画連絡室
    - 企画科
    - 連絡科
    - 情報資料課
    - 業務科
    - 地球環境研究チーム
  - 総務部
    - 庶務課
    - 会計課
  - 環境研究官
  - 環境管理部
    - 資源・生態管理科
      - 環境立地研究室
      - 資源・環境動態研究室
      - 影響調査研究室
      - 農村景域研究室
      - 植生動態研究室
    - 計測情報科
      - 隔測研究室
      - 生物情報計測研究室
      - 分析法研究室
      - 数理解析研究室
      - 調査計画研究室
      - 情報処理研究室
      - 情報システム研究室
  - 環境資源部
    - 気象管理科
      - 気候資源研究室
      - 気象特性研究室
      - 気象生態研究室
      - 大気保全研究室
    - 土壌管理科
      - 土壌調査分類研究室
      - 土壌生成研究室
      - 土壌コロイド研究室
      - 土壌物理研究室
      - 土壌生化学研究室
      - 土壌有機物研究室
      - 土壌保全研究室
    - 水質管理科
      - 水質特性研究室
      - 水質動態研究室
      - 水質保全研究室
  - 環境生物部
    - 植生管理科
      - 植生生態研究室
      - 保全植生研究室
      - 他感物質研究室
    - 微生物管理科
      - 微生物特性・分類研究室
      - 寄生菌動態研究室
      - 土壌微生物分類研究室
      - 土壌微生物生態研究室
      - 土壌微生物利用研究室
      - 線虫・小動物研究室
    - 昆虫管理科
      - 昆虫分類研究室
      - 昆虫行動研究室
      - 天敵生物研究室
      - 個体群動態研究室
  - 資材動態部
    - 農薬動態科
      - 殺菌剤動態研究室
      - 殺虫剤動態研究室
      - 除草剤動態研究室
      - 薬剤耐性研究室
      - 農薬管理研究室
    - 肥料動態科
      - 多量要素動態研究室
      - 微量要素動態研究室
      - 廃棄物利用研究室

National Institute of Agro-Environmental Sciences

- Director General
  - Research Planning and Liaison Office
    - Research Planning Division
    - International and Domestic Liaison Division
    - Documentation and Information Division
    - Division of Experimental Farm
    - Division of Changing Earth and Agro-Environment
  - Administration Department
    - General Affairs Section
    - Accounts Section
  - Environmental Research Coordinator
  - Department of Enviornmental Management
    - Division of Environmental Planning
      - Land Evaluation
      - Resource Dynamics
      - Impact Assessment
      - Rural Landscape
      - Vegetation Dynamics
    - Division of Information Analysis
      - Remote Sensing
      - Agrobiological Measurements
      - Isotope Technology
      - Biometrics
      - Statistics
      - Date Processing
      - Information System
  - Department of Natural Resources
    - Division of Agrometeorology
      - Climatic Resources
      - Micrometeorology
      - Bioclimatology
      - Air Quality Conservation
    - Division of Soil Science
      - Soil Survey and Classification
      - Soil Genesis
      - Soil Inorganic Chemistry
      - Soil Physics
      - Soil Biochemistry
      - Soil Organic Chemistry
      - Soil Conservation
    - Division of Water Quality Science
      - Water Quality Assessment
      - Water Quality Dynamics
      - Water Quality Conservation
  - Department of Environmental Biology
    - Division of Vegetation Sciencs
      - Plant Sociology
      - Vegetational Ecosystem Conservation
      - Allelopathy
    - Division of Microbiology
      - Microbial Systematics
      - Pathology
      - Soil Microbial Systematics
      - Soil Microbial Ecology
      - Soil General Microbiology
      - Nematology and Soil Zoology — Dr. T. Matsumura ①
    - Division of Entomology
      - Insect Systematics ✓ — Dr. O. Saito ② ✓
      - Insect Behavior ✓
      - Biological Control Agents — Dr. E. Yano ④
      - Population Ecology — Dr. O. Imura ③
  - Department of Farm Chemicals
    - Division of Pesticides
      - Fungicide Chemistry
      - Insecticide Chemistry — Dr. M. Kuwabara ⑤
      - Herbicide Chemistry
      - Pesticide Resistance
      - Environmental Pesticide Assessment
    - Division of Fertilizers
      - Macro-components
      - Micro-components
      - Waste Resources

Outline of Insect Museum

Laboratory of Insect Systematics
Entomological Division
Department of Environmental Biology
N I A E S

This is the sole museum in the ministry of Agriculture, Forestry and Fisheries, and one of the most important in Japan with respect to the number of specimens it contains.

1. Main duties
   (1) Collection and preservation of agricultural pests and related insects from Japan and abroad.
   (2) Identification of insects for which scientific names need to be known by researchers or civilians.
   (3) Offering use of the museum for taxonomists and lending out specimens for taxonomic research.
   (4) Housing voucher specimens that form the data base of important agricultural research.

2. Present conditions
   (1) Institution

Storage for type specimens	1 room
Storage for dry specimens	3 rooms
Storage for liquid and preparation specimens	1 room
Storage for ecological specimens and identificating laboratory	1 room

(2) Number of specimens possessed at present

Arranged specimens	800,000	
Type specimens		2,000
Taxonomic specimens		650,000
Ecological specimens		8,000
Specimens sent to museum for identification		120,000
Voucher specimens		20,000
Unarranged specimens	200,000	
Total number	1,000,000 (Full capacity)	

Number of Insect Species

1. Estimated number of insect species on earth
   2,000,000～3,000,000
   Number of species known at present 780,000
   (70～80 % of the whole animal species on earth)

2. Estimated number of Japanese insect species
   70,000～100,000
   Number of species known from Japan 30,000
   Number of agricultural pests among them 2,200
   (7 % of known species)

3. Major orders of insects and the described numbers of species
   1) Coleoptera (beetles) 300,000
   2) Lepidoptera (butterflies, moths) 112,000
   3) Hymenoptera (sawflies, wasps, bees) 103,000
   4) Diptera (flies, mosquitoes, midges) 98,500
   5) Hemiptera (bugs, cicadas, leafhoppers, aphids, scale insects) 82,000

distribuição geográfica dos insetos pragas do Japão. Continuando nosso trabalho visitamos o laboratório de Ecologia de Populações, cujo chefe Dr. Osamu IMURA nos atendeu e logo em seguida nos explicou os trabalhos realizados com pragas e inimigos naturais. Aqui são desenvolvidos 6 projetos incluindo plantas crucíferas.

No laboratório de Controle Biológico fomos recepcionada pelo Dr. Eizi YANO que nos relatou a situação do controle biológico no Japão. Comentou a respeito do uso do Bacillus thurigiensis (BT) no controle de pragas e outros inimigos naturais.Finalizando o dia visitamos o laboratório de Toxicologia, onde Dr. Masahiko KUWAHARA,chefe do laboratório nos aguardava para uma breve explicação dos trabalhos. Aqui as pesquisas estão mais direcionadas ao mecanismo de resistência de inseticidas em pragas de crucíferas, utilizando inclusive o (BT) no controle biológico.

18/06/96

Visita ao National Institute of Sericicultural and Entomological Science.

Neste Instituto começamos pela Seção de Entomologia, com seus vários laboratórios. O primeiro a nos receber foi o Dr. Yoshio HIRAI do laboratório de Fisiologia e Comportamento de Insetos, onde são desenvolvidas pesquisas com hormônios de insetos em coleopteros da família Scarabeidae. Já no laboratório de Regulamento do Comportamento Dr. Sadao WAKAMURA nos mostrou os trabalhos conduzidos com semioquímicos mais especificamente ferormônios em lepdopteros e hymenopteros. Aqui também tivemos informações sobre formigas com o Dr.Tetsuya YASUDA. Em seguida no laboratório de Criação de Inimigos Naturais o Dr. Kenjiro KAWASAKI, que trabalha com seleção de inimigos naturais em casa de vegetação, nos relatou suas experiências com predadores de ácaros, citando como exemplo o caso de ***Encarsia formosa*** (Hymenoptera-Aphelinidae) que já é produzida comercialmente no Japão.

A tarde fomos recebida pelo Dr. Masakazu SHIGA, Diretor do Departamento de Fisiologia e Comportamento de Insetos do NISES, que nos deu as boas vindas ao Departamento, bem como nos explanou os objetivos e os principais resultados de pesquisa do Departamento. Em seguida fomos para o laboratório de Seleção de Sinais, onde o Dr. Makoto HATTORI nos falou sobre resistência de plantas a insetos nas culturas de soja, faijão e arroz, trabalha com os insetos ***Etiella zincknella*** (Lep.) e ***Nilaparvata lugens*** (Hom.) (Brown planthopper) e Nephotettix cinticeps (Hom) (Green rice leafhopper). Já no laboratório de insetos pragas Dra. Sanae WADA e o Dr. Miyamato KAZUHISA nos relataram sobre estudos realizados com pragas em amoreira principalmente brocas (Cerambycidae) e o respectivo controle utilizando ***Beauveria bassiana.***

19/06/96

Pela parte da manhã visitamos o National Agriculture Resarch Center onde fomos recebida pelo Dr. Osamu MOCHIDA, que nos fez uma retrospectiva sobre as pesquisas entomológicas no Japão, com ênfase no controle biológico, como exemplo mencionou o inimigo natural *Trichograma chilonis*, parasita de ovos de *Mamestria brassicae*, praga de crucíferas. Continuando visitamos o laboratório de pragas onde os Drs. Hirai KASUO, Chie GOTO e Takeuchi HIROAKI nos aguardava. Neste laboratório são desenvolvidos trabalhos

ENTOMOLOGIST

Dr. Yoshio HIRAI

NATIONAL INSTITUTE OF SERICULTURAL AND
ENTOMOLOGICAL SCIENCE
DEPARTMENT OF INSECT PHYSIOLOGY AND BEHAVIOR
TSUKUBA, IBARAKI 305, JAPAN
TEL. 0298-38-6512

Dr. Sadao WAKAMURA

LABORATORY OF BEHAVIOR REGULATION
DEPARTMENT OF INSECT PHYSIOLOGY AND BEHAVIOR
NATIONAL INSTITUTE OF SERICULTURAL
AND ENTOMOLOGICAL SCIENCE

TSUKUBA, IBARAKI 305, JAPAN
TEL. 0298-38-6205 FAX. 0298-38-6028

National Institute of Sericultural and Entomological Science

Dr. Kenjiro Kawasaki

Chief
Laboratory of Natural Enemy Breeding
Department of Insect Genetics and Breeding
Tsukuba, Ibaraki 305, Japan Tel: 0298-38-6077
Fax: 0298-38-6028 E-mail: kenjiro@nises.affrc.go.jp

e-mail: kazshi@nises.affrc.go.jp
Masakazu SHIGA
Director
Div. Insect Physiology & Behavior
Nat'l. Inst. Sericultural
& Entomological Science (NISES)
Owashi 1-2, Tsukuba, Ibaraki 305
Japan
phone: 0298-38-6102 fax: 0298-38-6103

Dr. MAKOTO HATTORI
ENTOMOLOGIST

NATIONAL INSTITUTE OF SERICULTURAL AND
ENTOMOLOGICAL SCIENCE
DEPARTMENT OF INSECT PHYSIOLOGY AND BEHAVIOR
LABORATORY OF SIGNAL SELECTION

1-2 OHWASHI, TSUKUBA, IBARAKI 305, JAPAN
TEL 0298-38-6085
FAX 0298-38-6028

SANAE WADA ~~YAMASHITA~~

LABORATORY OF INSECT PEST
NATIONAL INSTITUTE OF SERICULTURAL
AND ENTOMOLOGICAL SCIENCE
THE MINIST OF AGRICULTURE, FORESTRY AND FISHERIES

1-2, Ohwashi, Tsukuba, Ibaraki 305, JAPAN
Phone: 0298(38)6083
Fax : 0298(38)6028

Tetsuya YASUDA

Laboratory of Behavior Regulation
Department of Insect Physiology and Behavior

National Institute of Sericultural and Entomological Science
Ministry of Agriculture, Forestry and Fisheries

1-2, Ohwashi, Tsukuba, Ibaraki 305, JAPAN
TEL.(0298)38-6205
FAX.(0298)38-6028

農林水産省蚕糸・昆虫農業技術研究所
生産技術部虫害研究室 室長
Miyamoto Kazuhisa
宮本和久

〒305 茨城県つくば市大わし1－2
Phone 0298－38－6083
Fax 0298－38－6028

NAT'L AGRIC. RES. CENTRE (NARC)
IBARAKI-KEN, TUKUBA-SI,
KAN'NONDAI, 305 JAPAN

DR. OSAMU MOCHIDA
GOVERNMENT ENTOMOLOGIST

PHONE(OFFICE):(81)298-38-8939
(RSDNCE):(81)298-52-0933
FACS :(81)298-38-8837
TELX VIA TARC :3656156 TARCJP J
CABLE ADDRESS:NARCMAFF TUKUBA

HIRAI Kazuo NARC

Head of Paddy Crop Pests Laboratory
Entomologist, Ph. D.
[Armyworm, Trichogramma]

National Agriculture Research Center
Tsukuba 305, Japan
Phone +81-298-38-8838 (or 8889)
Fax +81-298-38-8837
e-Mail[Internet]khirai@narc.affrc.go.jp

Ms. Chie GOTO

ENTOMOLOGIST
(ARMYWORM, BACULOVIRUS)

NATIONAL AGRICULTURE RESEARCH CENTER
PHONE ~~92975-6~~ 0298-38-8838 (OR 8889)
TSUKUBA 305, JAPAN
email cgoto@ss.narc.affrc.go.jp

TAKEUCHI Hiroaki

Paddy Crop Pests Laboratory
Entomologist
(Leafhopper, Parasitoids)

National Agriculture Research Center
Tsukuba 305, Japan
Phone 0298-38-8838 (or 8889)
Fax 0298 38 8837

FRUIT TREE RESEARCH STATION
MINISTRY OF AGRICULTURE FORESTRY & FISHERIES

Dr. HARUO YANASE
DIRECTOR GENERAL

FUJIMOTO 2-1
TSUKUBA 305
TEL 0298-38-6411

DR. TAKESHI UJIYE
DIRECTOR
DIVISION OF PLANT PROTECTION

FRUIT TREE RESEARCH STATION
FUJIMOTO 2-1, TSUKUBA, IBARAKI
305 JAPAN
TEL 0298-38-6543
FAX 0298-38-6541

Tomoyuki SASSA Ph.D.
Director
International Forest Research Information & Cooperation Section
Research Coordination Division
Forestry and Forest Products Research Institute
Ministry of Agriculture, Forestry and Fisheries

P.O.Box 16, Tsukuba Science City, 305 Japan
☎ 0298-73-3211
Fax 0298-73-1541

FORESTRY AND FOREST PRODUCTS
RESEARCH INSTITUTE
Ministry of Agriculture, Forestry and Fisheries

KYOGO KODAMA
Liaison Officer
International Information and Cooperation Section

OFFICE
1, Matsunosato kukizaki Machi
Inashiki Gun Ibaraki Japan
TEL 0298 (73) 3210
FAX 0298 (73) 1541

DR. KATSUHIRO TABATA

DIRECTOR, PEST AND WILDLIFE MANAGEMENT SECTION
FORESTRY AND FOREST PRODUCTS
RESEARCH INSTITUTE

P. O. BOX 16, TSUKUBA NORIN
KENKYU DANCHI-NAI
IBARAKI 305, JAPAN
PHONE 0298-73-3211 (414)

RESEARCH PROJECTS OF POPULATION ECOLOGY LABORATORY 1995

National Institute of Agro-Environmental Sciences
Tsukuba, Ibaraki 305, Japan

1. Effects of spacial distribution of host plant on the population dynamics of pest insects.
K. Yamamura , O. Imura, and N. Morimoto

2. Effect of herbivory on the population dynamics of the horse nettle
O. Imura

Solanum carolinense

3.Community ecology of herbivorous arthropods-Greenhouse pests.
O. Imura, E. Yano(Biol. Cont. Agents Lab.), D. Andow(Univ. Minnesota)

4. Ecology of the rice water weevil.
N. Morimoto

5. Fauna of exotic insets in Japan.
N. Morimoto

6. Potential effects of global warming on the insect populations.
O. Imura, N. Morimoto, K. Yamamura, T. Kiura(Tropical Res. Center)

NATIONAL INSTITUTE OF SERICULTURAL AND ENTOMOLOGICAL SCIENCE

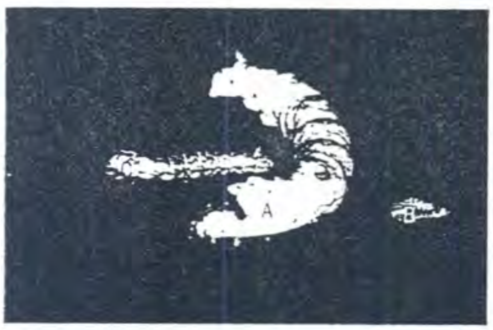
MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES

Department of Insect Physiology and Behavior

Research Purpose

This department aims at development of new technologies for pest control and production of useful substances by utilizing behavioral, physiological and biochemical properties in insects and related microorganisms. To achieve these objectives, basic research is executed at the levels of the molecule, cell, tissue and organism.

Main Results



Ultranumerary-ecdysed larvae induced by ecdysone in *Bombyx mori*

A: Normal fifth-instar larva (25 days after hatching)

B: Fifth-instar larva induced by ecdysone (10 days after hatching)

C: Tenth-instar larva induced by ecdysone (25 days after hatching)

Mechanisms of prey-attacking behavior

Carnivorous stink bugs attacking *Spodoptera litura* larva

Biological defence mechanisms in insects

E. coli inhibition zone (B) produced by silkworm blood; control (A)

B

Studies on information processing mechanisms in the insect nervous system

A: Single brain neuron of *[illegible] auratus* identified by injection of lucifer yellow dye

B: Brain neuron of *Periplaneta americana* isolated for patch-clamp recording

A fungus which lives in insect cells

The yeast-like symbionts (red purple) provide host planthopper with nutrients

Laboratory Presentation

Bioactive Substances Laboratory
Department of Insect Physiology and Behavior,
National Institute of Sericultural
and Entomological Science,

- 'Metabolism and the information transfer of molting hormone in insects'

  Ecdysone and 20-hydroxyecdysone are the two major molting hormone. Recently,our laboratory staff succeeded in inducing 11 larval ecdysis, i.e. seven addtional ecdysis with low mortality by the application of ecdysone in the silkworm,Bombyx mori. Furthermore, we found that dietary supplement of ecdysone and 20-hydroxyecdysone affect larval development differently. These phenomena suggest that the effect of ecdysone on the mechanisim regulating the ecdysteroid titre is qualitatively different from that of 20-hydroxyecdysone.

- 'Mechanism of regulating diapause and metamorphosis in insects'

  Juvenile hormone is another two major hormone controlling the moult and metamorphosis. Measuring the change of the titre of the the hormone with the passage of time is difficult. Because, the degradation of the hormone easily occurdue to the enzymes and the oxidation. Another reason is difficulty in making adistinction between the hormone and another lipids. Developing the method of the assay which is utilizing the specific affinity of protein is now on progress.

- 'Hormonal regulation of larval diapause in phytophagus scarabeid insects'

  Larvae of scarabaeid beetle that oviposited and hatched in the soil in summer grow up to third instar by the fall. They diapause at the late in the third instar for almost half year. They start to pupate and emerge to adult in the coming summer. The termination of diapause is induced not by the photoperiod but a span of low temperature. Experimenting on the hormonal regulation of their larval development of the mediating environmental factor is now going on. Application of synthesized hormone was examined to know the mechanism of their diapause.

- 'Mechanisim of endocrinological regulation of social behavior in honey bee'

  Main study is concerning to a regulation of division of labour by juvenile hormone in honey bee. And developing a quantitative method using the high pressure liquid chromatography is now on progress. Chemical ecological study ofkin recoginition and response to a parasitic mites and flower s cents in two species,Japanese and European honey bees is another subject.

Staff :
- Dr.Yoshio Hirai
- Dr.Takahiro Shiotsuki
- Dr.Yoshiaki Tanaka
- Dr.Hiromi Sasagawa (postodoctorial fellow)
- Dr.Yue-Jin Hua (STA fellowship)

com Trichograma parasitando ovos de Lepidopteros e, Baculovírus e outros parasitóides no controle biológico de pragas. O fungo *Beauveria brongniartii* já se encontra registrado no Ministério da Agricultura para uso comercial principalmente para pragas de citros (brocas) a exemplo de *Anoprophora malasiaca* (Col: Cerambycidae).

Neste mesmo dia á tarde visitamos o Fruit Tree Research Station onde fomos recepcionados pelos Diretores Drs. Haruo YANASE, Takeshi UJIYE e Tomoyuki SASSA, que nos fizeram uma breve explanação dos trabalhos desenvolvidos pelo Instituto Na área de entomologia vimos as principais pragas de fruteiras.

Após visitarmos este Instituto nos dirigimos para o Forestry and Forest Products Research Institute onde acompanhada do Dr. Kyogo KODAMA assistimos a uma brilhante apresentação do Dr. Katsuhiro TABATA sobre Insetos Pragas De Florestas E Seu Manejo, onde enfatizou as principais pragas que a mais de 20 anos danificam as florestas de ciprestes, entre estas foram destacadas o *Monochamus alternatus* vetor do nematóide *Bursaphelenchuns xylophilus* que segundo estimativa do Dr. TABATA, no Japão se tem hoje 1 milhão de ciprestes infestados com esta praga (nematóide). Além de outros Cerambicideos importantes como: *Anaglyptus subfaciatus* (Cryptomeria twing borer) e *Semanotus japonics* (Cryptomeria bark borer) que danifica a madeira.

20/06/96

Visita a Saitama Horticultural Experiment Station na cidade de KUKI -SAITAMA onde a agricultura é o ponto forte e de onde sai o maior abastecimento para a região metropolitana de Tokyo. Aqui a semelhança dos dias anteriores fomos recebida pelo Diretor da Estação Dr. WATANABE e Dr. Atsuo KUBOTA que nos deram as boas vindas e relataram os trabalhos realizados. Nos últimos 10 anos fomos a primeira brasileira a visitar esta estação experimental. Aqui a pesquisa concentra-se em Horticultura, Floricultura e Fruticultura, em uma área de cultivo de 12 ha com uma equipe de 40 pesquisadores. Após apresentação dos Drs. Imawa e Hirashi NEMOTO percorremos toda a área experimental (campo, casas de vegetação e cultivos protegidos), onde presenciamos a liberação de inimigos naturais na cultura do tomate.

21/06/96

Visita á KUBOTA CORPORATION, marca de uma revolução agrícola, industrial e informação, que tem contribuido para aindustrialização e modernização do Japão, através de uma base firme que é a inovação tecnológica. Nesta corporação Dr. Hidetaka HORI nos mostrou o que é a KUBOTA CORPORATION, onde a alta tecnologia é um fator predominante. A atividade principal é concentrada em 3 departamentos: Biotecnologia, Materiais Eletrônicos e Máquinas Agrícolas. Aqui visitamos os laboratórios de tecnologia avançada, onde são desenvolvidos trabalhos de controle biológico com coleópteros, utilizando o Bacillus thurigiensis, explicação dada pelo Dr. Tkeshi MARUYAMA, novamente aqui me senti uma previlegiada pois fui a primeira brasileira a visitar esta corporação. Após a demostração neste laboratório nos dirigimos a KUBOTA FARM INDUSTRIAL MACHINERY SERVICE LTADA, onde o Dr. Shigeyuki YAMADA nos atendeu, mostrado-nos toda a fábrica. Aqui me emocionei, pois fui recebida com a Bandeira saitama.

埼玉県園芸試験場

園芸環境部長

久保田篤男
Atsuo Kubota

〒346 埼玉県久喜市六万部９１
電話 (0480) 21-1113
FAX (0480) 29-1021

Gerente.

saitama

埼玉県園芸試験場

場　長

渡　辺　昌　司
Dr. Watanabe
chefe da Estação

〒三四六 埼玉県久喜市六万部九一
電話 [illegible]
FAX [illegible]

彩の国さいたま

saitama.

彩の国さいたま

副場長　稲　山　光　男
Dr. Inawama

埼玉県園芸試験場
勤務先　埼玉県久喜市六万部９１番地
〒346　TEL　0480 (21) 1 1 1 3
FAX　0480 (29) 1 0 2 1

Dr. Hisashi Nemoto
Researcher of Pest Management

Saitama Horticulutural Experiment Station
91 Rokumanbu, Kuki, Saitama 346, Japan
FAX 0480-29-1021
TEL 0480-21-1113

HIDETAKA HORI Ph. D.
BB-PT
Office of Business
Planning & Development

KUBOTA Corporation
Advanced Technology Laboratory
5-6, Koyodai
Ryugasaki City, Ibaraki, Japan 301
Phone: 0297-64-7474
Fax: 0297-64-7217
Email: hide-hri @ kubota.co.jp

Kubota

SHIGEYUKI YAMADA
MANAGER
SERVICE DEPT. (TSUKUBA DIVISION)
KUBOTA FARM & INDUSTRIAL
MACHINERY SERVICE, LTD.
TSUKUBA DIVISION
SAKANO-SHINDEN, YAWAHARA-MURA, TSUKUBA-GUN,
IBARAKI-KEN, JAPAN
PHONE:0297-52-3118 FAX:0297-52-0523
HEAD OFFICE
64, ISHIZU-KITAMACHI, SAKAI-CITY, OSAKA, JAPAN
PHONE:0722-41-1126

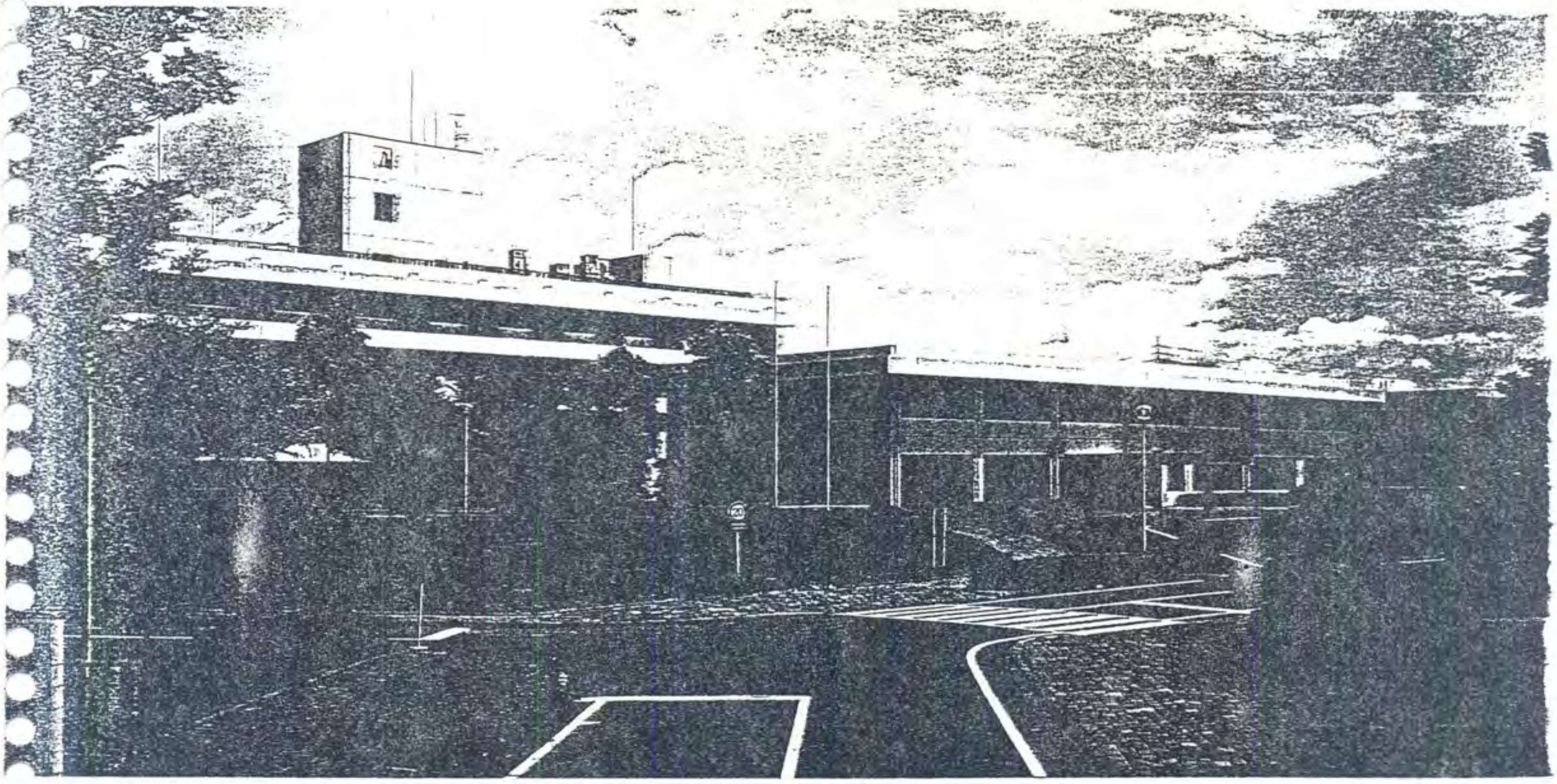
TAKESHI MARUYAMA, Ph. D.
(Entomologist)
Deputy Section Manager
BB-PT
Office of Business
Planning & Development

KUBOTA Corporation
Advanced Technology Laboratory
5-6, Koyodai
Ryugasaki City, Ibaraki, Japan 301
Phone: 0297-64-7473
Fax: 0297-64-7217
Email: takesi-m @ kubota.co.jp

Research activities in Fruit Tree Research Station

August, 1994.

Fruit Tree Research Station
Ministry of Agriculture, Forestry and Fisheries



農林水産省

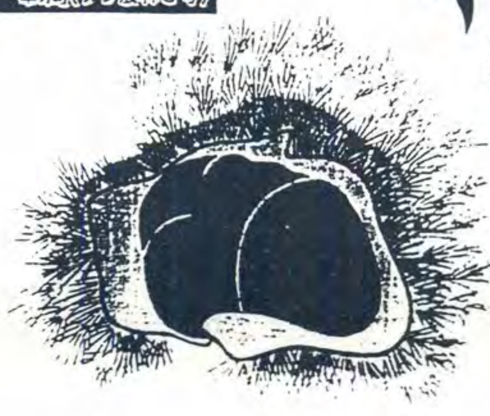
果樹試験場

Ministry of Agriculture, Forestry and Fisheries

FRUIT TREE RESEARCH STATION

Apple 'Fuji'

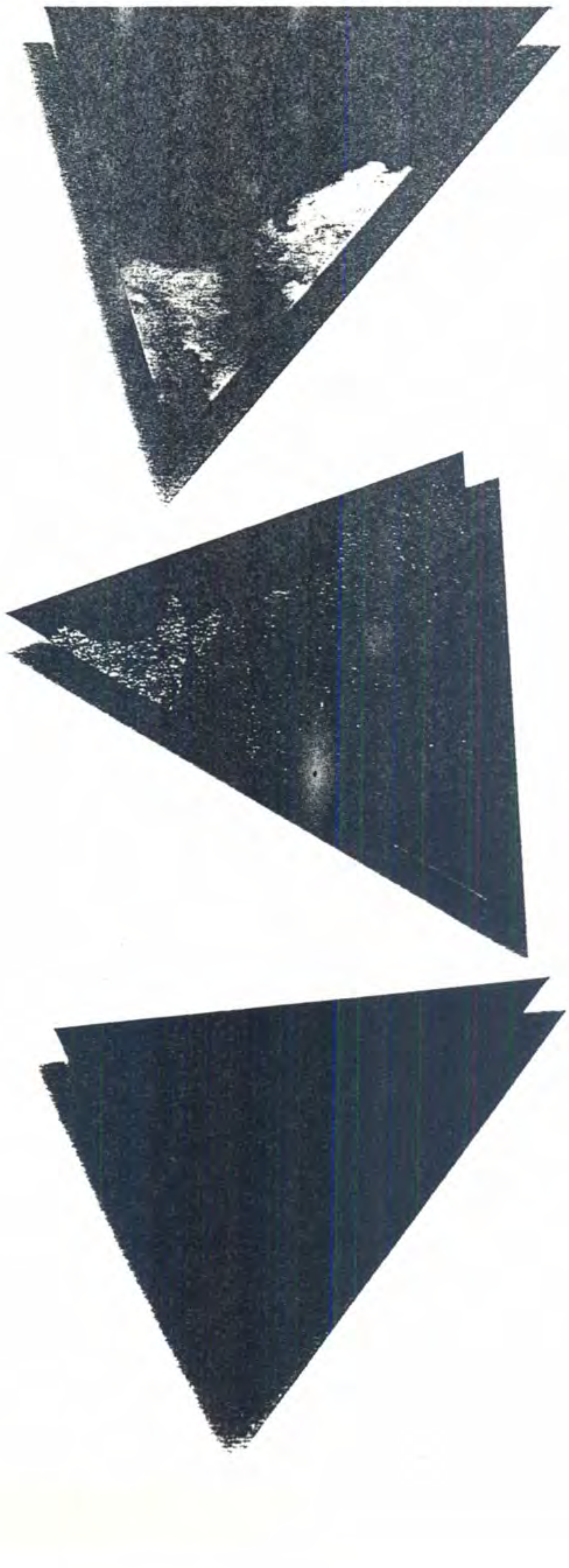
Japanese pear 'Kosui'



「本草図譜」

1916.

森林総合研究所



FORESTRY AND FOREST PRODUCTS RESEARCH INSTITUTE

Forest Pest Insects and Their Managements in Japan

by

Katsuhiro Tabata

Forest Biology Division
Forestry and Forest Products Research Institute

ごあんない

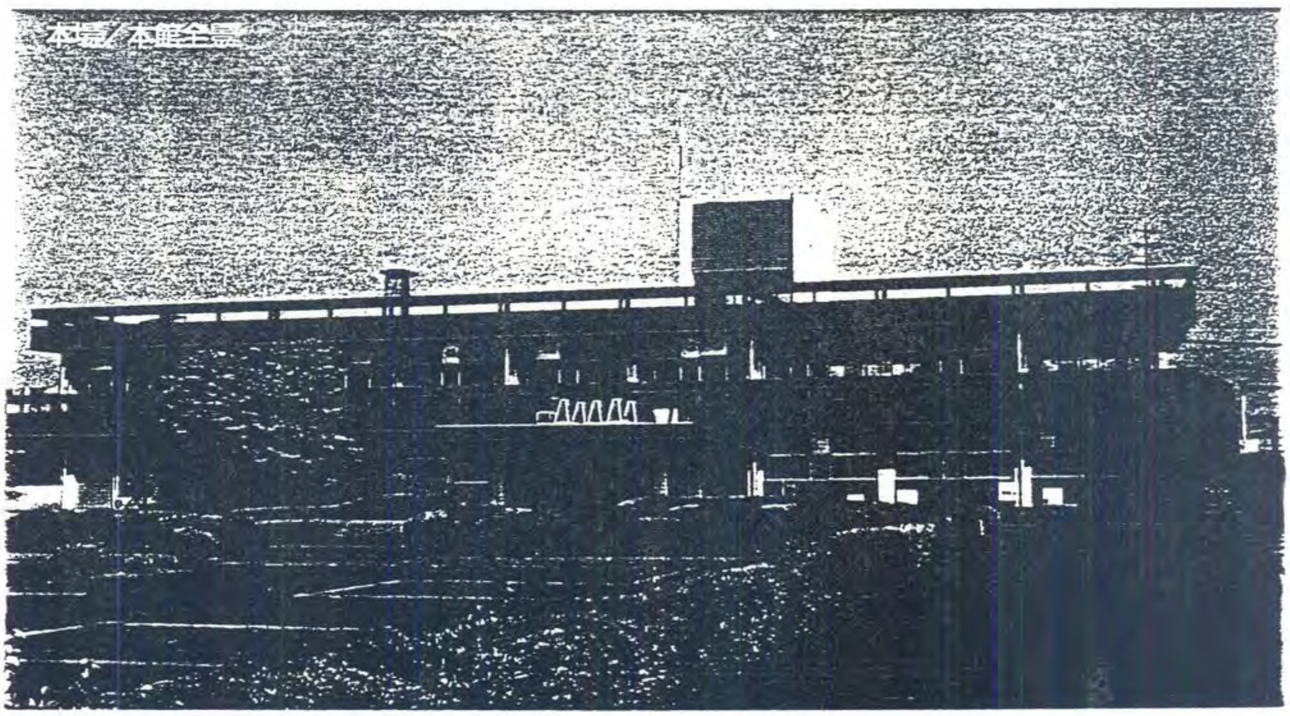
彩の国さいたま

要覧

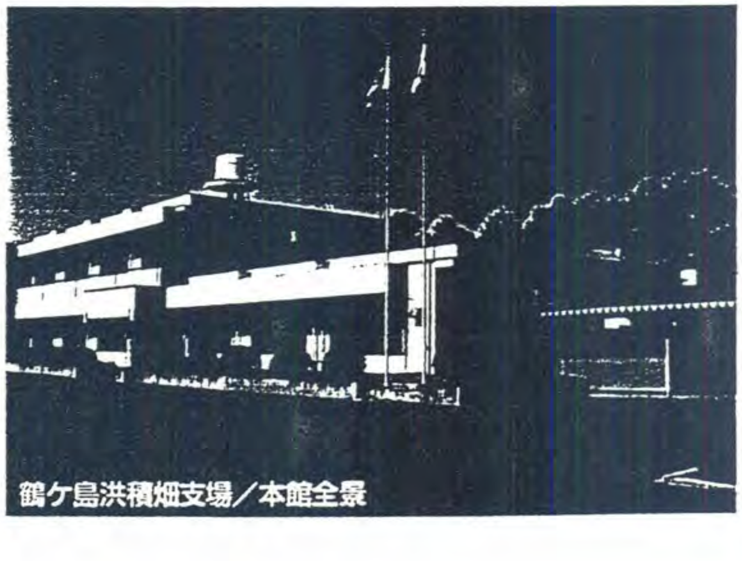
緑と食糧を次の世代へ

埼玉県園芸試験場

SAITAMA HORTICULTURAL EXPERIMENT STATION



本場／本館全景



鶴ケ島洪積畑支場／本館全景

Kubota

The Agricultural Revolution

In the year 1900, Kubota became the first Japanese corporation to commence the development and manufacture of cast iron pipes, for which Japan had previously relied upon foreign imports. Proceeding from this technological foundation, the company then expanded into the production of mechanical parts and subsequently into the area of machinery. In 1917, Kubota developed and marketed steam engines as well as various types of marine machinery, machine tools and a small scale agricultural engine, the "Kubota Engine". In 1960, Kubota developed and marketed Japan's first small-size agricultural tractor. The latter product introduced revolutionary mechanical techniques into Japanese agriculture, which had previously depended completely upon human power of beasts of burden. In 1952, Kubota successfully applied cast iron pipe technology to the design and construction of cement mixing plants with a view to improvement of agricultural water supply facilities. Thus, through high-level civil engineering technology, Kubota greatly contributed to labor-saving, intensification, and rationalization in the agricultural industry, thereby accelerating the transition of Japanese agriculture to the age of mass production.

KUBOTA Past and Present

Seeds created by eminent technical innovators stand in the background of the every aspect of technological revolution. Kubota has been an outstanding innovator during past technological revolutions, and has thereby provided substantial contributions to the development of human social life. Now and throughout the future, Kubota will continue to play an important role as an innovator in the service of contemporary technological revolution.

The Industrial Revolution

Since the Meiji Era, Japan has followed a path of steady economic growth centered upon industrialization. Starting from the development and manufacture of cast iron pipes in the year 1888, Kubota progressed on the basis of high-level casting technology and developed a host of superior products in categories such as cast iron pipes, castings, and machines, and vigorously expanded into a wide variety of technological fields including farm and industrial machinery, pipe systems, consolidated materials, environmental plant engineering, and building and housing materials, as a pioneer of technical innovation in the areas of cast iron pipe and industrial production equipment.

Kubota contributed to the emergence of modern Japanese mass production systems which have supported mass consumption, thus playing a major role with respect to the rationalized production systems, high productivity and labor-saving which have constituted the principal factors sustaining Japan's rapid economic growth. At present, through the application of cast iron pipe technology, Kubota is substantially contributing to the further development of modern water supply and sewage systems, thereby revitalizing the metabolism of cities and assisting in urban redevelopment schemes as well as facilitating progress in the treatment and disposal of home and industrial wastes from refuse and sewage, which are essential in providing a solid foundation for the further development of Japanese industry.

The Information Revolution

Advances in computers and techniques for their utilization have vastly increased the importance of data collection, storage, and processing in our social and economic environment as well as industrial activities involving data supply and transmission. With a view to the creation of a system which can collect dynamic micro and macro information with important significance in the context of an anthropocentric outlook, the new Kubota Corporation is actively contributing to the information and communication revolution. In 1987, Kubota Computer Inc. was established as a subsidiary, and in 1986, the production and sale of the TITAN graphics supercomputer was commenced under an agreement with Stardent Computer Inc., while manufacture and sale of the M/120 Workstation was initiated in 1987 under an agreement with MIPS Computer Systems.

At present, Kubota is devoting particular attention to the development of computer software. To this end, Kubota has been actively engaged in overseas equity participation and technical cooperation. In 1989, Kubota concluded an equity and technology agreement with the American-based Rasna Corporation, which is engaged in the development of application software for mechanical design and analysis.

While continuing to develop innovative products in the areas of biotechnology, new materials, and electronics, Kubota is also devoting unremitting effort to upgrade its products by the introduction of intelligent features with integrated information components.

Brasileira, qu com certeza tocou fundo no meu instinto patriota. Ao percorrer a fábrica acompanhada de um guia, que ia explicando tudo tive a oportunidade de ver desde o início ao final da montagem de tratores agrícolas. Nesta fábrica produzem 40 mil tratores por ano, sendo considerada a 1ª em produção no Japão e no mundo; 40% desta produção é destinada a exportação. Aqui a prioridade é a qualidade.

22/06/96 - Viagem para Fukuoka - Hakata

23/06/96 - Domingo

24/06/96

Visita a Universidade de Kyushu, Faculdade de Agricultura.

Inicialmente, pela manhã estivemos com Dr. Michio OHBA, no Instituto de Controle Biológico (Laboratório de Patologia de Insetos e Controle Microbiano, que nos relatou os principais estudos desenvolvidos neste laboratório entre eles citamos:

1. Microbial control of insects pests and microbial insecticides (Insect pathogenic viruses, Bacteria, Protozoa).
2. Infection and replication of insect viruses (Baculoviroses, Insect cell cultures)
3. Bacteria producing inseticidal toxins (Bacillus thurigiensis, Delta-endoxin, Screening, Serotyping, Distribuition)
4. Infection and development of insect pathogenic protozoa (Nosema, Microsporidea, Insect cell cultures).

A tarde fomos para o laboratório de Inimigos Naturais com o Prof. Yozo MURAKAMI, que se ateve em explicar detalhadamente as pesquisas realizadas por ele e sua equipe, como a seguir:

1. Biological control of the chestnut gall-wasp (Dryocosmus kuriphilus, Torymus sinensis, colonization)
2. Biological control of stink bugs attacking soybeans (Egg parasitoid, Stink bugs, Parasitoid-host community)
3. Biological control of the arrowhead scale (Unaspis yanonensis, Aphytis yanonensis, Coccobius fulvus)
4. Biological control of Thrips palmi (Ceranisus, Orius, Wollastoniella)

25/06/96

Pela parte da manhã deslocamento de Fukuoka para Kumamoto

Atarde visitamos a Kyushu National Agricultural Experiment Station em Nishigoshi Kikuchi em Kumamoto onde fomos recepcionada pelos diretores Drs. Shigeo TANAKA, Takahiro INOU e Dr. Komoto YUKIOMI. Em seguida fomos para o Departamento de Recalcitrant Disease and Pest Management.

MICHIO OHBA, Ph. D.
INVERTEBRATE MICROBIOLOGIST

INSTITUTE OF BIOLOGICAL CONTROL
FACULTY OF AGRICULTURE
KYUSHU UNIVERSITY
FUKUOKA 812 JAPAN
TEL: (092) 641-1101 (EXT 6411)
FAX: (092) 632-1964

YOZO MURAKAMI, PH.D.
PROFESSOR

INSTITUTE OF BIOLOGICAL CONTROL
FACULTY OF AGRICULTURE
KYUSHU UNIVERSITY

6-10-1 HAKOZAKI, HIGASHI-KU, FUKUOKA 812, JAPAN
PHONE: (092) ~~[illegible]~~
641-3035

Interpreter · Translator
Yukari Kishikawa
1-5-5-504, Akasaka, Chuo-ku,
Fukuoka 〒810 Japan
Phone & Fax: 092-724-6040

English · Portuguese · Japanese

通訳・翻訳
岸川 ゆかり
〒810 福岡市中央区赤坂1丁目5-5-504
Tel & Fax: 092-724-6040

Dr. YOSHITO SUZUKI

Senior Researcher

Laboratory of Pest Management Systems.
Kyushu National Agricultural Experiment Station
Nishigoshi, Kumamoto 861-11, JAPAN
Phone : 096-242-1150
Fax : 096-242-3919

Masaichi TSURUMACHI

Lab. of Insect pest control.
Kyushu National Agricultural Experiment Station

Suya-2421, Nishigoshi, Kikuchi-gun,
Kumamoto, 861-11 Japan
Tel 096-242-1150

Kyushu National Agricultural Experiment Station

Dr. WADA Takashi

(Entomologist)

Office: Suya 2421, Nishigoshi, Kikuchi
Kumamoto 861-11, JAPAN
Tel. 81(Japan)-(0)96-242-1150
Fax. 81(Japan)-(0)96-249-1002

農林水産省 九州農業試験場
地域基盤研究部

部長
農学博士 河本征臣

Dr. Komoto Yukiomi

勤務先 〒861-11 熊本県菊池郡西合志町大字須屋二四二一
電話(〇九六)二四二-一一五〇
FAX(〇九六)二四九-一〇〇二

SHIGEO TANAKA

Director General

Kyushu National Agricultural Experiment Station
Ministry of Agriculture, Forestry and Fisheries

2421, Suya, Nishigoshicyo, Kikuchigun
Kumamoto, 861-11 Japan

Tel.(096)242-1150
Fax.(096)249-1002

DR. TAKAHIRO INOUE

DIRECTOR

RESEARCH PLANNING AND COORDINATION DEPT.
KYUSHU NATIONAL AGRICULTURAL EXPERIMENT STATION

SUYA 2421,
NISHIGOSHI-MACHI, KUMAMOTO
861-11 JAPAN

PHONE 096-242-1159
FAX 096-242-4846

DIVISION OF AGRICULTURE
GRADUATE SCHOOL
KYUSHU UNIVERSITY

SPECIAL COURSE ON

INTERNATIONAL DEVELOPMENT RESEARCH

DOCTOR'S COURSE

(NON-MONBUSHO SCHOLARSHIP)

INFORMATION BULLETIN

Academic Year 1996

FUKUOKA JAPAN

Plant Pathology

Nobuaki MATSUYAMA, Ph.D., M.Sc., Professor
Yoichi TAKANAMI, Ph.D., Associate Professor
Naruto FURUYA, Ph.D., M.Sc., Assistant Professor

1.Physiology of parasitism of plant pathogens (Rice blast, Grain rot of rice)
2.Physiology and ecology of plant pathogenic bacteria (Pathogenic races, Bacteriophage, Serology, Detection method)
3.Biocontrol of plant diseases (Productivity of antibiotics, Biocontrol agents)
4.Diagnosis and identification of plant virus diseases
5.Molecular biology of plant virus replication and host specificity

Entomology

Katsura MORIMOTO, Ph.D., M.Sc., Professor
Osamu TADAUCHI, Ph.D., M.Sc., Associate Professor
Satoshi KAMITANI, M.Sc., Assistant Professor

1.Systematics of insects and spiders (Hymenoptera, Coleoptera, Diptera, Hemiptera, Lepidoptera, Isoptera, Araneae)
2.Evolution, phylogeny, distribution and biology of insects (East Asia, Pacific area)
3.Biodiversity conservation (Monitoring, Measurement)
4.Computer taxonomy (Numerical taxonomy, Identification system, Database, Catalogue production, Multivariate analysis)
5.Biological control (Natural enemies, Parasites, Biology, Morphology)

Michitaka CHûJô, M.Sc., Associate Professor
(Hikosan Biological Laboratory)

1.Insect taxonomy, especially Coleoptera of Asia and Pacific area
2.Insect diversity and environment

Sericultural Science

Katsumi KOGA, Ph.D., M.Sc., Professor
Yutaka KAWAGUCHI, Ph.D., M.Sc., Associate Professor
Yutaka BANNO, Ph.D., M.Sc., Assistant Professor

1.Genetics of silkworm (Gene, Chromosome, Linkage, Mutant)
2.Gene expression in relation to development and differentiation of silkworm (Embryogenesis, Phenocopy, Diapause)
3.Biochemical genetics of proteins changing during metamorphosis of silkworm (Hemolymph, Digestive juice, Proteinase inhibitor, Female specific protein, Aldolase)
4.Developmental genetics in Drosophila

Insect Pathology and Microbial Control (Institute of Biological Control)

Takeshi KAWARABATA, Ph.D., M.Sc., Professor
Michio OHBA, Ph.D., M.Sc., Associate Professor
~~Masako FUNAKOSHI, Ph.D., M.Pharm.Sc., Assistant Professor~~
Chisa YASUNAGA, M.Sc., Assistant Professor

1.Microbial control of insect pests and microbial insecticides (Insect pathogenic viruses, Bacteria, Protozoa)
2.Infection and replication of insect viruses (Baculoviruses, Insect cell cultures)

3. Bacteria producing insecticidal toxins (Bacillus thuringiensis, Delta-endotoxin, Screening, Serotyping, Distribution)
4. Infection and development of insect pathogenic protozoa (Nosema, Microsporidia, Insect cell cultures)

Insect Natural Enemies (Institute of Biological Control)

Yozo MURAKAMI, Ph.D., M.Sc., Professor
Yoshimi HIROSE, Ph.D., M.Sc., ~~Associate~~ Professor
~~Hiroshi KAJITA, Ph.D., M.Sc., Associate Professor~~
Masami TAKAGI, Ph.D., M.Sc., Assistant Professor

1. Biological control of the chestnut gall-wasp (Dryocosmus kuriphilus, Torymus sinensis, Colonization)
2. Biological control of stink bugs attacking soybeans (Egg parasitoid, Stink bugs, Parasitoid-host community)
3. ~~Biological control of the greenhouse whitefly (Trialeurodes vaporariorum, Encarsia formosa)~~
4. Biological control of the arrowhead scale (Unaspis yanonensis, Aphytis yanonensis, Coccobius fulvus)
5. Biological control of Thrips palmi (Ceranisus, Orius, Wollastoniella)

Environment Control for Biology (Biotron Institute)

Hiromi EGUCHI, Ph.D., M.Sc., Professor, Director
Jiro CHIKUSHI, Ph.D., M.Sc., Associate Professor, Vice Director
Masaharu KITANO, Ph.D., Assoiciate Professor
Yasuhiko SOEJIMA, M.Sc., Assistant Professor
Satoshi YOSHIDA, Ph.D., M.Sc., Assistant Professor
Toshihiko EGUCHI, M.Sc., Assistant Professor

1. Environment control for biology (Phytotron, Growth chamber, Air temperature, Air humidity, Air current, Light, Rhizosphere)
2. Environmental botany (Environmental effect on plants, Root and stomatal responses, Plant water relation)
3. Plant instrumentation (Plant growth, Plant image processing, Leaf temperature, Heat balance, Water uptake, Transpiration, Plant water relation, Root respiration)

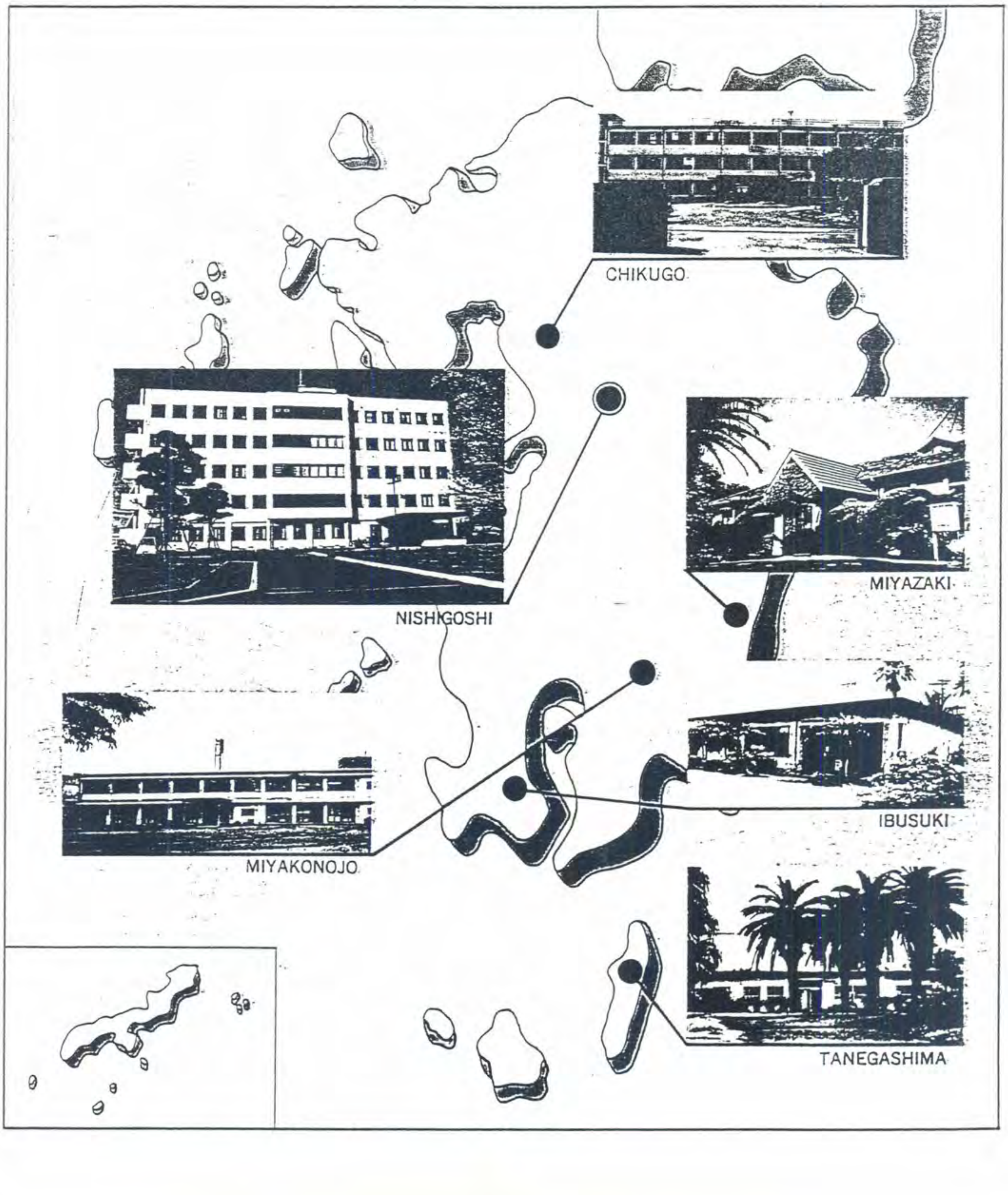
Fruit Tree Science (University Farm)

Shin-ichi SHIRAISHI, Ph.D., Professor
Akira WAKANA, Ph.D., M.Sc., Associate Professor
Michikazu HIRAMATSU, M.Sc., Assistant Prefessor

1. Study of nutrition and quality in fruits (Vegetable nutrition)
2. Soilless growing systems (Hydroponics)
3. Horticulture under structure
4. Germplasm evaluation, conservation and utilization of fruit trees (Grapes, Citrus, Persimmons)
5. Protected cultivations in fruit trees
6. Adventive embryogenesis in fruit trees (Embryo culture, Mutation, Morphogenesis)
7. Interspecific and intergeneric hybridization of fruit trees (Electrophoresis, Cytogenetics, Compatibility, Evolution)
8. Polyploid breeding in grape, citrus and loquat (Triploid, Parthenocarpy, Male and female sterility)
9. Isozyme analysis in fruit trees (Evolution, Diversity, Heredity)

KYUSHU NATIONAL AGRICULTURAL EXPERIMENT STATION

MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES



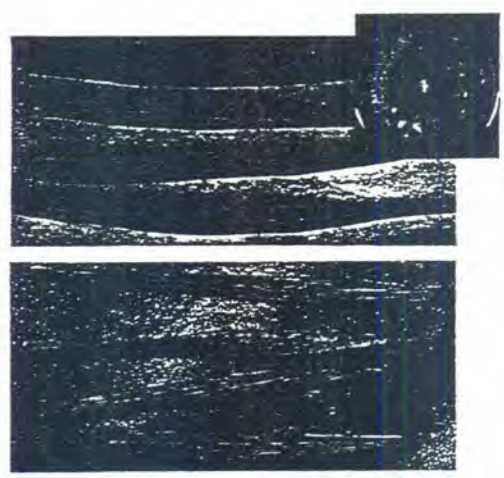
Department of Recalcitrant Disease and Pest Management

The Kyushu region is blessed with a temperate climate and rainfall sufficient to support a variety of crops year long. Unfortunately, the climate is also conducive to plant diseases (fungi, bacteria, and viruses) as well as pests (insects, mites, nematodes, and snails). Growers inevitably use chemicals in high frequency to avoid the enormous losses that these diseases and pests can cause. The frequent use of these biocides has resulted in the selection of pests and pathogens resistant to the chemicals used.

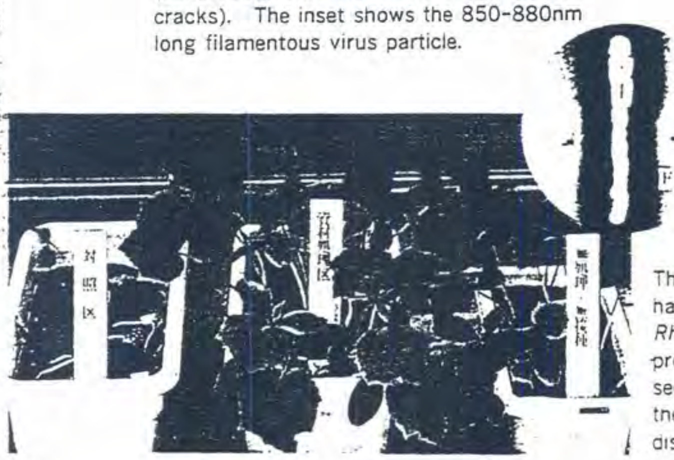
In addition to climate, another factor complicating pest control in Kyushu is the proximity of the Asian land mass. The Kyushu region is constantly invaded by long distance migratory insect pests which are carried from China and Southeast Asia on the low level jet streams in summer. These migratory insects also vector some important plant pathogens. Furthermore, changes in cultural systems and succession in cultivars or varieties of crops have altered the pathogens and pest species present requiring constantly changing control strategies. Of the diseases present in Kyushu, soil born diseases are an important factor adversely affecting crop production.

In order to develop and establish basic methods and technologies to manage populations of recalcitrant disease pathogens and pests below a tolerable injury level, researches in the department are concerned with the biological and ecological characteristics of pathogens and pests, advancements in more simplified and highly accurate methods for dianosis and identification, epidemics, population establishment and dynamics, emergence mechanisms of new races or populations of pathogens and pests resistant to chemicals, utilization of resistant varieties for pathogens and pests, and interactions between organisms including pathogens, pests, and natural enemies in the agro-ecosystem. Analytical research works based on computer technologies are also utilized for facilitating pest management systems.

The symptom of sweet potato "Obijo-sohi" (zonal rough skin with many minute vertical cracks). The inset shows the 850-880nm long filamentous virus particle.



Suppression of wheat powdery mildew by a fungus isolated from wheat leaves in the field.
Upper: Fungus isolated from wheat and wheat leaves treated with the fungus.
Lower: Control (untreated)



The pot on the left contains a cucumber seedling that has succumbed to damping-off disease caused by *Rhizoctonia solani*. The seedling in the center pot was protected from damping-off by a soil antagonist. The seedling on the right is the control. The inset shows the same soil antagonist inhibiting *R. solani* in a petri dish culture.

No laboratório de Sistema de Manejo de Pragas Dr. Yoshito SUZUKI nos falou sobre insetos parasitóides e predadores, já no laboratório de Controle de Insetos Pragas o Dr. Masaichi TSURAMACHI discorreu sobre resistência varietal à pragas em arroz, enfatizando que inicialmente as pesquisas eram mais voltadas para a qualidade do arror do que a resistência à pragas; atualmente vem sendo o contrário, menor uso de inseticidas com maior uso de variedades resistentes . Dr. Wada TAKASHI em seu laboratório também discorreu sobre os trabalhos desenvolvidos, onde os maiores esforços são na área de controle biológico, nos relatou sobre as principais pragas da soja no Japão e o uso de inimigos naturais para o seu controle, a exemplos de percevejos como: *Oencyrtus nezarae* e *Telenomus triptus*. Trabalha também com *Pomacea canaliculata* (gold apple smale)- marujo muito nocivo ao arroz, cujo controle vem sendo feito através do manejo de água.

26/06/96 - Deslocamento Kumamoto-Nagoya-TSU

27/06/96

Visita a National Research Institute of Vegetables, Ornamental Plants and Tea (NIVOT) em TSU, aqui fomos recebida pelo Dr. Shigeo IMADA, que nos acompanhou pela estação, nos mostrando os trabalhos realizados, como cultivos protegidos, cultivos de hortaliças em fitotrons (condições simuladas), casas de vegetação e outros. Após percorrermos toda a estação voltamos para o Departamento de Proteção de Plantas, onde visitamos 2 laboratórios (Laboratório de insetos sugadores e Laboratório de insetos mastigadores) coordenados pelos Drs. Tetsuzo HAMAMURA, Nobuo TEZUKA e Dr. Masaharu MATSUI que desenvolvem pesquisas com inssetos mastigadores, ácaros e tripses. Trabalham com ácaros predadores, mecanismos de resistência de plantas à ácaros etc.... No controle biológico utilizam Spidex (produto comercial)-(*Phytoseiulus persimilis*) importado da Holanda e Aphipar (produto comercial)-(Aphidius colemani) importado do Chile e Mediterrâneo para o controle de ácaros.

A tarde deslocamento da estação experimental de TSU para a cidade de Shimada em Shizuoka.

Visita a Estação Experimental de Chá na cidade de Kanaya, próxiam a cidade de Shimada, na Província de Shizuoka. Nesta estação fomos recebida pelo Dr. Hachinoche chefe da estação, que em seguida nos encaminhou ao laboratório de Entomologia do Departamento de Agronomia do Chá, onde o Dr. Akira KAWAI nos apresentou as principais pragas do chá no Japão, bem como nos acompanhou em visita ao laboratório de processamento do chá, que do início do processo ao final leva 3 horas. Dentre as pricipais pragas pragas destaca-se: *Tetranychus kanzawa* (kanzawa spider mite), *Scirtotrips dorsalis* (yellow trips), *Pseudalacaspis pentagona* (Mulberry scale), *Adoxophyes* sp. (Smaller tea tortrix), *Homona magnanima* (Oriental tea fortrix), *Empoasca onukii* (Tea green leafhopper).

NATIONAL RESEARCH INSTITUTE OF
VEGETABLES, ORNAMENTAL PLANTS & TEA-NIVOT
DIVISION OF RESEARCH PLANNING AND COORDINATION

SHIGEO IMADA

KUSAWA 360
ANO, MIE 514-23, JAPAN

PHONE 0592 (68) 4621
FAX 0592 (68) 3213
E-MAIL imadas@nivot.affrc.go.jp

Dr. TETSUZO HAMAMURA
CHIEF OF 1st ENTOMOLOGY LAB.

NATIONAL RESEARCH INSTITUTE
OF VEGETABLES, ORNAMENTAL
PLANTS AND TEA (NIVOT)

ANO-CHO, MIE 514-23 JAPAN
TEL 0592-68-1331

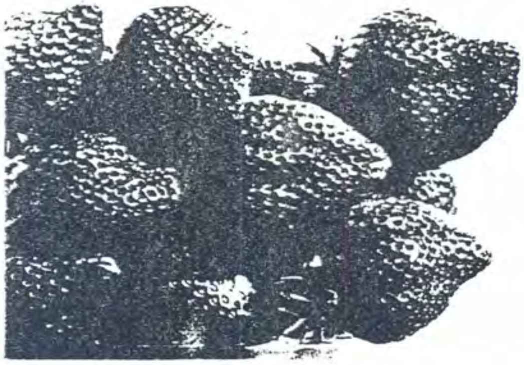
Dr. NOBUO TEZUKA
Plant Pathologist
National Research Institute of Vegetables and
Ornamental Plants and Tea

Ano-cho, Age-gun, Mie-Pref. 514-23 JAPAN
Telephone: 0592-68-1331

Dr. MASAHARU MATSUI
Chief of Entomology Laboratory
NATIONAL RESEARCH INSTITUTE OF VEGETABLES,
ORNAMENTAL PLANTS AND TEA

Ano, Mie 514-23, Japan
TEL. 0592-68-1331

27/6/96.



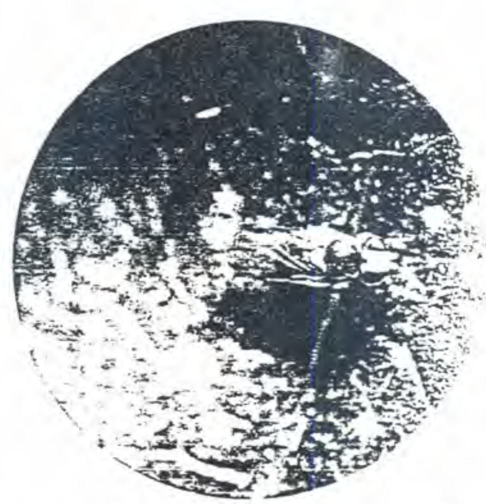
National Research Institute of Vegetables, Ornamental Plants and Tea (NIVOT)

Ministry of Agriculture, Forestry and Fisheries

Department of Plant Protection and Soil Science

Advanced research on the following major subjects relating to vegetables and ornamental plants is carried out : (1) Etiology and epidemiology, mechanism of plant resistance, methods for integrated control and molecular biological techniques for the control of major diseases.
(2) Ecology and physiology, forecasting technology, biological control, and integrated pest management of major insect pests. (3) Optimum plant growth environment and its control through rational management of soil and plant nutrition, growth diagnosis based on nutritional status, and physiological disorders of plants. (4) Preservation of production environment and promotion of low-input sustainable farming.

Laboratory of Air-borne and Virus Diseases : Basic research to control air-borne and virus diseases of vegetables and ornamental plants is carried out. Current studies are focused on the etiology of new plant diseases, phylogeny of downy mildew fungi of crucifers, analysis of plant virus genomes and production of transgenic plants resistant to viruses.



Adult of Florida leafminer, *Liriomyza trifolii*.

Laboratory of Soil-borne Diseases : Research on soil-borne diseases of vegetables and ornamental plants is carried out with emphasis placed on identification, ecology, biological differentiation and seed transmission of major pathogens. Research on the development of integrated control of Fusarium and Verticillium diseases is also being actively promoted.

Laboratory of Chewing Insect Pests : For development of methods for integrated control measures of chewing insect pests of vegetables and ornamental plants, especially of the diamondback moth (*Plutella xylostella*), ecological and behavioral studies on the chewing insect pests and their natural enemies are carried out.

Laboratory of Sucking Insect Pests : For the development of methods for integrated control of sucking insect pests of vegetables and ornamental plants, such as thrips, aphids and whiteflies, the following basic studies are being carried out : physiology, ecology, molecular endocrinolgy of the pests, mechanism of pest resistance of plant. Utilization of natural enemies for pest control is also extensively studied.

A parasitoid, *Encarsia formosa*, ovipositing on the larvae of the greenhouse whitefly, *Trialeurodes vaporariorum*.

Laboratory of Soil Science and Plant Nutrition : Research on soil and fertilizer management for vegetable and ornamental plant production and crop nutrition for optimum growth is carried out. Current research is focused on the development of rational methods of soil improvement and fertilizer application, evaluation and control of crop nutritional status, and promotion of low-input sustainable production.

Department of Tea Agronomy

The department consists of seven laboratories, a field management section and a factory. Research on breeding, cultivation and protection of tea plants is carried out. Recent research activities are as follows :

1) Development of breeding technology and new breeding materials through the use of biotechnological procedures.
2) Collection, evaluation and utilization of genetic resources.
3) Breeding of high-quality and high yielding cultivars resistant to pests and diseases.
4) Improvement of field management through the use of various machines.
5) Forcasting and prevention of meteorological hazards.
6) Analysis of canopy photosynthesis in relation to skiffing and pruning.
7) Analysis of amino acid metabolism in relation to tea quality.
8) Development of soil science and rational methods of fertilizer application.
9) Ecological and physiological studies on major pests and diseases of tea.
10) Biological control of pests and diseases of tea.

Regeneration of shoot from stem-derived callus. Process of regeneration is necessary for developing new tea cultivars by gene recombination.

Heptophylla picea Motschulsky. Injury by the pest has recently spread over the tea fields of Japan.

Canopy structure of mature tea bush. New shoots which will become photosynthetic parts are harvested for the manufacture of tea.

虫害第2研究室 (Sucking Insect Pests Lab.)

施設における野菜栽培の発達・普及は、野菜生産の周年化、安定に大きく貢献しているが、一方では、恒常的な害虫の多発生や新しい加害種の登場を促すこととなった。なかでも、アザミウマ類、コナジラミ類、アブラムシ類、ハダニ類等の吸汁性害虫は、果菜類の施設栽培を中心に各地で多発生し、被害を激化させている。これらの害虫は、薬剤抵抗性を発達させ、防除困難な難防除害虫として生産の大きな障害となっており、早急に的確な防除対策を講ずる必要がある。

当研究室は、このような背景を踏まえ、野菜・花きの吸収性害虫の生理生態に関する研究並びに生物的手法を主体とした防除法の開発などを実施する。

メンバー (Member)

室長	(Chief)	松井正春	M.Matsui
主任研究官	(Senior Researcher)	小山健二	K.Koyama
研究員	(Senior Researcher)	篠田徹郎	T.Shinoda

試験研究課題 (平成8年度) (Main theme : 1996)

天敵利用関係 (Natural enemy)

○コナジラミ類防除における天敵利用技術の開発 (経常　平成6～9年)
Development of using methods for natural enemies against whiteflies (1994-1997)

＜トマトにおけるオンシツツヤコバチ等の天敵類の利用＞
Method for using *Encarsia formosa* on tomato in vinyl houses
(Side effects of chemicals against *E.formosa*)
(Influence of high and low temperature on *E.formosa*)
(Introduction of other natural enemies on tomato: *Orius, Eretmocerus*)

耐虫性関係 (Plant resistance)

○昆虫の寄主選択制御因子の解明と利用技術の開発 (大型別枠　平成元～10年)
The mechanism of host selection by insects (1989-1998)
＜ワタアブラムシ＞ *Aphis gossypii*
＜ミナミキイロアザミウマ＞ *Thrips palmi*

○コナジラミの栄養生理と摂食阻害物質の簡易検定法 (経常　7～9年)
Nutritional physiology of whiteflies and the method for searching resistant substances. (1995-1997)
＜シルバーリーフコナジラミ＞ *Bemisia argentifolii*
＜オンシツコナジラミ＞ *Trialeurodes vaporariorum*

侵入害虫関係 (Invaded insect pests)

○ミカンキイロアザミウマの防除に関する研究 (小事項　平成8～10年)
Control measurements against *Frankliniella occidentalis* (1996-1998)
○侵入害虫の経済的被害の評価 (小事項　平成8～10年)
Evaluation of economical damage by invaded insect pests (1996-1998)

生理活性物質関係 (Physiological active substances)

○吸汁性害虫に対する幼若ホルモンの作用機作の解明 (経常　平成2～9年)
(Mechanism of the action of juvenile hormone against sucking insect pest)(1990-1997)
＜ホソヘリカメムシ＞ *Riptortus clavatus*, bean bug

Principais insetos pragas no Japão

和名	英名	学名	No.
コナガ	diamondback moth	Plutella xylostella	
モンシロチョウ	common white	Pieris rapae crucivora	
タマナギンウワバ	beet semi-looper	Plusia nigrisigna	
ヨトウガ	cabbage armyworm	Mamestra brassicae	
ハスモンヨトウ	common cutworm	Spodoptera litura	
ハイマダラノメイガ	cabbage webworm	Hellula undalis	
カブラヤガ	cutworm	Agrotis segetum	
タマナヤガ	black cutworm	Agrotis ipsilon	
シロイチモジヨトウ	beet armyworm	Spodoptera exigua	
キスジノミハムシ	striped flea beetle	Phyllotreta striolata	
ウリハムシ	cucurbit leaf beetle	Aulacophora femoralis	
ドウガネブイブイ	cupreous chafer	Anomala cuprea	
タネバエ	seedcorn maggot	Delia ~~Hylemya~~ platura	
タマネギバエ	onion maggot	Hylemya antiqua	
ダイコンバエ	turnip maggot	~~Hylemya~~ floralis	
ネギハモグリバエ	stone leek leafminer	Liriomyza chinensis	
[illegible]		[illegible]	
ネギアザミウマ	onion thrips	Thrips tabaci	
ミナミキイロアザミウマ		Thrips palmi	
オンシツコナジラミ	citric white fly greenhouse white fly	Aleurocanthus [illegible] Trialeurodes vaporariorum	
タバココナジラミ	sweetpotato whitefly	Bemisia tabaci argentifolii	

マメハモグリバエ Liriomyza trifolii

28/06/96

Retorno para TSUKUBA

29/06/96 - Sábado

30/06/96 - Domingo

1º/07/96 - Avaliação JICA e preparo para o retorno

02/07/96 - Retorno ao Brasil

AGRADECIMENTOS

* À JICA pelo suporte financeiro;
* Ao Dr. Toru Kubota líder da Missão da JICA no CPAC e Dr. M.Miyazaki (TSUKUBA), pela excelente e proveitosa organização do programa de treinamento;
* Ao Ministério da Agricultura e do Abastecimento/EMBRAPA pela autorização concedida;;
* Ao CPAC pela oportumidade oferecida;
* Ao meu esposo e filhos pelo incentivo e apoio.

ANEXOS

* Certificados

*Bibliografia

農林水産省
野菜・茶業試験場
茶栽培部
部長
八戸三千男
Dr. Hachinoche
chefe Est. Exp. Tea
〒428
静岡県榛原郡金谷町金谷二七六九
電話 ○五四七(四五)四一○一(代表)
○五四七(四六)二三六六(直通)
FAX ○五四七(四六)二一六九(代表)
○五四七(四五)五○七○(直通)

Dr. Akira KAWAI

Head. Labaratory of Entomology.
Department of Tea Agronomy.
National Research Institute of
Vegetables. Ornamental Plants and Tea.
Ministry of Agriculture. Forestry and Fisheries.
Kanaya. Shizuoka 428. JAPAN
Internet: tpest@tea.affrc.go.jp

JICA

SHIGENARI KOGA

DIRECTOR
SECOND TRAINING DIVISION

TSUKUBA INTERNATIONAL CENTRE (TBIC)
JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

No. 3-7, KOYADAI, TSUKUBA-SHI,
IBARAKI-KEN, 305 JAPAN

TEL 0298-38-1111
FAX 0298-38-1776

Certificate

This is to certify that Mrs. Maria Alice Santos OLIVEIRA

has successfully completed the Individual Training Course

in Observation of Entomology

at Div. of Entomology, National Institute of Agro-Environmental Sciences
and other institutes of Ministry of Agriculture, Forestry and Fisheries
Kyushu University. Kubota Corp.

from June 13, 1996 to July 1, 1996

organized by the Japan International Cooperation Agency under the International Cooperation Programme of the Government of Japan.

Kimio Fujita

PRESIDENT
JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN

Date: July 1, 1996

NIAES No. 122

Certificate

This is to certify that Ms. Maria Alice Santos Oliveira of Federative Republic of Brazil has completed studies on the following subjects at the National Institute of Agro-Environmental Sciences of the Ministry of Agriculture, Forestry and Fisheries of Japan.

Period : from June 17 to June 28, 1996

Subjects of study : Inspection on the entomological researches in Japan

NIAES

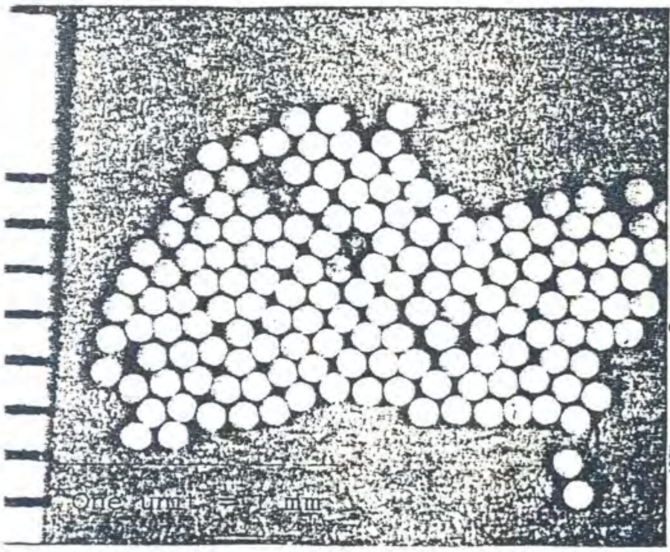
Date : June 28, 1996

T. Nagata

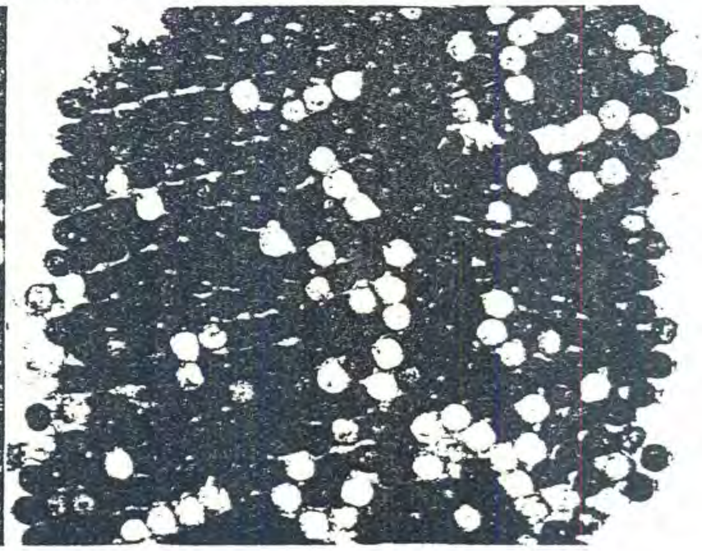
Dr. Toru Nagata
Director general
National Institute of Agro-Environmental Sciences

NARC-NVOCES COLLABORATIVE PROJECT "APPROACH TO MANAGING THE DBM (PLUTELLA XYLOSTELLA) BY PARASITOIDS"

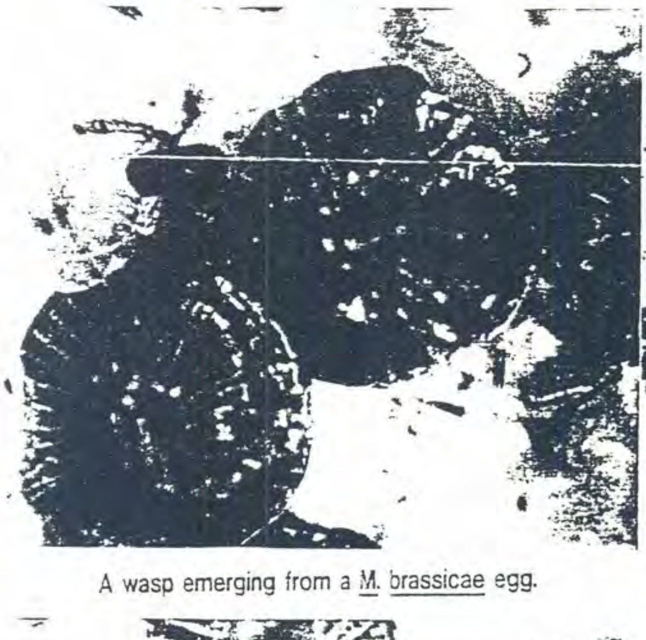
1. Massproduction of Trichogramma chilonis (Hym., Trichogrammatidae) with the eggs of an alternative host, Mamestra brassicae (Lep., Noctuidae) at NARC



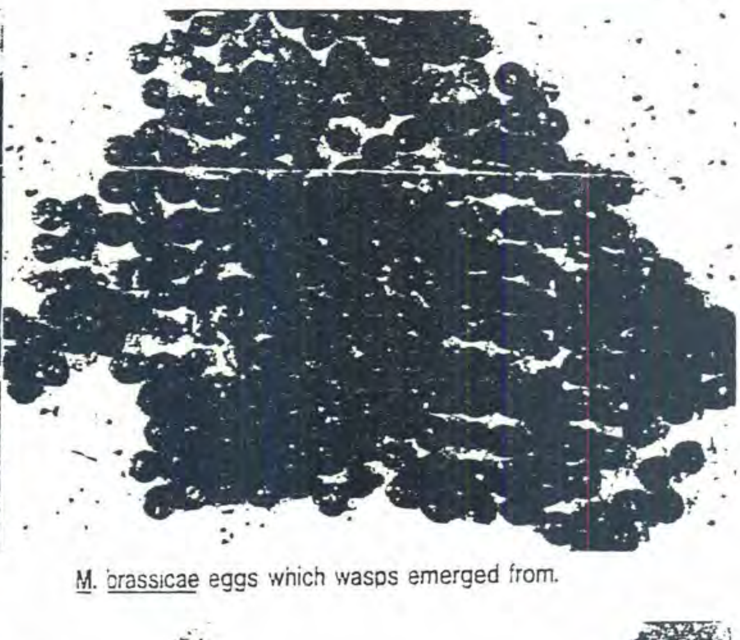
Normal eggs of M. brassicae.



Parasitized (black) and unparsitized (white) M. brassicae eggs.



A wasp emerging from a M. brassicae egg.

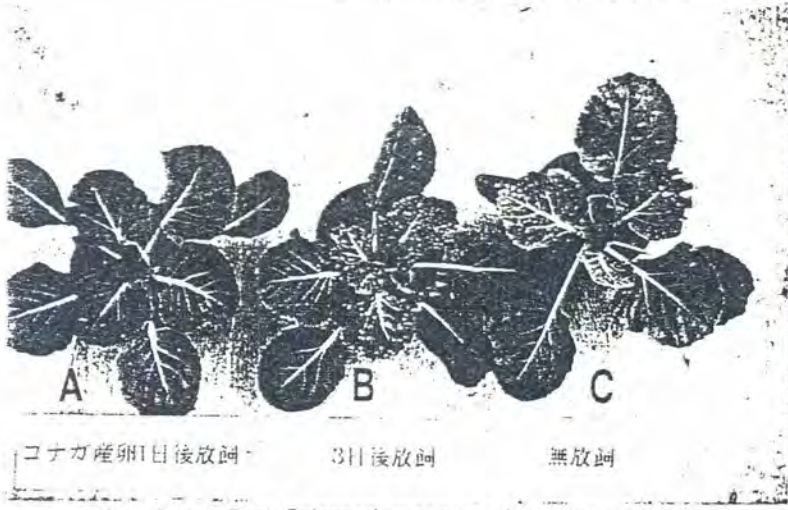


M. brassicae eggs which wasps emerged from.

Holes in M. brassicae eggs for wasp emergence

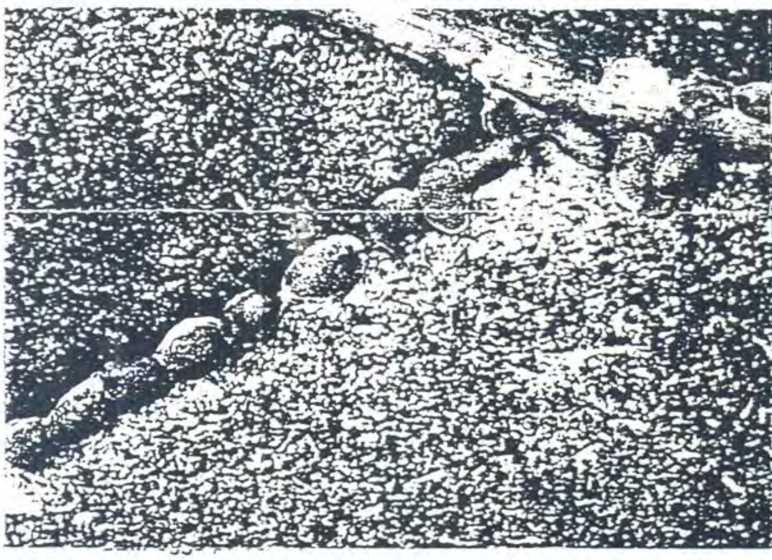
Female wasps ovipositing M. brassicae eggs.

2. Approach to managing the DBM by Trichogramma at NVOCES.

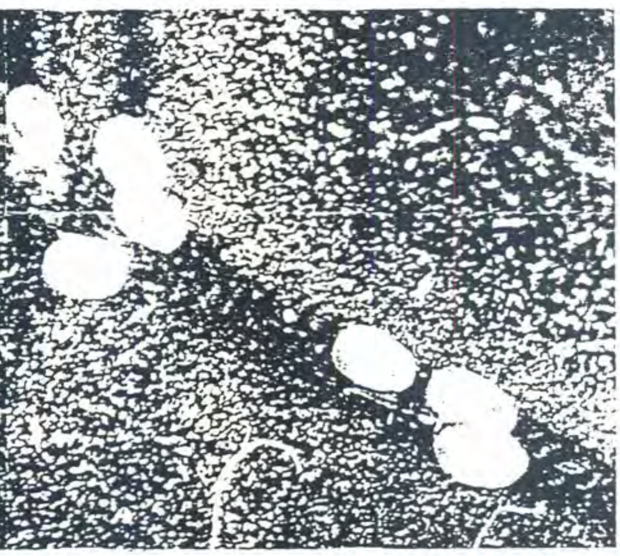


Greenhouse Expt. Released wasps one (A) and three (B) days after DBMs oviposited on cabbage. No. wasp was released (C). Photo taken seven days after DBMs oviposited.

Field Expt. Release of wasps in cabbage field.



DBM eggs parasitized.



DBM eggs unparasitized.

Field Expt. Cabbages in the plot with wasps released.

Field Expt. Cabbages in the plot without wasps: No ball developed.

Control of Scarabaeid Grubs with an Entomogenous Nematode, *Steinernema kushidai*

Nobuo OGURA

Forest Biology Division, Forestry and Forest Products Research Institute
(Tsukuba, Ibaraki, 305 Japan)

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Japan Agricultural Research Quarterly

Tropical Agriculture Research Center
Ministry of Agriculture, Forestry and Fisheries
Tsukula, Ibaraki, 305 JAPAN

FUTURE PROSPECTS FOR THE ERADICATION OF FRUIT FLIES

Masakazu Shiga
Laboratory of Biological Control,
National Institute of Agro-Environmental Sciences
Kannondai 3-1-1, Tsukuba, Ibaraki, 305 Japan

INTRODUCTION

The fruit fly eradication program in the subtropical part of Japan has successfully progressed to reach its final phase. That is, not only has the oriental fruit fly, *Dacus dorsalis*, been eradicated from all over Japan, but the melon fly, *D. cucurbitae*, has been eradicated throughout the Amami Islands and in most of Okinawa Prefecture (with the exception of the Yaeyama Islands where an eradication program is now being conducted).

In this paper, I shall briefly review the 24-year attempt to eradicate fruit fly in Japan, to show what difficulties have been encountered and how they were overcome, and offer suggestions for the successful implementation of the male annihilation method (MA) and the sterile insect technique (SIT) in other countries, expecially those of tropical Southeast Asia.

ERADICATION OF THE ORIENTAL FRUIT FLY

D. dorsalis was first recorded in Okinawa Prefecture in 1919 and in the Ogasawara (Bonin) Islands around 1925. Its distribution then expanded to cover the whole subtropical part of Japan, including the Amami Islands of Kagoshima Prefecture, by 1946 (Koyama 1989). Eradication experiments were conducted by USDA from 1960 to 1962, based on MA using poisoned methyl eugenol, in the Ogasawara Islands (Christenson 1963). A new eradication program supported by the Japanese Government was then begun in 1968 on Kikai Island in the Amami Islands. After 18 years of effort, *D. dorsalis* was fully eradicated from all of Japan by February 1986 (Fig. 1).

The Ogasawara Project

Details of the eradication program of *D. dorsalis* in the Ogasawara Islands have been summarized by Shiga (1989). Two problems were of fundamental importance in this project.

Resistance to Control Based on Methyl Eugenol

The possible existence of 'methyl-eugenol-insensitive genotypes' and the potential development of a fruit fly population less susceptible to methyl eugenol has been suggested by Christenson (1963) and by Itô and Iwahashi (1974). Itô and Iwahashi (1974) even recommended that an eradication program be carried out based on SIT rather than on MA, for this reason. In fact, the development of populations which are relatively unsusceptible to methyl eugenol has not yet been demonstrated, and fruit flies in the Amami Islands and Okinawa Prefecture were successfully eradicated by poisoned methyl eugenol. However, the decision to adopt SIT as the eradication method was reasonable, because the steep cliffs around the islets might make it difficult to apply the poisoned methyl eugenol effectively. Such difficulties actually occurred on Iriomote Island in Okinawa Prefecture, as discussed below.

Keywords: Fruit flies, *Dacus dorsalis*, *Dacus cucurbitae*, SIT (sterile insect technique), MA (male annihilation), Japan, monitoring, eradication

Journal of Applied Bacteriology 1994, 76, 307–313

Characterization of larvicidal toxin protein from *Bacillus thuringiensis* serovar *japonensis* strain Buibui specific for scarabaeid beetles

H. Hori, N. Suzuki, K. Ogiwara, M. Himejima, L.S. Indrasith, M. Minami, S. Asano, R. Sato[1], M. Ohba[2] and H. Iwahana[1]

Tsukuba Laboratories for Research and Development, Kubota Corp., Koyodai, Ryugasaki, Ibaraki, [1]Department of Applied Biological Science, Faculty of Agriculture and Technology, Tokyo University of Agriculture and Technology, Fuchu, Tokyo and [2]Institute of Biological Control, Faculty of Agriculture, Kyushu University, Fukuoka, Japan

4497/03/93: accepted 27 September 1993

H. HORI, N. SUZUKI, K. OGIWARA, M. HIMEJIMA, L.S. INDRASITH, M. MINAMI, S. ASANO, R. SATO, M. OHBA AND H. IWAHANA. 1994. The δ-endo toxin proteins from *Bacillus thuringiensis* which kill the larvae of various scarabaeid beetles such as *Anomala cuprea*, *A. rufocuprea* and *Popillia japonica* were purified by DEAE ion exchange chromatography. A protein with a molecular size of 130 kDa was purified. During the purification a minor peak was also detected which was estimated to be 67 kDa by SDS-PAGE. Both 130 and 67 kDa proteins showed larvicidal activity against *A. cuprea*. The lethal concentration of the 130 kDa protein which killed 50% of the larvae tested (LC_{50}) against *A. cuprea* was 2 $\mu g\ g^{-1}$ compost. A comparison by SDS-PAGE of the V8 protease digestion pattern of the 130 and 67 kDa larvicidal proteins showed that proteolytic resistant core peptides of approximately 60 kDa molecular size were resulted. The *N*-terminus amino acid sequence of the 130 and 67 kDa proteins was determined to be NH_2-XXPNNQNEYEIIDAL and NH_2-XSRNPGTFI, respectively, which is not identical to the sequence of CryIA, CryIB, CryIC and CryIII proteins.

INTRODUCTION

Bacillus thuringiensis produces insecticidal toxin proteins which are specific to the larvae of Lepidoptera, Diptera and Coleoptera. For example, a decade ago *B. thuringiensis tenebrionis* toxin was shown to be specific to the larvae of Chrysomelida and Tenebrionida (Krieg *et al.* 1983) while, more recently, *B. thuringiensis* strain EG2158 was also shown to be toxic to coleopteran insects including the families of Chrysomelidae and Tenebrionidae (Donovan *et al.* 1988).

Other Coleoptera such as the Scarabaeidae, including *Popillia japonica* and *Anomala cuprea*, are important pests that need to be controlled world-wide and much research has been carried out using the toxin proteins from *B. thuringiensis* to control them.

Recently it was found that *B. thuringiensis* serovar *japonensis* strain Buibui has a potent larvicidal activity against Scarabaeidae but not Chrysomelidae or Lepidoptera (Ohba *et al.* 1992; Suzuki *et al.* 1992). The LC_{50} of the toxin against cupreous chafer was estimated as 0·098 μg protein g^{-1} diet (Suzuki *et al.* 1992). In this study an attempt was made to characterize the biochemical properties of purified larvicidal toxin proteins produced by *B. thuringiensis* serovar *japonensis* strain Buibui.

Correspondence to: Dr H. Hori, Tsukuba Laboratories for Research and Development, Kubota Corp., Koyodai 5-6, Ryugasaki, Ibaraki 301, Japan.

MATERIALS AND METHODS

Culture of bacteria and preparation of crystals

A single colony each of *B. thuringiensis* serovar *japonensis* strain Buibui, *B. thuringiensis* serovar *kurstaki* HD-1 and HD-73 was removed from the surface of nutrient agar (first grade, Wako Pure Chemical, Osaka, Japan) medium and placed in 1-l flasks containing 200 ml of nutrient broth and grown at 35°C until the cell autolysed (Ogiwara *et al.* 1992).

Purification of crystals

The whole culture (600 ml) was centrifuged at 15 000 *g* for 15 min, washed twice with water and the crystals partially

Dear Maria Alice, With the best compliments
Y. Murakami

Appl. Ent. Zool. 19 (2): 237-244 (1984)

Parasitoids of Scale Insects and Aphids on Citrus in the Cerrados Region of Brazil (Hymenoptera: Chalcidoidea)

Yôzô MURAKAMI

Institute of Biological Control, Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan

Noboru ABE[1] and G. W. COSENZA

EMBRAPA-CPAC, Planaltina, Brasilia D.F. 73300, Brazil

(Received December 27, 1983)

Six species of scale insects and three species of aphids as well as their parasitoids were recorded from citrus orchards in Brasilia D.F. in the Cerrados region in January–February 1982. The parasitoids recorded from scale insects are as follows: Five species from *Chrysomphalus ficus*, one species from *Lepidosaphes beckii*, four species from *Pinnaspis aspidistrae*, and one species from *Coccus viridis*. Effective control of *Ch. ficus* can not be achieved by any parasitoids found in the Cerrados area. It is suggested that *Aphytis holoxanthus* be introduced into citrus orchards in the Cerrados area from areas in Brazil where the parasitoid has been established after importation in 1962. Since effective parasitoids of *C. viridis* have not been found, effort should be directed toward discovery of a beneficial species in Brazil, which is presumably the source country of the pest. No parasitoids of *Toxoptera citricidus* were found in the Cerrados area. It is suggested that the parasitoid, *Lysiphlebia japonica* be introduced into Brazil from Japan, where the parasitoid has been reported as the most effective natural enemy of the aphid.

INTRODUCTION

Citrus has rapidly developed into one of the most important crops in Brazil. From the standpoint of insect pest problems of citrus, Brazil is an area of much higher pest damage than other countries of the world. Expansion of citrus production in Brazil has exposed the crop to a high degree of risk from attack by a large and diverse pest species complex. GALLO et al. (1978) have recorded 18 species of scale insects and one aphid as the pests of citrus in Brazil. Among the scale insects, *Orthezia praelonga*, *Chrysomphalus ficus*, *Lepidosaphes* (=*Mytilococcus*) *beckii*, *Pinnaspis aspidistrae*, *Parlatoria ziziphi* (=*P. ziziphus*) are the most important pests of citrus in Brazil (CAETANO, 1980; NAKANO, 1982). The brown aphid, *Toxoptera citricidus*, is well known as the vector of Tristeza virus (MÜLLER, 1980). Predaceous coccinellids, syrphids, a thrips and a chrysopid, as well as 7 species of parasitoids and 6 pathogens have been recorded as natural enemies of these pests in Brazil (GALLO et al., 1978; GRAVENA, 1980).

[1] Present address: *Tropical Agriculture Research Center, Yatabe, Ibaraki 305, Japan*

Acta Phytopathologica et Entomologica Hungarica 27 (1-4), pp. 479-483 (1992)

Interspecific Relationship between an Introduced Parasitoid, *Torymus sinensis* Kamijo, as a Biological Control Agent of the Chestnut Gall Wasp, *Dryocosmus kuriphilus* Yasumatsu, and an Endemic Parasitoid, *T. beneficus* Yasumatsu et Kamijo*

S. Moriya[1], K. Inoue[1], M. Shiga[2] and M. Mabuchi[1]

[1] Fruit Tree Research Station, Tsukuba, Ibaraki 305, Japan
[2] National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki 305, Japan

Torymus sinensis (Ts), which was introduced from China into Japan to control *Dryocosmus kuriphilus*, was released in 1982. An indigenous parasitoid, *T. beneficus (Tb)* which is closely related to *Ts*, consists of two strains differing only in terms of the period of adult emergence. Females of *Ts* can be differentiated from those of *Tb* since *Ts* generally has a longer ovipositor sheath than *Tb* whereas males cannot be distinguished. The number of *Tb* has recently decreased although clear evidence of severe competition between *Ts* and *Tb* has not yet been obtained. Two years after the release, females in which the length of the ovipositor sheath was more or less intermediate between that of the two species have been detected. When *Ts* and *Tb* were artificially paired, such females were observed among the offspring. Furthermore, it appears that the females of the F_1 progeny remained fertile when they were experimentally backcrossed to males of the parent species.

A parasitoid wasp, *Torymus sinensis* Kamijo (*Ts*), was introduced from Mainland China into Japan in order to control the chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu, one of the most serious pests of chestnut trees in Japan (Murakami et al., 1977, 1980). In 1982, 260 mated *Ts* females were released at the Fruit Tree Research Station (FTRS), Tsukuba, Japan and they were confirmed to have become established at FTRS (Ôtake et al., 1984). It is currently being considered that *Ts* is a very promising biological control agent of *D. kuriphilus* in Japan (Moriya et al., 1989a). When *Ts* was released at FTRS, however, it was feared that an indigenous parasitoid, *T. beneficus (Tb)* might compete with *Ts* and adversely affect the release since the two species were closely related to each other. Furthermore, it was found in 1983 that *Tb* consists of two strains, which differed actually only in the period of adult emergence at and around FTRS (Moriya et al., 1989b). Ôtake (1987) pointed out that there was no clear morphological difference between the two strains, and tentatively designated them as "early-season strain" (*TbE*) and "late-season strain" (*TbL*), respectively. It is important and necessary, therefore, for the biological control of the chestnut gall wasp to investigate the interspecific relationship between *Ts* and *Tb*.

Since we are mainly interested in the possibility of crossing between *Ts* and *Tb* and the outcome of the crossing, this study briefly reports the annual changes in the number of the two torymid species and the intermediate one after the release of *Ts* at FTRS. Experimental crossing involved *Ts* and *Tb* and the females of the F_1 progeny were

* Contributions from the Fruit Tree Research Station, A-263.

Proc. Int. Symp. Insect Diversity Research
in Korea, Chuncheon (1993), 44-57.

Potential Effect of Global Warming on the Distribution of Insects in Japan

Osamu IMURA[1], Nobuo MORIMOTO[1] and Takuji KIURA[2]
([1]Division of Entomology, National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki 305, Japan,
[2]Research Information Division, Tropical Agriculture Research Center, Tsukuba, Ibaraki 305, Japan)

Abstract Potential effect of global warming on the occurrence of insects in Japan was studied. The occurrences of four insect species which have different types of life cycle were predicted, under 2℃ warming due to CO_2 doubling, using a computer program. Global warming would generally increase number of generations of the insects. It would allow *Spodoptera litura* to overwinter in larger area than at present. Could-susceptible *Tribolium confusum* would expand the distribution area northward and *Ehestia kühniella* which is susceptible to hot weather would shift the southern boundary of the distribution area northward leading to a large shrinkage of the distribution are. Effects of global warming on species interactions, physiological and genetic responses by insects and insect species diversity were discussed.

Key words Global warming, Thermal summation, Insect life cycle, Species interactions, Species diversity.

INTRODUCTION

IPCC(1990) reported that the atmospheric concentrations of greenhouse gasses such as CO_2, methane, nitrous oxide, CFCS, etc. which absorb long-wave terrestrial radiation from the warm surface of the Earth leading to global warming have been increasing since 1760, the beginning of the industrial revolution. The rates of increase in the concentration of theses gasses were noticeably accelerated after 1950. IPCC report (1990) predicted that the CO_2 concentration, including other greenhouse gasses (the equivalent CO_2 concentration) would double by 2030, if we will not take any

Appl. Entomol. Zool. 31 (1): 111–118 (1996)

Ovicidal Reaction of Rice Plants against the Whitebacked Planthopper, *Sogatella furcifera* HORVÁTH (Homoptera: Delphacidae)

Yoshito SUZUKI, Kazushige SOGAWA and Yoshito SEINO

Kyushu National Agricultural Experiment Station, Nishigoshi, Kumamoto 861-11, Japan

(Received 14 August 1995; Accepted 25 October 1995)

Association of the physiological egg mortality of *Sogatella furcifera* with the rice plant reaction of forming a watery lesion at oviposition sites was revealed: egg survival rate dropped to less than 20% in the watery lesion within 2 days after oviposition, while 88.8% of eggs developed to the eye-spot formation stage in the non-watery lesion, on rice plants 8 weeks after planting. *S. furcifera* eggs laid in large tillers and in the main stem suffered higher physiological mortality than those laid in small tillers on the same plant. The physiological egg mortality increased steadily with progression of the tillering of plants until 10 weeks after planting. Egg density did not affect the mortality. The importance of plant resistance as a factor determining the population growth pattern of *S. furcifella* is discussed.

Key words: *Sogatella furcifera*, ovicide, rice, plant reaction

INTRODUCTION

Trans-oceanic migrants of the whitebacked planthopper, *Sogatella furcifera* HORVÁTH, invading Japanese paddy fields in Baiu (rainy) season have been consistently increasing since the late 1970's (SOGAWA and WATANABE, 1989; MATSUMURA, 1991; NABA, 1992; ITOMI, 1992; WATANABE et al., 1994). This increase coincides with the prevalence in China of cultivating hybrid rice on which *S. furcifera* attains a population growth rate 10 to 20 times higher than that on traditional varieties (ZHU et al., 1984). As a consequence of population increase in the immigrant and subsequent reproductive generations, *S. furcifera* became established as a most serious pest of the rice plant in Japan, and since then, various new types of damage to rice by *S. furcifera* have been reported (NODA, 1986, 1987; KIYOTA and OKUHARA, 1990; ISIZAKI and MATSUURA, 1991; MATSUMURA, 1991). In western and southern Kyushu where immigrant *S. furcifera* population densities in Japan are highest, dark brownish discoloration of leaf sheaths induced by *S. furcifera* oviposition has become conspicuous. Heavy infestation thus suppresses the tillering and results in the death of affected plants in extreme cases.

SOGAWA (1991) revealed that the dark brownish discoloration is associated with a rice plant reaction that causes physiological death of *S. furcifera* eggs as evidenced by the low eye-spot formation rate of eggs. He further showed that, as a result of higher egg survival, the population growth rate of *S. furcifera* is ca. 6 times higher on varieties which scarcely exhibit the dark discoloration of leaf sheaths than on the Japonica variety Reiho which does exhibit it. SUZUKI et al. (1993) showed that the physiological death of eggs caused by plant reaction (hereafter referred to as physiological death) was responsible for 68.9 to 94.5% of the overall egg mortality of *S. furcifera* on the Hinohikari variety for a period of 5 to 10 weeks after transplanting in the field. They also pointed out that clarifying the factors which lead to physiological egg mortality are key to understanding the population dynamics of *S. furcifera*.

Special Issue

Use of Semiochemicals of Insects

By Dr. Sadao WAKAMURA
Laboratory of Behavior Regulation,
Department of Insect Physiology and Behavior,
National Institute of Sericultural and Entomological Science

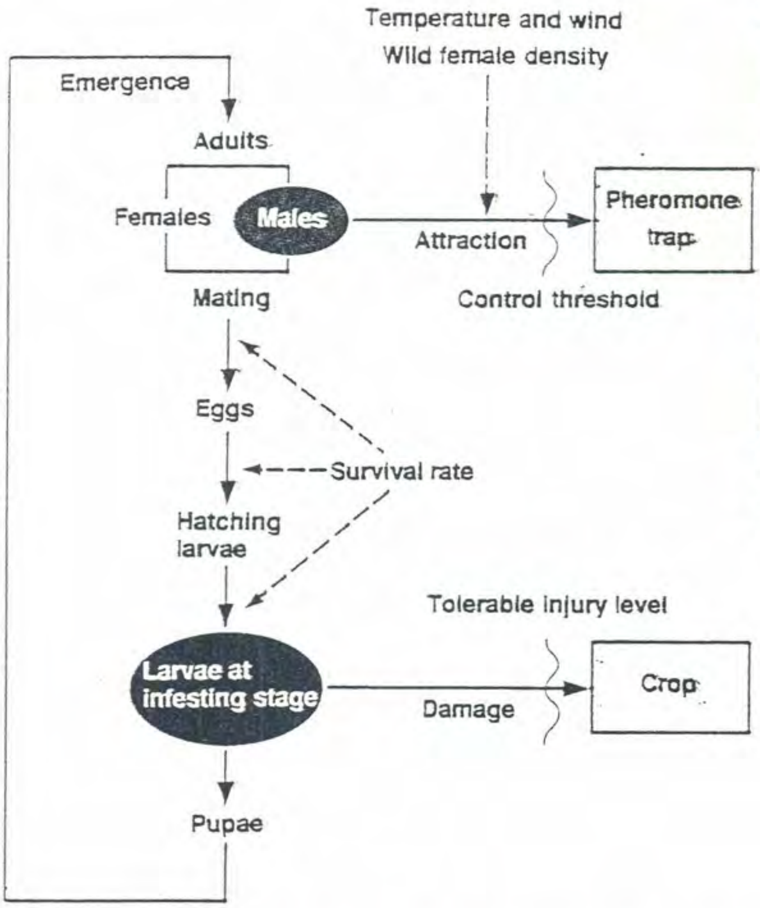
Insects, an animal group of remarkable diversity in form and habit, have adapted themselves to the environment by acquiring reactivity to diverse chemical stimuli they receive as information. The signal substances, or semiochemicals, used in those communications among individual insects and other organisms are classified into pheromone and allelochemic. While the former is used among individuals of the same species, the latter functions among different species.

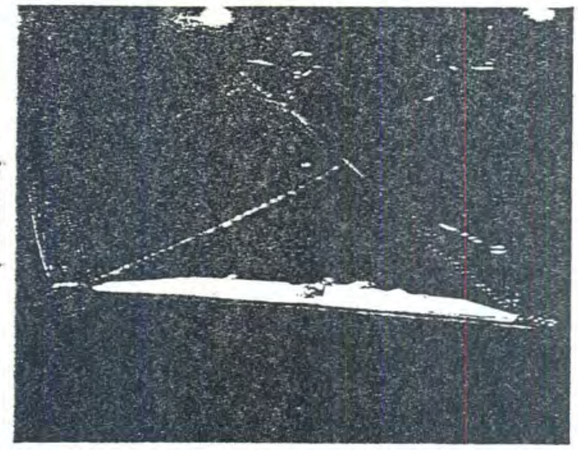
1. Pheromone

Sex pheromone: The study of pheromones has been most intensively conducted for the female sex pheromones which females release to attract males in moths and beetles. Its main purpose has been to use these pheromones for controlling insect pest population in agriculture.

The potent male-attracting activity of sex pheromones has been applied for forecasting and mass trapping techniques. In Japan, about 20 formulations are used for forecasting purpose, including those for the rice stem borer (*Chilo suppressalis*), the common cutworm (*Spodoptera litura*) and the oriental fruit moth (*Grapholitha molesta*). In general, pest population size should be influenced by weather, natural enemy, crop condition and another natural and artificial factors during the period between adult stage and the damaging larval stage (Fig. 1). Forecasting models would be necessary to be built by taking account of these factors.

Generally, males are able to copulate with and inseminate more than one female. Therefore, even if some of males are caught with sex pheromone trap, females can still mate with remaining males. So in the mass trapping techniques, the majority of males must be removed from the population before mating in order to decrease the mating rate in





Sex pheromone trap (SE trap®; sticky type) in which male tea tussock moths were captured. (by Dr. S. Wakamura)

Fig. 1. Forecasting of insect population from trap catch (Nakasuji, 1984)

females. In the click beetle (*Melanotus okinawaensis*), whose larvae feed on underground parts of sugarcane, the synthetic sex pheromone is much more attractive than females and males begin to respond to pheromone earlier than pheromone release by females. In this beetle, mass trapping was successful to reduce the population level in the fields. However, in the cases of lepidopterous insects, if the number of traps was increased to raise the total trapping efficiency, the interfering effect among the traps, that is, the effect of mating disruption, would result in decreasing the total number of males caught. Therefore, in the efforts to develop control techniques for lepidopterous pests, emphasis have been shifted to the mating disruption technique.

Synthetic sex pheromone formulation for mating disruption of lepidopterous pests on fruit trees. Sealed synthetic pheromone chemicals are released from the outer surface of the bag. (by Dr. F. Mochizuki)

In Japan, six types of formulations for mating disruption have been registered as pest control agents (Table 1). Worldwide, mating disruptants are most applied to the pink bollworm (*Pectinophora gossypiella*), a serious insect pest of cotton. As shown in Table 2, the action and effect of mating disruptant are basically different from those of conventional insecticides. Pheromone agents have been used for a single species only, but recently efforts are made to develop so-called "double purpose dispenser", a pheromone formulation against two or more serious insect pests of fruit trees and lawn.

Table 1. Sex pheromone formulations for pest management in Japan (Mating disruption)

Species	Components	(ratio)	Crops
Adoxophyes sp. *Homona magnanima*	Z11-14:Ac[a]		tea, grape
Adoxophyes orana fasciata *Archips breviplicanus* *Archips fuscocupreanus*	Z11-14:Ac[a]		apple, pear, peach
Carposina niponensis	(Z)-13-eicosen-10-one		peach, apple, pear
Synanthedon hector	Z3Z13-18:Ac E3Z13-18:Ac	(50%) (50%)	peach, Japanese apricot, cherry
Plutella xylostella	Z11-16:Ald Z11-16:Ac	(50%) (50%)	crucifer vegitables and ornamental flowers
Spodoptera exigua	Z9E12-14:Ac Z9-14:OH	(70%) (30%)	onion, vegetables, and ornamental flowers
Parapediasia teterrella	Z11-16:Ald Z9-16:Ald Z11-16:OH	(32.0%)[b] (1.5%) (1.5%)	lawn
Spodoptera depravata	Z9-14:Ac Z9E12-14:Ac	(30.0%) (7.0%)	lawn

a Same formulation; b Single formulation containing pheromones of two species.

Table 2. Differences between pheromone and conventional insecticides

	Pheromone	Conventional insecticide
Toxicity	No toxicity against mammals and fishes	New ones are less toxic but generally toxic
Effect on natural enemy	Natural enemies can survive	Secondary pest is often induced
Environmental pollution	Easily decomposed by microorganisms	Not negligible
Resistance or tolerance	No report yet but suggested	Generally induced
Times of application	One or two times a year	Several times at appropriate intervals
Population density	Less effective at higher population density	Effective at high density
Size of treated area	More effective in bigger size of field	Effective even in small area
Timing of application	Entire flight period of previous generation	Effective even just before damage increase
Weather	Less effective at windy place	Less effective in rain
Selectivity	Effective probably on target species only	Many pest species can be controlled by single application

After Ogawa (1990) with rearrengement

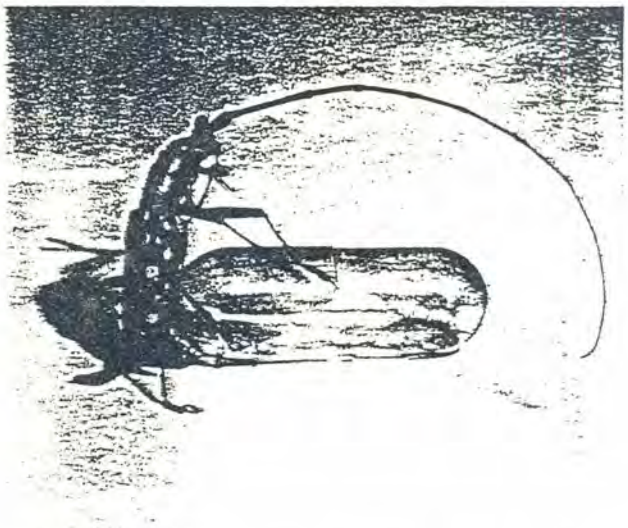
Recently a sex pheromone accepted by contact has been discovered in the yellow-spotted longicorn beetle (*Psacothea hilaris*) (See photo at right), a serious pest on the mulberry tree. This type of pheromone has also been found in the German cockroach (*Blattella germanica*) and the cinereous cockroach (*Nauphoeta cinerea*). These insects have this type of pheromone in the wax layer on the body surface. In the longicorn beetle, attempts to increase the infection rate are continued by combining contact pheromone with microbial insecticides.

Other types of pheromones: Females of the European cherry fruit fly (*Rhagoletis cerashi*) put oviposition-marking pheromone on the fruit when they lay eggs. In Europe, the oviposition by this insects was noticeably reduced by spraying an analogous compound which is as active as the natural oviposition-marking pheromone. The aggregation pheromone of weevils and heteropterous bugs attract both males and females and so it is likely to be an effective control to catch and kill the adults of these insects.

2. Use of allelochemics

The allelochemics which act among different species are classified into allomones, kairomones, and synomones according to which of the emitter, receiver and both of them are adaptively beneficial, respectively. From the viewpoint of their industrial use, the important functions will be related to attraction, arrest or dispersal.

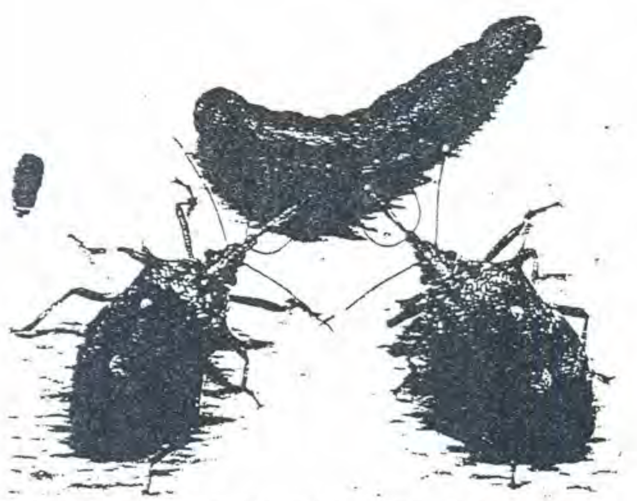
Interactions between plants and insects: Insect pests in agriculture are mostly phytophagous ones. When they lay eggs on or feed on plants, they rely on various chemical stimuli from the plants. Chemicals from the host plant may enhance the activity of sex or aggregation pheromone of a phytophagous insect. Male cabbage looper (*Trichoplusia ni*) was found to attract females more strongly when its smell was combined with the odor from host plant.



Male yellowspotted longicorn beetle, *Psacothea hilaris*, attempting to mate with a geration capsule coated with a female contact pheromone (by Dr. M. Fukaya)

What attracts attention in recent years is tritrophic interactions among the plant, phytophagous insect and its natural enemy. Damaged by the armyworm (*Mythimna* (*Pseudaletia*) *separata*), the leaves of corn may produce an attractant for the gregarious braconid wasp (*Apanteles kariyai*) which is a parasitoid and a natural enemy of the armyworm. When a plant is affected by the spider mite, the plant may begin to release an attractant for the predacious mite. However, these semiochemicals, which are symomones between plants and the parasitoids, have not yet been applied for industrial purposes including agricultural use. Studies on the functional constituents with repellent and dispersal effects would be necessary to be conducted more intensively as well as attractants.

Interactions between insects: There is an intensive increase of the use of natural enemies as pest control agents. Natural enemies use a variety of chemical substances to locate their host or food insect. Some of them utilize the host pheromone as kairomone. For example, the sex pheromone of aphid and scale insects are used by their parasitoid



Predatory stink bug, *Eocanthecona furcellata*, feeding on *Spodoptera litura* larva (by Dr. S. Wakamura)

wasps, and the aggregation pheromones secreted by male heteropterous bugs are by the parasitoid wasps and flies.

The synthetic pheromones of noctuid moths *Helicoverpa virlescence* and *Spodoptera furgiperda* attract egg-parasitoid wasps. However, there is a large gap in time between the emission of sex pheromone by the female moths and oviposition which usually take places during the following night of mating. It seems doubtful whether sufficient amount of moth pheromone remains on eggs in the following daytime when the egg-parasitoids make use of the moth pheromone for host location. The likelihood is that these parasitoids first use the remaining smell of moth pheromone to get a rough idea of where eggs exist and then some other cue for final host location.

Egg parasitoid *Telenomus euproctidis* hides a ride on the anal tuft at the abdominal tip of females of the tussock moth (*Euproctis taiwana*). When the moth lays eggs, the parasitoid may immediately lay its own eggs into the moth's eggs. This parasitoid wasp uses the moth's sex pheromone as a cue when it find a female moth. On the other hand, the predatory stink bug (*Eocanthecona furcellata*) (See photo above) is attracted by the smell from the larvae of the common cutworm (*Spodoptera litura*). One of the odor substances has been considered to be a defensive substance against microorganisms.

No adequate studies have been conducted yet on the utilization of the allelochemics for regulating natural enemies' activities. Although field experiments have succeeded in attracting natural enemies with attractants, the treatment with those attractants might result in disturbing host location by natural enemies.

3. Use of semiochemicals in future

There have been steady advances in the use of synthetic sex pheromones for insect pest control purposes. This is in the spotlight as a control technique with less adverse effects on the environment. However, some natural enemies may use sex pheromone of their host species as a cue for host location, or a kairomone. Mass trapping technique might eliminate these natural enemies, too. It is not clear wether the mating disruption may raise the percentage parasitism as a result of natural enemies concentrated to the areas treated with pheromones, or the percentage parasitism may be reduced as their host location was disrupted by abnormally high aerial concentration of pheromone. When we evaluate the control effect of synthetic sex pheromones, it is important to take a total performance into consideration, that is, to examine not only the net effect of the pheromone but also their possible impacts even if they are positive or negative.

It is not too much to say that almost no attempt has been made as to the industrial use of semiochemicals other than sex pheromones. However, these substances may have a great potential in the future since it is expected that their utilization will be realized in various fields, including the control of natural enemies' behavior and that of those other useful insects which will be discovered in the years to come.

2. Successful suppression of Arrowhead scale *Unaspis yanonensis* by *Aphytis yanonensis* and *Coccobius fulvus* introduced from China.

During August-September, 1980, while searching in the People's Republic of China for parasites of the California red scale, *Aonidiella aurantii*, Dr.DeBach (University of California, Reverside U.S.A.) made observation on the occurrence of parasites of the arrowhead scale, *Unaspis yanonensis*, main citruspest in Japan. After searching trip he recomended that for us, so we could organized introducing program. As a result of search, two parasites *Aphytis yanonensis* and Coccobius fulvus were introduced into Japan in October,1980 . Both wasps were released in many places after propagation in laboratory.

Fortunately we had gotten excellent results for control of arrowhead scale in all citrus growing areas. Now, there have been no need of chemical treatment for control of the scale insect, and the cost of chemical insecticides used in citriculture was reducced 1/3 previousely used.

「Biological control of fruit pests by natural enemies」

1. The use of *Torymus sinensis* to control chestnut gall wasp, *Dryocosmus kuriphilus*

There is a growing interest today in the control of agricultural pests by natural enemies,as an alternative to chemical control. Biological control is a way of reducing our present dependance on chemical pest control, although itis unlikely to replace it completely in the foreseeable future.

The chestnut gall wasp is one of the most serious pests of chestnut trees in Japan. It seems to have been accidentally introduced form China into Japan around 1940. A parasitoid wasp was introduced from China into Japan by the efforts of Dr.Qiu Shibang (Biological control laboratory Chinese Academy of Agricultural Sciences) and Prof. Hsien-bine Ao (Hopei Branch, Ent.Soc.Chn.Lab.Ins.Natural Enemies Hopei Fruuit-tree Res. Inst.). And then 260 mated females were released on a single occasion in 1982 at the Fruit Tree Research Station.

After establishment, the *T.sinensis* population increased and gradually spread each year further from the points of release (Fig 1). The gall formation rate of chestnut buds steadily decreased after the release of *T.sinensis*, reaching a level of about 0.7% in 1992 (Fig 2). Although there are still several problems to be solved, it is believed that *T.sinensis* is a very promising

biological control agent, not only for experimental fields but also for commercial orchards. Now points of practical release were increase. The activity of *T.sinensis* has already begin to have an impact on chestnut breeding. If the damage caused by the chestnut gall wasp can be reduced

by the parasistic activity of *T.sinensis*, the level of resistance to the wasp could be lowered in proportion to the effect of the parasitoid. Consequently,some chestnut varieties slightly resistant to the wasp may be selected and genetic variability may increase. In the case, the relationship between chestnut breeding and applied entomology is likelly to become closer in the future.

3.Control of longicorn beetle by insect parasitic fungi *Bauveria brongniartii*

Beauveria brongniartii(Deuteromycotina) is one of pathogen of coleopteran insects. In Japan, the fungus was firstly applied in mulberry field for control of adult yellow-spotted longicorn beetle, *Psacotea hilaris*. Thereafter the fungus was also applied in orchard, for control of adult white-spotted longicorn beetles, *Anoprophora malasiaca*(a pest of citrus), yellow-spotted longicorn beetdle (a pest of fig) and mulberry borrer, *Aporia japonica* (a pestof l oquat). The fungus is expected the registration as a microbial insecticide.

Management of Exotic Insect Pests in Japan

Masakazu Shiga

Department of Insect Physiology and Behavior, National Institute of Sericultural and Entomological Science, Tsukuba, Ibaraki 305, Japan

Abstract. In Japan, the rate of invasion by exotic insect pests increased in the last 23 years 2.6 times as much as it did before 1950. Recently several exotic insect pests are spreading on a worldwide scale. Furthermore, it is suspected in some cases that insecticide resistance had developed before the invasion occurred.

Three kinds of strategy are feasible for the management of exotic pest populations. These are eradication, classical biological control and integrated pest management (IPM). The ecological basis of these was considered by referring to the recent success of the eradication of the fruit flies, the introduction of exotic parasitoids of the chestnut gall wasp, *Dryocosmus kuriphilus*, and IPM approaches in dealing with *Thrips palmi*. In these cases, basic ecological studies in the field on interacting population systems including exotic pests, sterile insects, and introduced and native natural enemies are of fundamental importance.

Key words: exotic insect pests, eradication, classical biological control, integrated pest management, ecological studies

Introduction

The invasion of exotic insect pests is increasing in the world as transportation systems become more highly developed. These systems now enable us to transport large quantities of various agricultural products, including fresh vegetables, flowers, and fruits, quickly over long distances. As a result, the invasion of exotic insect pests is becoming a serious problem both in agriculture and in the conservation of endemic fauna and flora. I will review some recent advances in the management of exotic insect pests in Japan from an ecological point of view.

Exotic Insect Pests in Japan

Morimoto and Kiritani (1995) listed 240 exotic and 85 possibly exotic insects resident in Japan. The accumulated number of exotic insect species which were introduced accidentally into Japan is plotted in ten year intervals in Fig. 1. Although this figure shows only the

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Climatic factors affecting the occurrence of insect pests

O. Mochida, R.C. Joshi, and J. A. Litsinger
International Rice Research Institute
P.O. Box 933, Manila, Philippines

ABSTRACT

Many abiotic factors affect the distribution and bionomics of rice insect pests. Temperature extremes, water, and wind influence distribution. To a large extent, temperature and photoperiod regulate phenology. In temperate zones, multiple generations develop during warm weather. A few insects (*Agromyza* and *Oulema*) cause more damage at lower temperatures. In tropical areas, heavy rainfall can wash small insects off foliage. Outbreaks of locusts, armyworms, and leaffolders may follow prolonged drought. Outbreaks of *Mythimna separata* occur in ricefields after flooding. Low relative humidity and plant moisture are detrimental to most insects other than aphids, thrips, and mealy bugs. Combinations of climatic factors are known to be related to the occurrence of *Scirpophaga incertulas, Laodelphax striatellus,* and *Tetraneura ulmi.*

Climatic factors affect rice insect pests directly, by limiting or expanding their distribution, growth, reproduction, diapause, and dispersal, and indirectly, through plant mechanisms and natural enemies that regulate insect populations. Applied insecticides may be washed off plants during rainy periods or may degrade under high temperature and high solar radiation. This is not a negligible factor, because when insecticide application has been delayed by rain or when it has rained heavily just after application, stem borer control frequently has failed.

Insect pest outbreaks may be stimulated by the climatic parameters believed to be governed by sunspot frequency. In China, outbreaks of the Oriental migratory locust *Locusta migratoria* in the Hwai-Ho basin were recorded 236 times in the 1,000 yr between 957 and 1956. Although correlations between the periodicity of annual relative sunspot numbers and the outbreaks were weak, 2 population peaks every 10 yr or 5 peaks every 20 yr were quite evident, corresponding roughly to periodic climate variations in certain locations (66).

In Japan, outbreaks of the whitebacked planthopper *Sogatella furcifera,* with or without the brown planthopper *Nilaparvata lugens,* were recorded 111

Utilization of Egg Parasitoids for Biocontrol of Agricultural Insect Pests

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Dr. Kazuo HIRAI
Department of Plant Protection
National Agriculture Research Center
Ministry of Agriculture, Forestry and Fisheries

□ Special Issue □

Utilization of Egg Parasitoids for Biocontrol of Agricultural Insect Pests

By Dr. Kazuo HIRAI
Department of Plant Protection
National Agriculture Research Center

Introduction

To prevent the outbreak of insect pests by reducing their eggs, their original source, is not a recent idea. It seems to have been adopted for many years. S. E. Flanders (1929) is probably the first man in the world who used natural enemy insects to control eggs of insect pests.

The natural enemies of insect eggs include predators, such as lacewings, big-eyed bugs and predatory mites, and the egg parasitoids which belong to seven families of Hymenoptera. In particular, egg parasitoids of genus *Trichogramma* are a very small wasp 1 mm or less long, which lives in the eggs of other insects and kills them. In 1929, the mass production of this parasitoid was successfully achieved by Flanders in the eggs of Angoumois grain moth (*Sitotroga cereatella*) in the U.S. After that, the egg parasitoid began to be used for biocontrol purposes.

Today, egg parasitoids are extensively used in the former Soviet Union, China, Europe, Mexico and some other countries for the biocontrol of insect pests belonging to Order Lepidoptera, such as cabbage armyworm (*Mamestra brasicae*), corn earworm (*Helicoverpa armigera*), corn borer (*Ostrinia furnacallis* in Asia and *O. nubilalis* in Europe and America), rice leaf roller (*Cnaphalocrocis medinalis*), *Laspeyresia pomonella* and leaf roller moths. According to the statistics of 1985, the area of biocontrol using this insect was 15 million hectares in the former Soviet Union, 1.7 million hectares in China and 650,000 hectares in Mexico. The figure for the U.S. was 200,000 hectares in 1979.

This article will mainly describe the method of reproducing and using egg parasitoids for biocontrol purposes.

1. Species of egg parasitoids

Since the existence of *Trichogramma evanescens* was first reported in Europe in 1833, about 110 species of *Trichogramma* wasps have been recorded up to the present. This wasp is identified by the structure of the genitalia of its male. In addition to the morphological method of classification, electrophoresis and chromatography are expected to be used for the identification of this wasp. These two analyzing methods have recently revealed that the electrophoretic pattern of esterase isoenzyme is fixed for each of these species.

In the Rice Insect Laboratory of the National Agriculture Research Center, we are studying the method of identifying the species on a gene level by using the polymerase chain reaction (PCR) method.

In Japan, only a small number of egg parasitoids have been identified: they are *T. chilonis*, *T. dendrolimi*, *T. japonicum*, *T. papilionis* and *T. ostriniae*. It is believed that many other species and ecotypes of egg parasitoids exist in this country, and high hopes are placed on future efforts to identify them.

Of the above-mentioned species, *T. chilonis*, *T. dendrolimi* and *T. ostriniae* have been the subjects of researches on biocontrol use in Japan. All of these three wasps are easy to rear since they are multivoltine and dependent on temperature in their development. For the wasp having dispause, like *T. japonicum*, some special devices are needed, such as rearing under an appropriate temperature zone between 20°C and 25°C.

2. Mass production of egg parasitoids

To use egg parasitoids for insect pest control, you should select the suitable species which can adapt to the insect pest and ecosystem concerned, and a stable mass-production of high parasitic or reproductive capacity wasps can be achieved. To realize mass production, you have to choose those good host eggs in which the wasp can grow well and to store their own eggs for a long period of time.

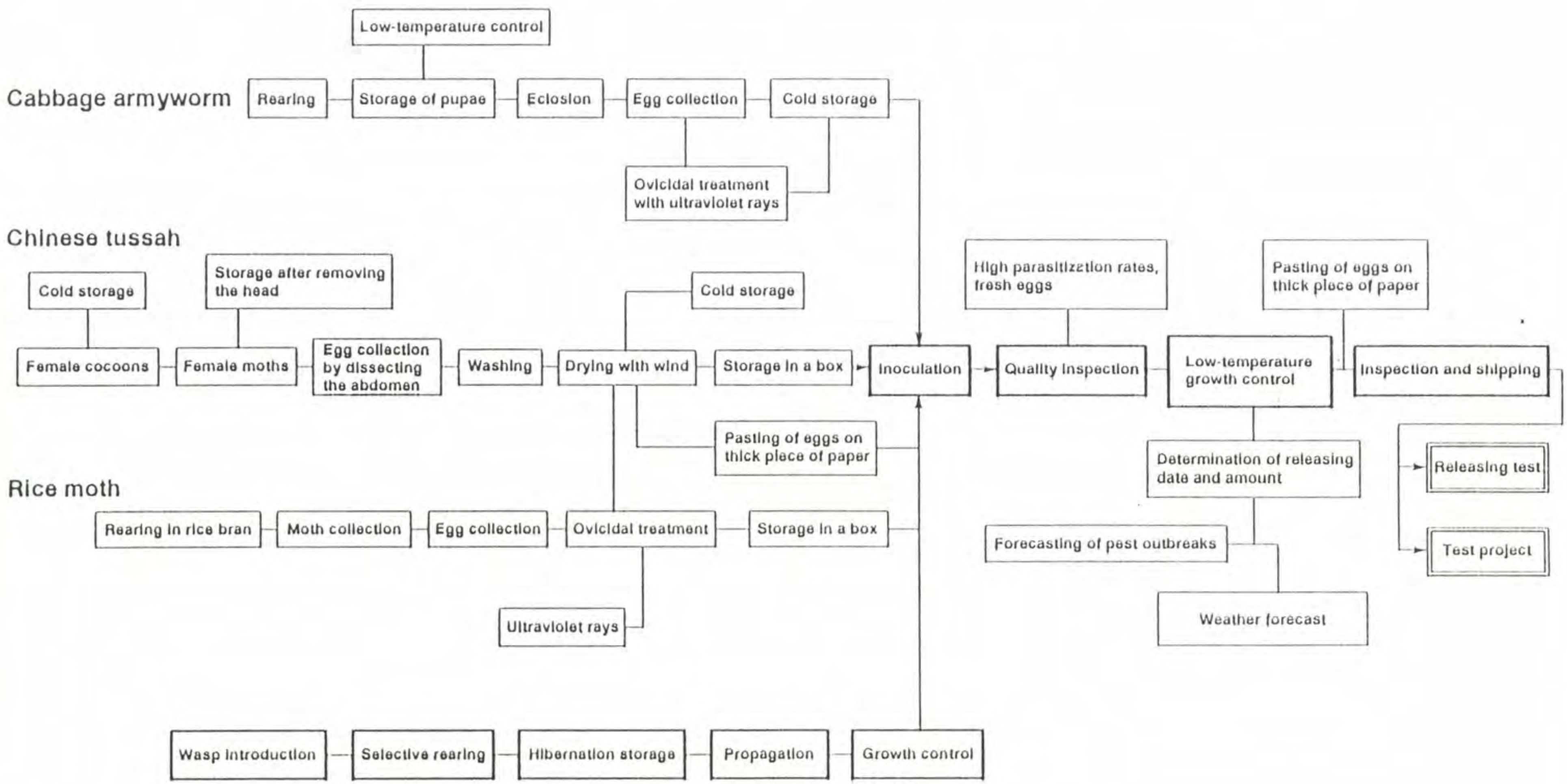
For the mass production of egg parasitoids, the eggs of Angoumois grain moth are used as host eggs all over the world.

But the eggs of Angoumois grain moth are very small and have some problems for application. For example, only one egg parasitoid can live in each host egg, and its eggs are apt to be deteriorating in a short period of time. Thus in China, Chinese tussah (*Antheraea pernyi*) is widely used for mass production because this silkworm has larger eggs 3 mm in diameter and more eggs. Moreover, it is easy to get from sericultural farmers.

Figure 1 is a flowchart of the mass production method of egg parasitoids introduced at our Research Center and at the Jilin Academy of Agricultural Sciences, China, using the eggs of Chinese tussah and rice moth (*Corcyra cephalonica*).

Just as those of giant silkworm moth (*Antheraea yamamai*) and silkworm (*Bombyx mori*), the egg shell of Chinese tussah hardens after having been oviposited, and so it is difficult for a parasite to lay eggs into eggs. Thus, some device must be introduced in order to use these as host eggs. When demand for host eggs arises, the cocoons of the silkworms are made to eclose and the abdomen of the adult female is immediately cut to take out eggs before hardening. The collagenous substance on the egg surface is washed away with water, and dry up. Then, the eggs are sticked on a piece of paper with glue or other similar paste. The pieces of paper with eggs are hung in front of light source or put on a flat box in a room kept at 25°C, and egg para-

Fig. 1. Flowchart of *Trichogramma* production for insect pest control



Note: Items in thick rectangulars show the propagation processes of the wasp.

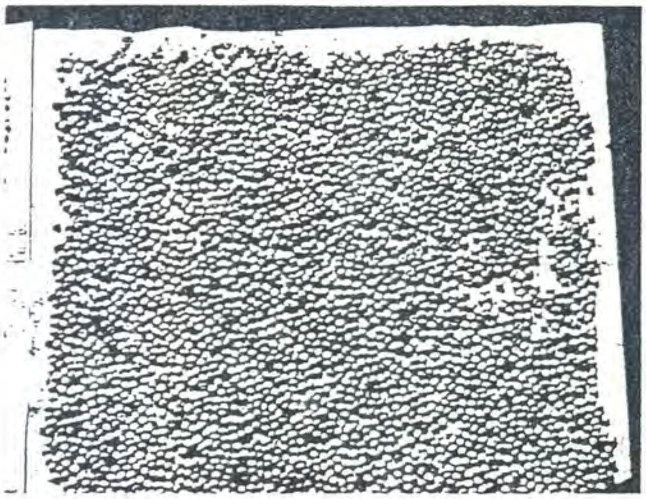


Photo 1. Sheets of paper to which Chinese tussah eggs are pasted (Jilin Academy of Agricultural Sciences, China)

Photo 2. Egg parasitoids growing in the eggs of Chinese tussah

sitoids are inoculated into the eggs (Photo 1). It is possible to make 50 to 262 egg parasitoids (60 on average) in each of the Chinese tussah eggs (Photo 2).

For the stock culture of Chinese tussah, the wasps collected outdoors are reared and hibernated at the Jilin, China, and are mass-produced for releasing them in the following spring.

To facilitate the mass production of egg parasitoids and transport of Chinese tussah eggs, there is the need of storing them for a long period of time. It is possible to store Chinese tussah for ten days to six months by (1) low-temperature storage of its abdomen, (2) storage of female moths after their head has been cut, and (3) low-temperature storage of cocoons.

T. ostriniae and *T. japonicum* cannot be reared in the eggs of Chinese tussah. For these wasps, the eggs of rice moth are used instead. Rice moth is reared with rice bran or flour of wheat or corn. When you give it feed of one kilogram, you will get 10 grams of its eggs (equivalent to 200,000 eggs) (Photo 3).

To store the eggs long and to prevent them from being eaten by the larvae which are hatched from some eggs omitted from parasitizing, the eggs of rice moth are given ovicidal treatment by the radiation of ultra-violet rays before they are parasitized by the wasps.

Rice moth eggs can be stored for 90 days if they are initially stored at 8°C and 25°C alternately and then only at 8°C when the wasps reach the second half of the larval stage.

In Japan, the eggs of cabbage armyworm and Mediterranean flour moth (*Ephestia kuehniella*) are used for the mass production of egg parasitoids. Mediterranean flour moth can be mass-produced using pressed corn pellets for domestic animals. Its eggs are pasted on a piece of paper and given ovicidal treatment with the radiation of

Photo 3. Parasitized eggs of rice moth

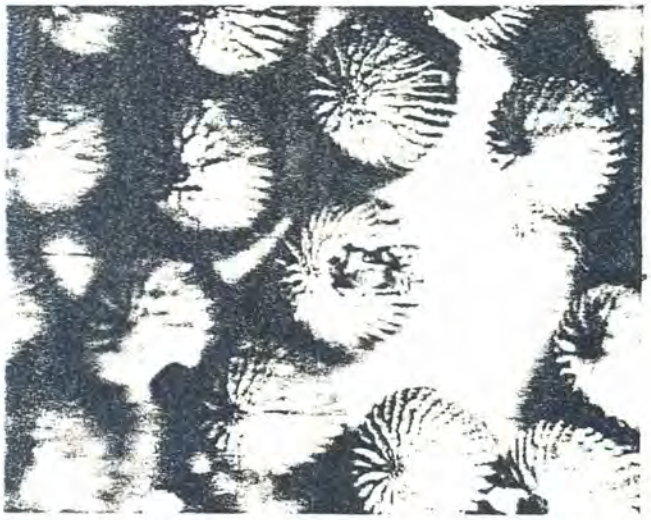


Photo 4. Propagation of egg parasitoids using the eggs of cabbage armyworm

ultraviolet rays, and then the wasp is parasitized to the eggs for reproduction.

At our Research Center, the eggs of cabbage armyworm (approx. 0.6 mm in diameter), which are bigger than those of Mediterranean flour moth, are used to mass-produce larger sizes of egg parasitoids (Photo 4). The process of this method is described below in detail:

1) Five pairs of male and female cabbage armyworms after eclosion and 10% honey solution are put in a round container to cause them to copulate with each other. The egg mass is taken out and stored at about 8°C. Before an embryo begins to grow in the egg (about four weeks before the formation of the head capsule), egg parasitoids are inoculated to the egg in a tubular bottle placed in a room which is kept at 20 to 25°C. In the case where an egg mass has 200 eggs or so, 10 to 20 female wasps, which are one hour or more after eclosion and in the state of having mostly copulated, are inoculated to the egg mass so that three (two females and one male) or less will parasitize each egg. Large and healthy wasps will be produced.

The eggs of cabbage armyworm are suited to the reproduction of several kinds of wasps. Wasps grow favorably at some different temperature conditions (Table 1). Even if egg parasitoids are reared on this insect for eighty generations in a row, there occurs no deterioration in their function as a natural enemy.

2) Several days after egg parasitoids have been caused to parasitize the eggs of cabbage armyworm, several parasitized eggs are dissected to confirm that the wasp in them has become prepupa. Once the wasp has turned into prepupa, it can be stored for 40 days to five months if it is kept at the low temperature condition of the hibernation stage (10 to 5°C), and so the egg can be transported to a distant place. Even when the temperature is a room temperature of about 25°C, the egg can be transported before growing to an adult wasp if the transport is made within several days after para-

Table 1. Generation period of egg parasitoids reared in the eggs of cabbage armyworm

Rearing temperature	*T. dendrolimi*	*T. ostriniae*	*T. chilonis*
32°C	6.9 (2)	Do not grow (10)	6.5 (7)
30	7.6 (5)	8.3 (10)	6.9 (15)
25	10.4 (3)	11.7 (5)	9.7 (4)
19	16.9 (8)	20.3 (9)	16.2 (6)
15	33 (3)	45 (3)	33 (3)
13	37 (3)	53 (3)	43 (3)

Note: Figures show the average number of days, and the figures in parentheses are the number of parasitized egg masses used.

sitization (Table 1).

3) In the case where you got a large amount of cabbage armyworm eggs which completed fertilization and turned yellow or if you want to prevent larvae hatched from some eggs not paratisized from eating paratisized eggs, you have to give the eggs ovicidal treatment using ultraviolet rays and store them at a low temperature of 8°C. When you give this treatment to the eggs, you will be able to make egg parasitoids parasitize them even about 50 days after (of course, you can store white unfertilized eggs at low temperatures without any ovicidal treatment).

When you use a 15W bactericidal lamp to kill the eggs of cabbage armyworm with ultraviolet rays, you can do so by placing the eggs before the larva formation stage – before the formation of the head capsule – 10 to 15 centimeters below the lamp (wavelength: 253.7 nm) for 20 minutes.

If you use the eggs after larvae have been formed in them which have been radiated with ultraviolet rays, the inoculated wasps will not lay many eggs and the larvae of the wasps will not grow well.

4) In vitro rearing method: Besides the method of using insect host eggs, the method of rearing egg parasitoids on artificial media has been studied. These media include semisynthetic ones containing the body fluid of insects and total synthetic ones containing no such body fluid.

Researches on the semisynthetic media for egg parasitoids have been conducted at the Insect Research Institute in Guangdong Province (since 1975) and at the University of Wuhan in Hubei Province (since 1979). In these studies, artificial eggs were made by wrapping the mixture of the fluid of cocoons of Chinese tussah or *Phylosamia cynthia* (27 to 50% of the total fluid), yolk, milk and inorganic salts with polyethylene film, and egg parasitoids of the wasp were successfully reared. The production of these artificial eggs has been mechanized.

By releasing 300,000 egg parasitoids reared with the artificial eggs per hectare, a parasitization rate of 84 percent was obtained for pine caterpillar. For stem borers, the pests for corn sugar, the rate was 81 percent by releasing 150,000 egg parasitoids in 7 hectares, and for corm earworm (*Helicoverpa armigera*), the figure was 92 percent by releasing 150,000 per hectare.

Studies for an inexpensive and more convenient production technology of total synthetic feed for egg parasitoids, which contains no insect fluid, are conducted in Europe and America, but have not been completed yet.

3. Quality control

After causing egg parasitoids to parasitize into the host eggs, it is necessary to see if healthy wasps are growing in the eggs by dissecting the host eggs.

According to the author's experience, egg parasitoids were sometimes small in size or their wings did not grow when the parasitization was too much or when we used Angoumois grain moth, Mediterranean flour moth (*Ephestia kuehniella*) or diamondback moth (*Plutella xylostella*) of which eggs are small. But when we made the wasps parasitize cabbage armyworm at a rate of two wasps (one female and one male) or three (two females and one male) per egg, we were able to produce big and normal wasps and found no abnormality.

The mass-produced egg parasitoids are stored at low temperatures (10 – 20°C) to slow their growth. Prior to their release, the wasps are moved to a temperature of 25°C, while normal host eggs are selected. When normal host eggs are moved to a temperature of 25°C, adults of egg parasitoids get out of the eggs within five days. Before they get out, the wasps are released in the field.

European and American researchers believe that in egg parasitoids and other parasitic wasps, specific characters are selected by rearing for generations and that as a result their capacity for searching and parasitizing host eggs becomes different from that of wild population. The quantitative evaluation of parasitization capacity is part of quality control of egg parasitoids, and the following surveys are necessary for this evaluation: (1) eclosion rate, (2) sex ratio, (3) egg production capacity, (4) capacity for searching host eggs (walking speed), (5) life span, and (6) malformation rate.

4. Time, quantity and method of releasing

In order to achieve a stable effect of parasitization in the field, you have to repeat the release of egg parasitoids several times and increase releasing locations to make up for the short moving distance of the wasps after pest insects begin to lay eggs.

In the biocontrol extension project undertaken by the Jilin Academy of Agricultural Sciences, China, using *T. dendrolimi* in the areas where one generation of oriental corn borers breaks out, farmers are instructed to release about 10 female wasps per square meter in one place of a corn field of 6.7 ares first at the beginning of July and 12 females per square meter a week after. The location of releasing is the back of leaves of corn on the middle position in height.

We at the National Agriculture Research Center are conducting the applicability tests of *T. ostriniae* (Photo 5) in the districts where three generations of oriental corn borers appear. In the corn field where corn is sown in early June, we release the wasps six times in total in one location per 0.5 are from mid-July to August when the insect pest lays eggs, 10 to 40 wasps per square meter at a height of 30 centimeters above the ground (Photo 6). As a result, the parasitization rate of the wasps on the eggs of the insect pest rises to 80 to 87 percent, and the damage to corn seeds is controlled to about 19 percent. This is the effect equal to or better than that of two times of insecticide spraying, and we consider that *T. ostriniae* is a high practical agent for the biocontrol of the corn borer (Fig. 2).

To avoid the wasp from being eaten by predators and from dying from rain, the wasps should be put into a container before releasing them (Photo 6).

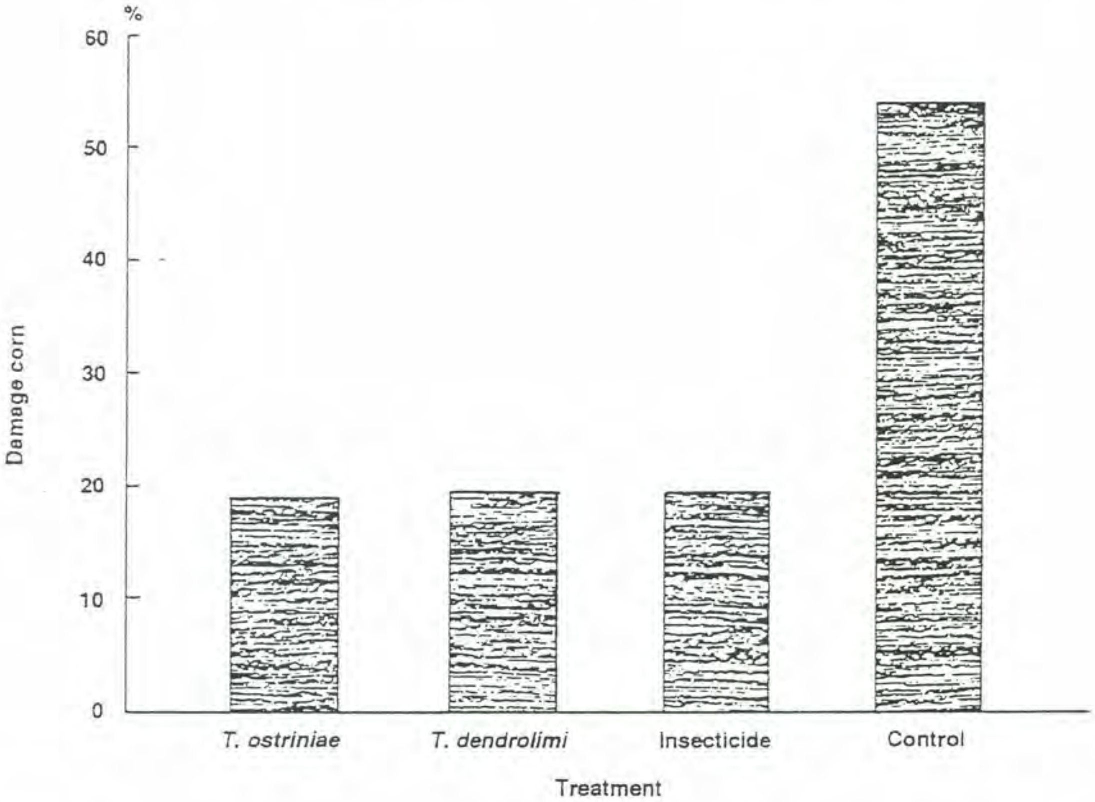
In large fields in the former Soviet Union, China and Europe, there are some cases where an airplane was used to spray wasps which were put in soil-soluble containers.

There are two main methods of releasing egg parasitoids. One of them is the inunda-

Photo 5. *Trichogramma ostriniae*

Photo 6. Container for releasing egg parasitoids

Fig. 2. Control effect of oriental corn borer by egg parasitoids



tive release by which a large amount of the wasp is released to attain an eradication like one by insecticide when there would be an outbreak of insect pest. In this method, 50,000 to 100,000 wasps per hectare are needed for rice leaf rollers, and 150,000 per hectare for oriental corn borers. The other is the inoculative release by which a small amount of the wasps (one-tenth to one-twentieth of the inundative release) is released at the early stage of pest outbreak and the parasitization rate is gradually raised by the natural propagation of the wasps. In order to save rearing and releasing cost, studies in recent years are mostly attempting to utilize the latter method.

5. Future tasks

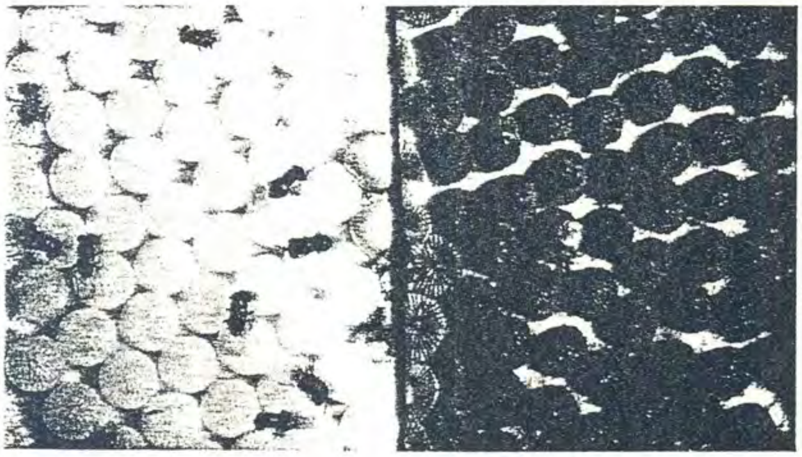
Egg parasitoids are not effective for all insect pests. They cannot be applied to an ecosystem where the insects are hard to be parasitized by the wasp or where many insect pests exist.

Thus, what is needed first is to identify the ecosystems for which this wasp can be utilized. The wasp has a high possibility for the pests of the crops whose major insect pests are limited in species and number. Among them are oriental corn borer (main pest of corn), soybean pod borer (*Leguminivora glycinivorella*; soybean), diamondback moth (greenhouse vegetables), *Theretra silhetensis* (taro) and rice leaf roller (paddy rice).

State and prefectural research institutes in Japan are now carrying out applicability tests on egg parasitoids for the biocontrol of the above-mentioned insect pests. In addition, the development of artificial rearing methods of this wasp, establishment of a supply system of the wasp needed for biocontrol, methods of introducing the wasp into the field and use of the wasp in combination with agrochemicals are being studied as the problems to be solved in the future.

● Insect eggs and parasitoids

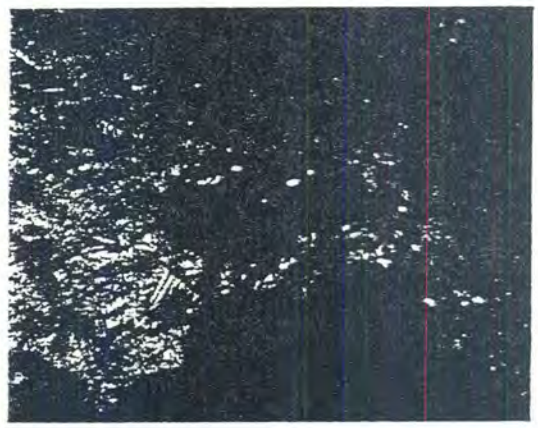
Oviposition to development of the egg parasitoid



Trichogramma sp. prefers to lay eggs into younger host eggs (left) before the headcapsule of the embryo forms in the host egg (right).

◄ *Trichogramma* sp. lays eggs even into an artificial egg.

► Development of *Trichogramma* larvae: one-day old larvae

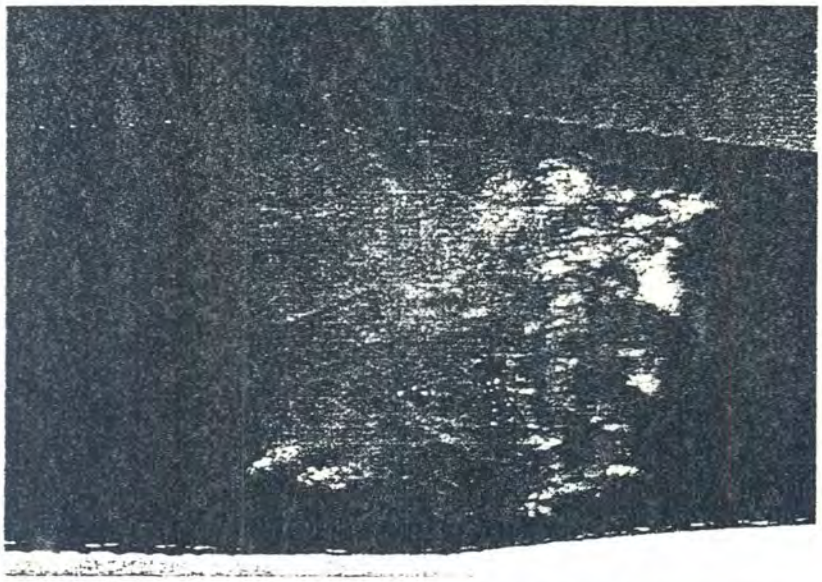


◄ Two-day old

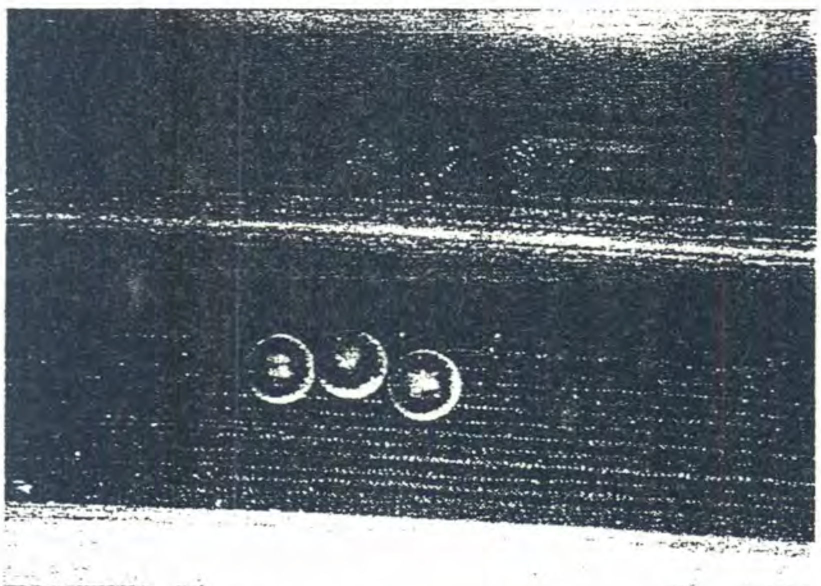
► Three-day old
The inside of host eggs starts to get dark by excretions of parasitoids.

◄ Six-day old

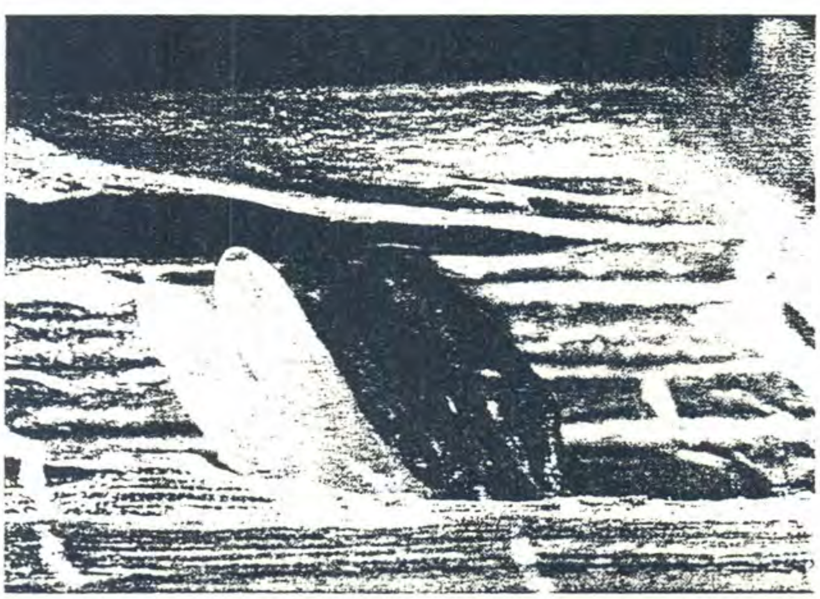
► Seven-day old
One day before emergence from a host egg



Egg of *Chilo suppressalis* and ovipositing *Trichogramma japonicum*: rice



Parasitized eggs (top) of *Naranga aenescens* and intact ones (bottom): rice



Parasitized eggs (right) of *Nephotettix cincticeps* and intact ones (left): rice

Insect and p

Many kinds of creatures liv tems. Minute insect eggs, ception to the ecological o natural enemies. Among th are minute fringe-winged ch used in an attempt to cont some devices for their prote like substances, sometime thick chorion. The followin enemies.

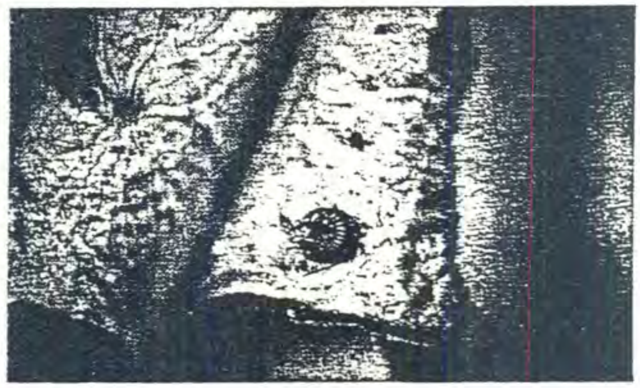
Egg of *Mamestra brassicae* and *Trichog*

eggs
rasitoids

:e with other creatures in natural ecosys-
. sources of insect occurrence, are no ex-
e always exposed to the menace of their
i,hest threat to the existence of insect eggs
ps. So, a number of wasp species have been
ls insect pests. Naturally insect eggs have
e eggs are sometimes surrounded by a glue-
1 with scales, and sometimes covered with
veral kinds of insect eggs and their natural

lími: cabbage

Trichogramma papilionis emerging from an egg of *Pieris rapae*: cabbage A first-emerged male tries to copulate with the following- emerged female.



A male of *Trichogramma chilonis* emerging from an egg of *Autographa nigrisigna* is waiting to copulate with a female: cabbage

Parasitized eggs of *Plutella xylostella* by *T. chilonis*: cabbage

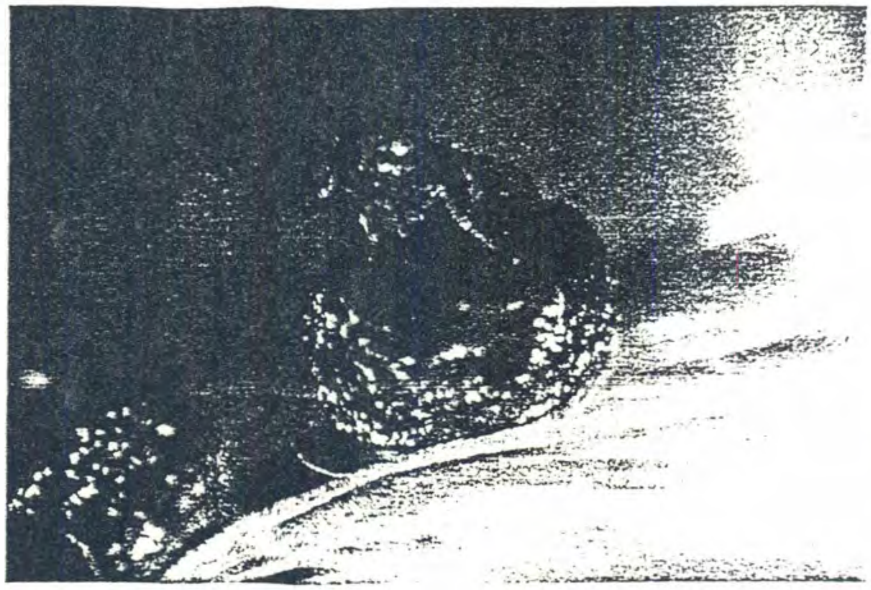
Parasitized egg of *Leguminivora glycinivorella* by T. chilonis and intact one: soybean

♦ Photos on pp. 31–34 were offered by Dr. K. Hirai.

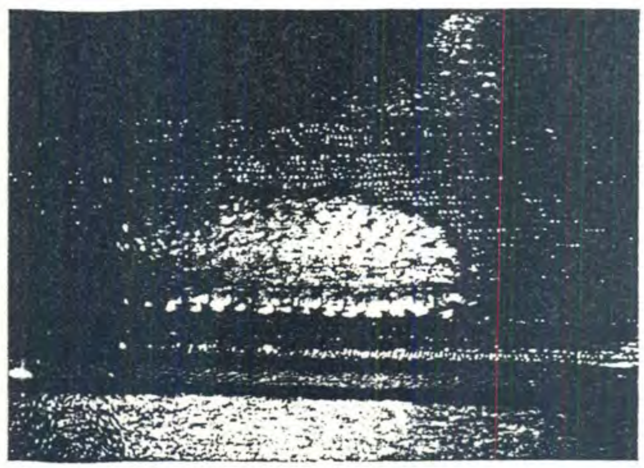
● Insect eggs and parasitoids

The following two eggs are less parasitized by egg parasitoids, due to the thick egg shell, laid-in-a-few-layers eggs, and coverage of scales on eggs.

The egg of bean bug, *Riptortus clavatus* is made with thick egg shell. A wasp tries to assume an ovipositional behavior, but impossible to lay eggs.

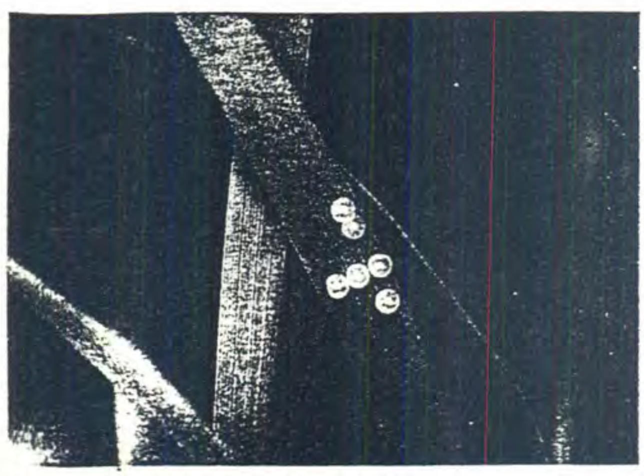


The egg of *Spodoptera litura* is laid in a few layers with coverage of scales, and is less parasitized by wasps.



Egg of *Ostrinia furnacalis*: corn

Eggs of tiger moth: corn



Eggs of *Mycalesis gotama fulginia*: rice

□ Special Issue □

Use of Arthropod Natural Enemies in Protected Crops

By Dr. Eizi YANO
Division of Entomology.
National Institute of Agro-Environmental Sciences.
Ministry of Agriculture, Forestry and Fisheries

Modern commercial use of arthropod natural enemies in protected crops was initiated in the U.K. and in the Netherlands in the late 1960's. Commercial use has remarkably progressed in western Europe in these 20 years. Natural enemies are used on a large scale in greenhouse cucumbers, tomatoes and sweet peppers in this area. Basic studies on biological control agents for commercial use have also been done in universities or institutes in cooperation with extension services and producers of natural enemies.

The situation was quite different in Japan. Fundamental studies on biological control agents for greenhouse pests have a history as long as those in western Europe. Japanese researchers have made a great contribution in basic and applied studies on *Phytoseiulus persimilis* and *Encarsia formosa* in the 1970's and 1980's. However, only limited progress has been made in commercial application of these two natural enemies until recently. The present situation in Japan is promising for future development of commercial use of natural enemies. Studies on use of natural enemies are very active in many experiment stations and import and mass production of natural enemies were started by some private companies.

The purpose of this article is to review the history of biological control for greenhouse pests using arthropod natural enemies both in western Europe and Japan and to make some recommendations for future development of biological control in Japan.

1. Historical overview of use of arthropod natural enemies in western Europe

Special Issue

Industrial Use of Insects Attracting Much Attention

By Dr. Kenji UMEYA
Technical Adviser,
Agriculture, Forestry & Fisheries Technical Information Society (AFFTIS)

Insects have developed their own functions for survival through the long history of their evolution. While some of them, including honeybees and silkworms, have been used for industrial purposes, most of them have been the targets of control as hazardous to humans.

However, the recent rapid progress of science and technology, such as biotechnology, and allied appliances is finally making it possible to analyze, regulate and reconstruct a wide variety of heretofore unused insects' functions. And their industrial application is expected to offer an almost limitless potential in such areas as agriculture, life science, medicine and engineering. There is now an increasing recognition all over the world that insects are the largest virgin resources still remaining on the earth.

Against this background, the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan launched in 1992 a series of study projects on industrial application of insects in cooperation with the private sector. These projects cover both fundamental studies and those for commercialization.

Use of living insects

The most accessible insect use for agriculture is as natural enemy insects and microorganisms. This subject was already dicussed in *Farming Japan*, Vol. 27-6, 1993 and so readers are referred to that issue for further details. In Europe and America, there are a lot of natural enemy firms. To use natural enemies on an industrial basis, there is the need of discovering promising insects as natural enemies. Also necessary is to develop low-cost mass-propagation techniques and the methods of storing and transporting, quality control and evaluating effects.

The withering of pasture by animal wastes and propagation of flies in animal houses are posing serious problems, too. Studies have already been started on the technique of using coprophagous insects for efficiently disposing of livestock excreta and recycling the mass-propagated insects by such technique as a concentrated feed for domestic animals.

Use of insect functions

The walking and flying functions of insects are attracting attention as the models for developing new small-sized robots. The cerebral nervous system of insects is simple but has advanced functions, too, and is studied as the model system for examining the