

**"Environmental and pest grasshoppers in
Brazil" project : first progress report.
April 1994**

by

Michel LECOQ and Ivo PIEROZZI Jr.

Document 489b

id: 1530
OK

CEC
EMBRAPA-NMA
PRIFAS

Montpellier, May 1994

AMT 1083
AINFO 1994
Cx22 - FW
28/6/2004

**"Environmental and pest grasshoppers in
Brazil" project : first progress report.
April 1994**

by

Michel LECOQ and Ivo PIEROZZI Jr.

LIST OF ABBREVIATIONS

CEC	Commission of the european communities
ECOFORÇA	Pesquisa e desenvolvimento (São Paulo)
EMBRAPA	Empresa brasileira de pesquisa agropecuaria
EMPAER	Empresa agropecuaria de extensão rural
FAO	Food and agricultural organization of the United Nations
FAPESP	Research support foundation of São Paulo state
FUNAI	Fundação nacional do Indio
IBAMA	Instituto brasileiro do meio ambiente e dos recursos naturais renovaveis/Brazil
IBGE	Instituto brasileiro de geografia e estatistica
INPE	Instituto brasileiro de pesquisa espacial
NMA	Nucleo de monitoramento ambiental e recursos naturais por satélite
PRIFAS	Acridologie opérationnelle - Ecoforce [®] internationale

* *
*

LECOQ M. & PIEROZZI I. Jr., 1994

"Environmental and pest grasshoppers in Brazil" project : first progress report. April 1994.— D. 489b, CEC : Bruxelles / CIRAD-GERDAT-PRIFAS : Montpellier / EMBRAPA-NMA : Campinas.— 14 p. (Printed document).

Keywords : Acridology, Brazil, *Rhammatocerus*, progress report, EMBRAPA-NMA, biotopes.

© CIRAD-GERDAT-PRIFAS, 1994.

SUMMARY

This report reviews the initial progress, from August 1992 to April 1994, of the "Environment and Pest Locusts of Brazil" project, funded by the CEC. The eleven reports/publications and four polychrome maps presented in the Appendix sum up the ground already covered in this project. Several basic points have been assessed, the main one concerning the history of locust outbreaks in Mato Grosso. The results prompted an overall revision of the basic project premises concerning the determining factors of locust outbreaks, which previously focused directly on recent environmental changes. The research scientists are now concentrating on obtaining fine ecological characterizations of habitats that are suitable for locusts in the region, and on drawing up habitat maps.

* *
*

CONTENTS

LIST OF ABBREVIATIONS	II
SUMMARY	III
CONTENTS	IV
INTRODUCTION	1
The context	1
The research project and objectives	1
Project developments	4
Progress report on 30 April 1994	4
1. SCIENTIFIC RESEARCH CARRIED OUT IN 1992/93/94	4
Introduction	4
1.1. Bibliographical synthesis	5
1.2. Preliminary locust habitat maps	5
1.3. Field missions	5
1.4. Locust bioecological data acquisition	6
1.4.1. Life cycle	6
1.4.2. Migratory behaviour	6
1.4.3. History of locust outbreaks and determining factors	7
2. RESEARCH SCHEDULE FOR 1994/95	7
CONCLUSIONS	8
BIBLIOGRAPHY	9
- References cited	9
- Reports and various articles published within the project	9
- Recent news articles on the locust problem in Brazil	11
LIST OF ILLUSTRATIONS	
Fig. 1. Location of the main <i>Rhammatocerus schistocercoides</i> outbreak areas in Mato Grosso.	2
Fig. 2. <i>Rhammatocerus schistocercoides</i> (Rehn, 1906), pest locust of Mato Grosso state in Brazil.	3

INTRODUCTION

The context

From 1983, outbreaks of a then unknown locust species caused serious problems in newly cropped and developed areas of Mato Grosso and Rondonia states in Brazil, on a strip of land extending schematically from 12° to 15° latitude south and 52° to 61° longitude west (Fig. 1) (COSENZA et al., 1990). The affected areas are mainly former "cerrados" (tree savannas) that were deforested and predominantly replaced by commercial soybean crops, as well as sugarcane, rice and maize crops. The locust species involved in these outbreaks was later identified (CARBONELL, 1988), after a series of errors, as *Rhammatocerus schistocercoides* (Rehn, 1906) [*Orth.*, *Acrididae*, *Gomphocerinae*] (Fig. 2). Moreover, very little is known on the bioecology of this pest.

A national locust control program was developed by the Brazilian government in 1986. Since then extensive control treatments have been carried out which have had considerable economic and environmental impacts. The locust problem now seems to be chronic in Mato Grosso and present control strategies are not very satisfactory.

The factors that determine outbreaks are still unclear. The effects of meteorological conditions on the population dynamics of this particular locust are completely unknown. One hypothesis first expressed at the onset of outbreaks in 1983 is that the locust problem is probably related to the accelerated agricultural development in the concerned areas. The intensive deforestation carried out to create crop- and pasturelands has often been mentioned. The phenomenon could be explained by the appearance of new biotopes suitable for locusts, due to the change to crop- and pasturelands, or by an upset in the ecological balance, thus considerably reducing natural locust predators and promoting outbreaks (LECOQ and PIEROZZI, 1994a; BARRIENTOS, 1993). None of these hypotheses have been confirmed to date.

The research project and objectives

In this context, EMBRAPA-NMA and CIRAD-GERDAT-PRIFAS are developing a research project combining NMA's remote sensing skills with those of PRIFAS in acridology. This project falls within the general scope of the EMBRAPA/CIRAD "Operational Ecology" Programme. One of the goals of the project, entitled "Environment and Pest Locusts of Brazil", is to investigate possible links between *Rhammatocerus schistocercoides* outbreaks and agricultural land use and recent natural landscape changes. Overall, the project is aimed at establishing the scientific bases required to improve the present strategies used to control this locust.

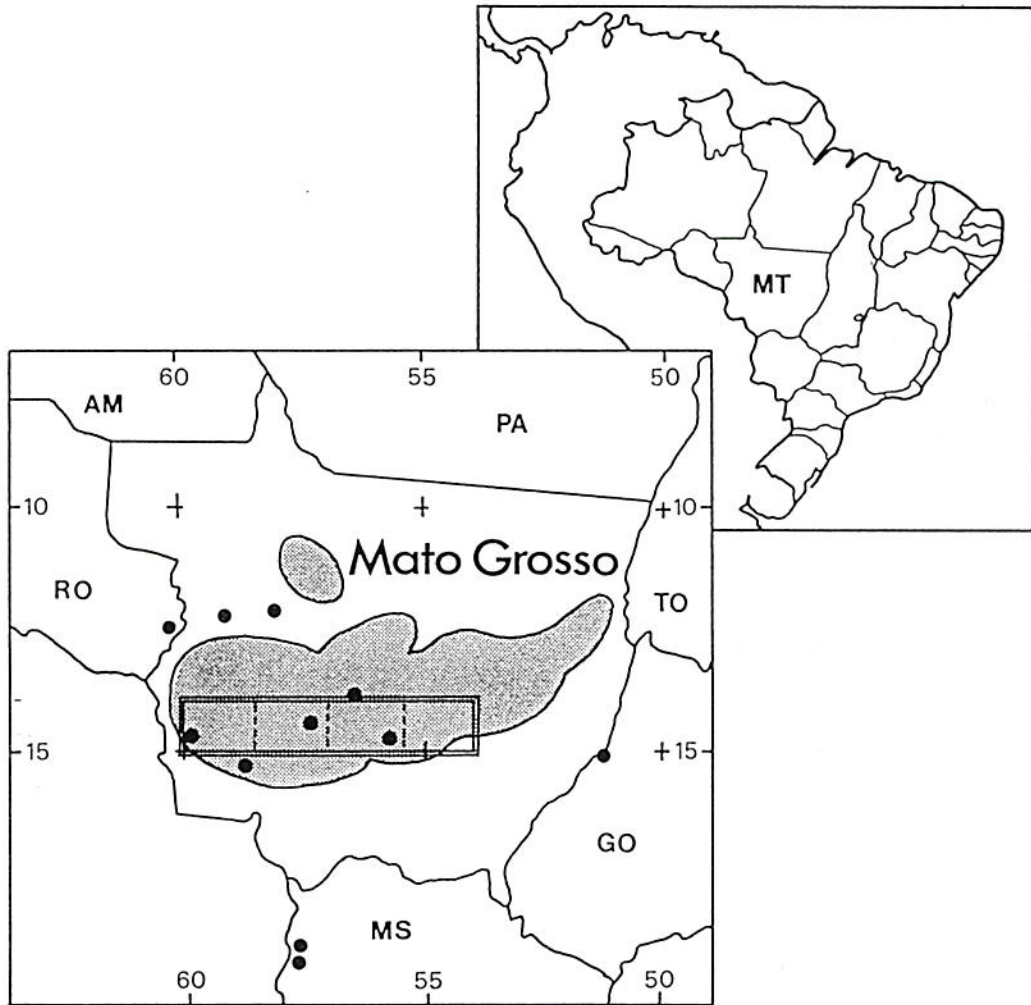


Fig. 1.— Location of the main *Rhammatocerus schistocercoides* outbreak areas in Mato Grosso.

Grey zones : main outbreak areas from 1984 to 1986.

Black spots : Outbreak areas reported by CARBONELL (1988).

Brazilian states : AM, Amazonas ; GO, Goiás ; MS, Mato Grosso do Sul ; MT, Mato Grosso ; PA, Para ; RO, Rondônia ; TO, Tocantins.

▬▬▬ Project pilot research area for which vegetation maps have already been drawn up

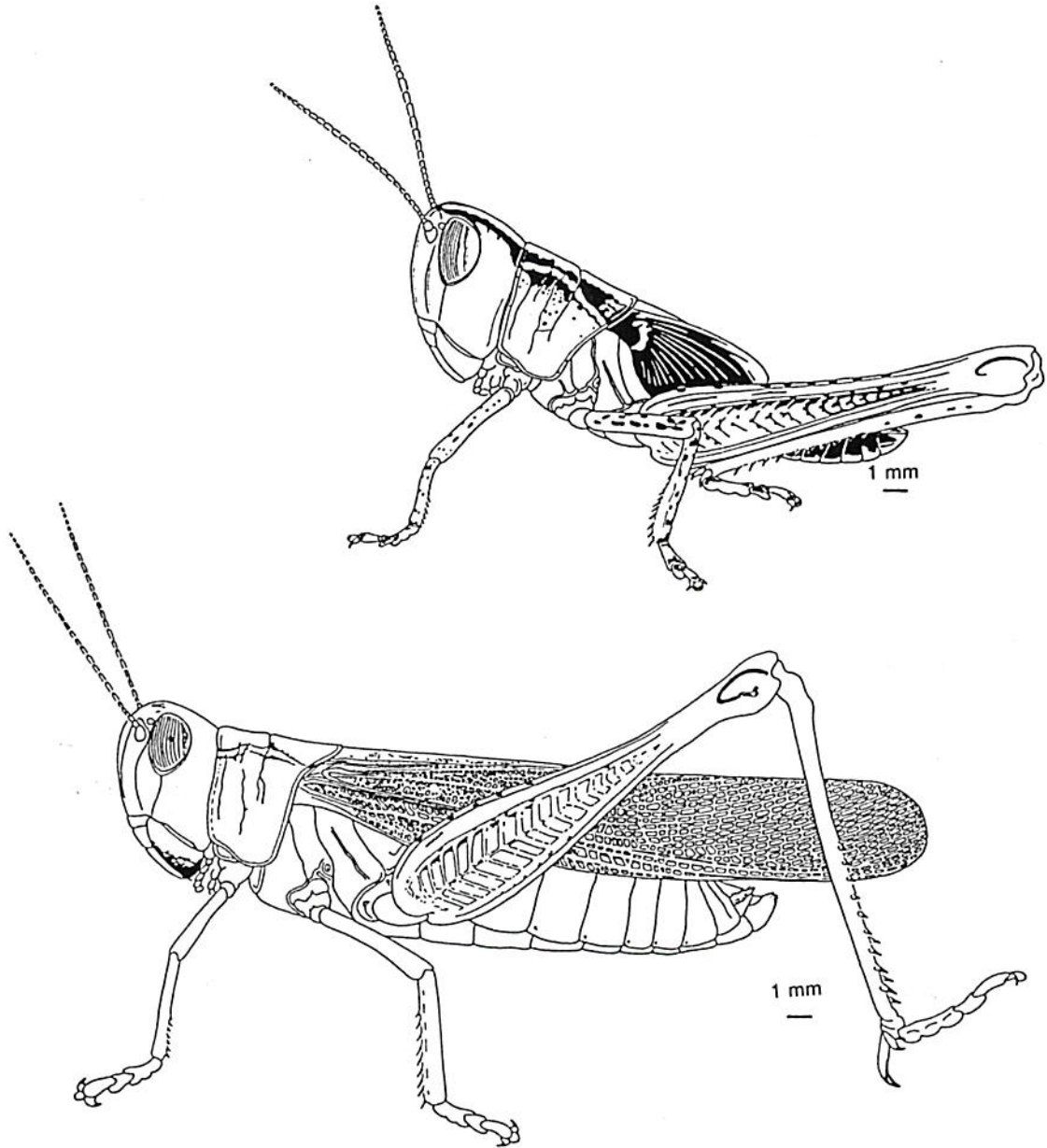


Fig. 2.— *Rhammatocerus schistocercoides* (Rehn, 1906), pest locust of the Mato Grosso state in Brazil (5th instar hopper on top and male adult below).

Project developments

The CEC (Commission of the European Communities) approved and agreed to fund the project. The contract for this 30-month project with the CEC officially started on 1st June 1993 and is to terminate on 31 May 1996.

However, beginning in August 1992, both EMBRAPA-NMA and CIRAD-GERDAT-PRIFAS began preliminary work using their own funds :

- a PRIFAS entomologist (M. LECOQ) was assigned to NMA in late August 1992 to set up the project;
- consultancy mission of an environmental botanist (J.-F. DURANTON) in October and November 1992;
- computer support mission of a PRIFAS researcher (J. GIGAULT) to NMA in June 1993;
- preliminary work of an NMA entomologist (IVO PIEROZZI Jr.), including a research trip to Europe to visit PRIFAS (Montpellier), the Paris Museum, the British Museum in London and NRI in Chatham (UK) (on a FAPESP grant);
- in collaboration with a Brazilian NGO (ECOFORÇA), vegetation maps of the study area were drawn up through interpretation of LANDSAT images;
- a preliminary bibliographic synthesis on the topic was compiled (LECOQ & PIEROZZI Jr., 1994a);
- organization of three field missions to the project study area in Mato Grosso.

Progress report on 30 April 1994

The present report reviews the main project activities at NMA in Campinas (Brazil) and at PRIFAS in Montpellier (France), between August 1992 and May 1994. It highlights the results already obtained and the work planned over the coming months based on various documents, reports and articles published within the project (see list of project publications in the Appendix).

1. SCIENTIFIC RESEARCH CARRIED OUT IN 1992/93/94

Introduction

Research undertaken since the beginning of the project can be classified into two categories :

1. Research aimed at obtaining information on the bioecology of the locust and factors that determine outbreaks. These are mainly field studies carried out over a few weeks during missions to locust outbreak areas in Mato Grosso.
2. Research aimed at drawing up locust biotope maps. These activities are mainly carried out at NMA headquarters in Campinas, and the maps are checked during field missions to Mato Grosso.

The above research work is presently under way. The main results are set out in the following paragraphs.

1.1. Bibliographical synthesis

Preliminary work of the project included an extensive bibliographical search aimed at pooling all information on this topic, but few scientific publications were found. Most of the information was derived from various reports of national and international organizations, from articles in many newspapers and journals, including many television programmes focusing on the problem.

This work led to publication of a book which provides a critical synthesis of all documents that are presently available (LECOQ and PIEROZZI Jr., 1994a). The following topics are covered : a history of locust outbreaks in Brazil, taxonomy and characterization of *Rhammatocerus schistocercoides*, range, morphology and pigmentation, possible phase polymorphism, biology, ecology and outbreak determining factors, economic impact, control strategies and techniques, future and ongoing research. This document is supplemented with a commented bibliography presented in chronological order to provide an overview of the problem from its first appearance to present.

1.2. Preliminary locust habitat maps

Recent *R. schistocercoides* outbreak areas stretch from southeastern Rondônia to the Goiás state border, including much of Mato Grosso. This region is from 12°00 to 15°00 latitude south and 51°00 to 61°00 longitude west, covering approximately 300 000 km².

In the initial project studies, a smaller pilot area was chosen because of its acridological importance and logistics facilities. It is located from 14° to 15° latitude south and 54° to 60° longitude west. This rectangular area covers approximately 60 000 km² and has been affected by great locust outbreaks over the past few years. It also includes the area where the first outbreaks occurred between 1979 and 1984 : in the Parecis Indian Reservation.

Substantial documentation work was carried out and preliminary maps of the main vegetation units were drawn up before the first research mission in this area.

Several data sources were tapped to draw up the preliminary maps of the main vegetation units in the study area and to be able to correctly stratify the field sampling : LANDSAT data, RADAMBRASIL project maps, topographical maps.

Four vegetation maps were thus drawn up, essentially by photo-interpretation of LANDSAT images, at a 1/250 000 scale (MIRANDA and DURANTON, 1993a to d : 4 polychrome maps).

1.3. Field missions

Several field missions have been conducted in the locust outbreak areas of Mato Grosso between October 1992 and April 1994. These multi-purpose missions were aimed at :

- contacting people and institutions concerned by the locust problem and collecting evidence;
- setting up a cooperative network of concerned parties to help in expanding the project research activities under way and to enhance local cooperation;

- checking vegetation and biotope maps drawn up through interpretation of satellite data;
- acquiring original data on the bioecology and behaviour of the locust.

There have been four missions so far :

- October/November 1992
- May 1993
- June/July 1993
- October/November 1994

There will be a fifth mission in April/May and a sixth in August/September 1994.

The missions are timed to coincide with key steps in the biological cycle of the locust, which breeds only once yearly.

The results of these missions have been published in various reports (DURANTON, 1993; LECOQ and PIEROZZI Jr., 1992; LECOQ and PIEROZZI Jr., 1993a; LECOQ and PIEROZZI Jr., 1993b; LECOQ and PIEROZZI Jr., 1994e), and they will be comprehensively analyzed at the end of the project. Nevertheless, some interesting conclusions can already be drawn (see paragraph 1.4). Some of these results are presently being published in French and Brazilian scientific journals.

1.4. Locust bioecological data acquisition

1.4.1. Life cycle

The life cycle of *Rhammatocerus schistocercoides* was studied during the field missions. The findings are generally in keeping with previous knowledge, but we quickly observed that many aspects needed to be clarified or even completely revised. For example, the number of hopper stages differs markedly from that of prior assumptions (8/9 instead of 5/6). These stages were described for the first time and the main characterization criteria are now established for future population dynamics studies (LECOQ and PIEROZZI Jr., 1994c).

1.4.2. Migratory behaviour

Although the results are still provisional and the observations incomplete, the migratory behaviour of this insect seems to be much more limited than previously assumed. Rather than large-scale migrations, this locust exhibits nomadic behaviour throughout the dry season when it is in the imaginal state, and movements occur in various directions but are more or less restricted to local areas (LECOQ and PIEROZZI Jr., 1993a,b).

The assumed eastward swarm migration phenomenon, which was previously considered to be a great threat for neighbouring states (particularly Goias), now appears to be an artefact resulting from errors in interpreting locust report data during the first 1983/85 outbreak periods. In fact, the wind systems essentially favour migrations in NE-SW directions, sometimes westward but almost never eastward.

These observations are critical for defining recommended control strategies. They will be expanded as the project develops.

1.4.3. History of locust outbreaks and determining factors

This is undoubtedly the most important result of the first part of the project.

The bibliographic search and field surveys allowed us to bring together documents and evidence which clearly indicate that *Rhammatocerus schistocercoides* (Rehn, 1906) outbreaks are by no means a new phenomenon in Mato Grosso (Brazil), in terms of their nature and extent. This radically changes present notions concerning outbreak determining factors and refutes earlier hypotheses blaming the accelerated agricultural development of the concerned areas in the eighties (LECOQ and PIEROZZI Jr., 1994b).

Various evidence obtained either orally or from publications clearly indicate :

- that *Rhammatocerus schistocercoides* outbreaks are a very long-standing phenomenon in Mato Grosso;
- that the extent and frequency of past and present outbreaks are identical;
- that the two main outbreak areas have not changed over the century : Chapada dos Parecis and the Paranatinga region.

The proof of the long-standing history of *Rhammatocerus schistocercoides* outbreaks is a major discovery that radically changes our understanding of this phenomenon and its determining factors.

Locust outbreaks can no longer be explained as being the result of mechanized intensive agricultural techniques used in the new Brazilian farming frontiers.

Outbreaks might be a long-standing phenomenon, but the economic problem created by this locust in Mato Grosso is obviously recent. It started in the eighties, at the beginning of the intensive agricultural development when crops were introduced in the usual locust outbreak areas.

New research areas should now be investigated to understand the determining factors of *Rhammatocerus schistocercoides* outbreak cycles. The hypothesis of a meteorological correlation seems particularly promising.

2. RESEARCH SCHEDULE FOR 1994/95

Several field missions are planned in Mato Grosso to complement the bioecological studies of *Rhammatocerus schistocercoides*. Two missions are scheduled for periods when this locust has not yet been studied : in April to study the end of hopper development and in August/September to observe the flight behaviour of adult swarms and to conduct detailed studies on factors that influence sexual maturation in these locust populations.

The work on locust biotope maps already under way will be continued to obtain more precise results.

CONCLUSIONS

The "Environment and Pest Locusts of Brazil" project is presently being carried out under suitable conditions. Research activities began in August 1992 on the incentive of the two partners - EMBRAPA and CIRAD - before the CEC funds were made available.

Studies on *Rhammatoderus schistocercoides* (Rehn, 1906), the pest locust in Mato Grosso, are going well and many important facts have already been uncovered. They have been reported in several scientific reports and articles now in press (2 publications, 9 reports including 3 publication projects, 337 pages of text and 4 maps).

The most important finding is definitely the long-standing history of outbreaks of this locust. The basic hypotheses of the project therefore had to be reconsidered in order to refocus the research.

Research will be ongoing in 1994 and include further field missions to investigate specific points on the bioecology of the locust and habitat mapping will be continued.

* *
*

BIBLIOGRAPHY

References cited

- BARRIENTOS L. L., 1993. The present state of the locust and grasshopper problem in Brazil. *6th International Meeting of the Orthopterist Society*. Hilo, Hawaii, USA. Summari in : *Metaleptea* 14(3) : 11.
- CARBONELL C. S., 1988. *Rhammatocerus schistocercoides* (Rehn, 1906), especie perjudicial para la agricultura en la region centro oeste de Brasil (Orthoptera, Acrididae, Gomphocerinae). *Bol. Mus. Nac. Rio J. Zool.*, 318 : 1-17.
- COSENZA G. W., CURTI J. B. & PARO H., 1990. Comportamento e controle do gafanhoto *Rhammatocerus schistocercoides* (Rehn, 1906) no Mato Grosso. *Pesq. agropec. bras., Brasilia*, 25(2) : 173-180.

Reports and various articles published within the project

1. Anonymous, 1993. Novidades sobre os gafanhotos no Mato Grosso. *Via Satélite, NMA/EMBRAPA*, Campinas. 1(6) : 2.
2. DURANTON J.-F., 1993. *Rapport de mission auprès de l'EMBRAPA-NMA (25 octobre-13 novembre 1992). Contribution à l'étude mésologique des biotopes à Rhammatocerus schistocercoides (Rehn, 1906) au Mato Grosso (Brésil)*. D. 468, CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 47 p. (printed document).
3. LECOQ M. & PIEROZZI Jr. I., 1992. *Rapport d'une mission d'étude préliminaire du Rhammatocerus schistocercoides (Rehn 1906) au Mato Grosso (27 octobre au 8 novembre 1992)*. D. 464, CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 36 p. (Printed document).
4. LECOQ M. & PIEROZZI Jr. I., 1993a. *Rapport d'une mission d'étude du Rhammatocerus schistocercoides (Rehn 1906) au Mato Grosso (4 au 15 mai 1993)*. D. 474, CEC/CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 36 p. (Printed document).
5. LECOQ M. & PIEROZZI Jr. I., 1993b. *Troisième mission d'étude du Rhammatocerus schistocercoides (Rehn 1906) au Mato Grosso (22 juin au 3 juillet 1993)*. D. 480, CEC/CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 41 p. (Printed document).
6. LECOQ M. & PIEROZZI Jr. I. 1994a. *Rhammatocerus schistocercoides (Rehn 1906), criquet ravageur de l'état du Mato Grosso au Brésil. Essai de synthèse bibliographique*. CEC/CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 99 pp. (Printed document).

7. LECOQ M. & PIEROZZI Jr.I., 1994b. *L'ancienneté des pullulations du criquet Rhammatocerus schistocercoides (Rehn 1906) [Orth. Acrididae Gomphocerinae] au Mato Grosso : une hypothèse vérifiée. D. 485, CEC/CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 17 p. (Printed document). (To be published in Portuguese in a Brazilian journal)*
8. LECOQ M. & PIEROZZI Jr. I., 1994c. *Les stades larvaires de Rhammatocerus schistocercoides (Rehn 1906) [Orthop. Acrididae Gomphocerinae], criquet ravageur de l'état du Mato Grosso, au Brésil. D. 486, CEC/CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 20 p. (Printed document). (To be published in a French entomology journal)*
9. LECOQ M. & PIEROZZI Jr. I., 1994d. *Le criquet du Mato Grosso : l'agriculture est-elle responsable ? D.487, CEC/CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 2 p. (Article written for a Brazilian journal, in press)*
10. LECOQ M. & PIEROZZI Jr. I., 1994e. *Prospections et enquêtes sur Rhammatocerus schistocercoides (Rehn 1906) au Mato Grosso (25 octobre au 14 novembre 1993). D.488, CEC/CIRAD-GERDAT-PRIFAS/EMBRAPA-NMA, Montpellier. 34 p. (Printed document).*
11. LECOQ M., PIEROZZI Jr. I., de MIRANDA E. E., BATISTELLA M. & DURANTON J.-F., 1993. *Rhammatocerus schistocercoides (Rehn, 1906), gafanhoto praga do estado do Mato Grosso. Pesquisa em Andamento, n°1 (Oct. 93) : 1-3.*
12. MIRANDA E. E. de & DURANTON J.-F., 1993a. *MIR 371 - Unidades de vegetação. Folha SD.21-Y-B ; Mato Grosso. ECOFORÇA/NMA-EMBRAPA, Campinas and CIRAD-PRIFAS, Montpellier. Polychrome map (1/250 000). "Environment and pest locusts of Brazil" project. Coord. 14°00'-15°00' S and 57°00'-58°30' W.*
13. MIRANDA E. E. de & DURANTON J.-F., 1993b. *Rosário Oeste - Unidades de vegetação. Folha SD.21-Z-A ; Mato Grosso. ECOFORÇA/NMA-EMBRAPA, Campinas and CIRAD-PRIFAS, Montpellier. Polychrome map (1/250 000). "Environment and pest locusts of Brazil" project. Coord. 14°00'-15°00' S and 55°30'-57°00'W.*
14. MIRANDA E. E. de & DURANTON J.-F., 1993c. *Uirapuru - Unidades de vegetação. Folha SD.21-Y-A ; Mato Grosso. ECOFORÇA/NMA-EMBRAPA, Campinas and CIRAD-PRIFAS, Montpellier. Polychrome map (1/250 000). "Environment and pest locusts of Brazil" project. Coord. 14°00'-15°00'S and 58°30'-60°00'W.*
15. MIRANDA E. E. de & DURANTON J.-F., 1993d. *Paranatinga - Unidades de vegetação. Folha SD.21-Z-B ; Mato Grosso. ECOFORÇA/NMA-EMBRAPA, Campinas and CIRAD-PRIFAS, Montpellier. Polychrome map (1/250 000). "Environment and pest locusts of Brazil" project. Coord. 14°00'-15°0' S and 54°00'-55°30' W.*

Recent news articles on the locust problem in Brazil

The following articles were published by the Brazilian press in 1992 and 1993 and provide an overview of recent developments in the locust situation in Mato Grosso.

1992

Anonymous, 1992a. Cosenza vai para programa de gafanhoto. *Folha da EMBRAPA*, April 1992, page 6.

G. W. COSENZA was nominated coordinator of the National Locust Control Programme. The locust problem is now particularly serious in the three states of Rio Grande do Sul, Mato Grosso and Paraíba.

LUZ D., 1992a. EMBRAPA vai pesquisar gafanhotos na Amazônia. *Folha do Meio Ambiente*, May 1992, page 10.

The EMBRAPA/CIRAD research project on *Rhammatocerus schistocercoides* was approved by the CEC and they will provide \$350 000 US to fund it.

GUERRA W.D., 1992. *Relatório de viagem. 11 au 13/8/199 2*. Delegacia Federal de Agricultura do MARA. Setor de Defesa Vegetal. Várzea Grande. 4 pp. (Printed document).

Mission report in the Paranatinga region (MT) and aspects of the locust situation. Description of the survey and mapping project for *R. schistocercoides* planned by EMPAER and the Ministry of Agriculture in Mato Grosso, with funding from the FAO. Biological control tests are also planned with *Metarhizium flavoviride*, *M. anisopliae*, *Beauveria bassiana* and *Nosema locustae*.

Anonymous, 1992b. Satélite vai monitorar gafanhotos. *Correio Braziliense/Meio Ambiente*, 4 October 1992, page 21.

The NMA-EMBRAPA/CIRAD-PRIFAS research project on *Rhammatocerus schistocercoides* and the use of satellite images to survey this locust.

JOHN L., 1992. Cientistas alertam para infestação de gafanhotos. *O Estado de São Paulo/Geral*, 14 November 1992, page 15.

Rhammatocerus schistocercoides hopper population densities reached the danger threshold in many areas of Mato Grosso. Recommendations were made to strengthen the watch and to treat the largest hopper concentrations immediately.

Anonymous, 1992c. Grave infestação de gafanhotos em MT. *O Estado de São Paulo/Suplemento Agrícola*, 25 November 1992, page 10.

A joint French-Brazilian NMA-EMBRAPA/CIRAD-PRIFAS mission reports that the locust situation is worrisome in Mato Grosso. Control treatments should be carried out immediately.

Anonymous, 1992d. Governo lança campanha de combate a gafanhoto. *O Estado de São Paulo/Economia*, 17 December 1992, page 8.

The Ministry of Agriculture and Land Reform has launched a locust control campaign in Mato Grosso (1 billion cruzeiros, 16 000 litres of insecticides, 2 100 000 hectares invaded by locusts).

1993

SOAREZ A.R., 1993. Gafanhotos ameaçam plantações em MT. *O Estado de São Paulo/Economia*, 7 January 1993 : 1 and 10.

2.1 million hectares are threatened by *Rhammatocerus schistocercoides*. In the Chapada dos Parecis hopper densities have reached 1000 per square metre. A control campaign has been launched (16 000 litres of insecticides, 1.1 billion cruzeiros).

ALMEIDA S. C. de, 1993. Nuvem de gafanhotos. *O Estado de São Paulo/Economia*, 15 January 1993, page 2.

The President of the Republic is concerned about the locust situation in Mato Grosso and asks for energetic control operations, supported by the army and airforce if necessary, despite protests by the ecologists.

MACIEL S. C. de, 1993. Nuvem de gafanhotos. *O Estado de São Paulo/Economia*, 26 January 1993 : page 3-C.

Locust outbreaks have been reported in the eastern and western parts of Mato Grosso, from the Agua Boa region to the Comodoro region. Nine counties - threatening about two million hectares of pastures and croplands with rice, maize and sugarcane.

Anonymous, 1993a. Gafanhotos. *Correio Braziliense*, 3 February 1993.

The FAO is to provide Brazil with substantial locust control aid for the whole Brazilian territory.

Anonymous, 1993b. Gafanhotos proliferam no cerrado do MT. Controle da praga nao pode ser indiscriminado. *O Estado de São Paulo. Suplemento Agrícola*, 24/2/93, N° 1946, p. 1 and pp. 8-9.

It was recommended that pesticides be used sparingly for locust control in Mato Grosso.

SPINELLI R., 1993. Campinas tenta deter nuvem de gafanhotos. *Folha de São Paulo/Folha Sudeste SP*, 28 April 1993, page 1.

EMBRAPA has obtained funding from the EC to control locusts in the croplands of Mato Grosso. The research to be carried out will include satellite mapping and field work in an area of more than 100 000 km².

Anonymous, 1993c. Testes buscam controle natural do gafanhoto. *Correio Braziliense*, 8 May 1993, page 11.

Testing is being carried out by CENARGEM (national research centre for genetic resources and biotechnology) to check the efficiency of various fungi (*Metarhizium anisopliae*, *M. flavoviridae*, *Beauveria bassiana*), with the aim of developing a biological locust control technique.

JOHN L., 1993. Praga de gafanhotos infesta Mato Grosso. *O Estado de São Paulo/Geral*, 11 May 1993, page 14.

Locust outbreaks have reached an alarming level in Mato Grosso. This is the most important locust invasion since 1987.

AMARAL C., 1993. *Discurso pronunciado pelo Deputado CHICO AMARAL (PMDB-SP) na sessão de 19/05/93 da Tribuna da Câmara dos Deputados*. Câmara dos Deputados, Brasília, 3 pp.

Speech in the Chamber of Deputies pointing out that a research project on the locusts of Mato Grosso was signed by EMBRAPA and the CEC.

Anonymous, 1993d. Técnico garante que gafanhoto não ameaça DF. *Correio da terra*, Brasília, 11 June 1993, page 5.

Locust outbreaks reaching Mato Grosso are not presently threatening the Federal District or the state of Goiás.

OLIVEIRA J., 1993. Gafanhoto não sai de Mato Grosso. *Folha Rural*, Londrina, 12 June 1993, page 11.

According to NMA researchers, *Rhammatocerus schistocercoides* outbreaks in Mato Grosso are an ancient phenomenon, limited to this state, not threatening neighbouring states. The outbreaks are due to a series of favourable meteorological events.

FARIA M. R. de & MAGALHAES B. P., 1993. Bioassay of *Metarhizium flavoviride* against the grasshopper *Rhammatocerus schistocercoides*. *Society for Invertebrate Pathology, XXVIIth Annual meeting, August 1-6 1993, Asheville, NC*.

Metarhizium flavoviride strain IMI-330189 was found to be highly virulent against *Rhammatocerus schistocercoides* late instar hoppers in preliminary laboratory tests.

Anonymous, 1993e. Gafanhoto *Rhammatocerus schistocercoides*. CPAF avalia o problema na Chapada dos Parecis - MT. *Itinerante*, CPAF/Rondônia, 1(2) : 3.

Assessment of the *Rhammatocerus schistocercoides* problem in the Chapada dos Parecis Indian Reservations in a joint mission involving FUNAI, EMBRAPA and IBAMA. FUNAI fears that pesticide treatments are detrimental to the Indians. Locust bioecology studies have been requested in order to develop more environment-friendly control techniques.

Of all the recent television programmes on this topic, those broadcasted on the GLOBO channel are particularly noteworthy :

Regional TV news in São Paulo. 18 November 1992, 7:45 pm.
National TV news. 18 November 1992, 11:00 pm.
Globo Rural. 19 November 1992, 9:00 am.
Fantastico. 13 December 1992, 9:00 pm.
National TV news. 14 May 1993, 8:00 pm.
Fantastico. 30 May 1993, 8:30 pm.
National TV news. 22 June 1993, 8:00 pm.

* *
*