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CONCLUDING REPORT ON CONTROL OF *PROMECOTHECA CUMINGI*, THE INTRODUCED PEST OF COCONUT DECEMBER (1972)

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A. Introduction and Spread of Pest in Sri Lanka

The presence of *Promecotheca cumingi*, the Philippine Coconut beetle, in Ceylon was first reported to the Coconut Research Institute by a resident in Dehiwala in October 1970. At that stage the pest was presumably concentrated in the Dehiwala-Mt. Lavinia area. By June 1971 the pest had spread to the Wellawatte, Ratmalana and Nugegoda areas. By October-November 1971 a detailed survey showed that the main infested area extended up to Ja-Ela and Kelaniya in the North, Homagama and Piliyandala in the East and Moratuwa-Panadura in the South.

At that stage the pest was noted to be spreading both gradually outwards along the periphery of its main distribution area and rapidly into isolated pockets along main rail and road routes. Such pockets were observed in Negombo, Veyangoda, Mirigama, Alutgama, Balapitiya, Ambalangoda and Galle.

By June 1972 the rate of dispersal of the pest had slackened following an initial limited program of D.D.T. spraying of outlying infestations and a sustained program of parasite releases which commenced in December 1971. The isolated pockets of infestation had extended through Matara up to Weligama in the South and Negombo, Bangadeniya and Kochchikade in the North. The main infested area now extended up to Ja-Ela in the North, Panadura in the South and Horana–Padukka in the East. At this stage the parasite *Dimmockia javanica* was giving excellent control of the pest and today, coupled with the action of naturally occurring parasites and diseases, *Dimmockia* has given near complete control of the pest in most areas. For all purposes therefore the pest can now be considered as controlled and its distribution area has remained static since about July 1972.

There has been considerable speculation as to when and how *Promecotheca* entered Ceylon. Pest introductions through international plant quarantines take place usually as single to a very few individuals generally involving gravid females. *Promecotheca* probably reached Ceylon as a single gravid female or a few individual adults at least a year before it built up into sufficient numbers and its presence was noticed through severe damage to coconut palms. Its most likely source of origin was Singapore or Malaysia, whence it was carried by aircraft or, less likely by sea, on consignments of baggage or plant material or on the persons of passengers. It is unlikely that the pest was released when the doors of incoming aircraft were opened. If this was so the initial area of the infestation would have been around Katunayake. The record in the literature that orchids are an alternate host of *Promecotheca* is incorrect because this pest was never found to attack orchids in Sri Lanka despite its enormous populations in the Dehiwala-Mt. Lavinia area where orchids are plentiful.

B. Initial Control Action taken by Coconut Research Institute

Dr. U. B. M. Ekanayake, Crop Protection Officer of the Coconut Research Institute took prompt action to have the new coconut pest, reported from Dehiwala in October 1970, identified through the Commonwealth Institute of Entomology, London. At the same time he sought the services of the Commonwealth Institute of Biological Control in Trinidad and other agencies in Malaysia, Indonesia, Philippines, Fiji and Papua—New Guinea to obtain suitable parasites to control *Promecotheca* by the biological method. At that time the general consensus of opinion was that *Pediobius parvulus* was the parasite of choice to control *Promecotheca* and all efforts were directed towards obtaining that parasite. Correspondence with the various agencies commencing in March 1971 ultimately resulted in two consignments of *Pediobius parvulus* reaching Dr. Ekanayake from Fiji in late July, and early August 1971. All *Pediobius* were dead in the first consignment while the efforts to breed the surviving *Pediobius* from the second consignment at the Coconut Research Institute laboratories at Lunuwila were unsuccessful.

A preliminary survey of the area infested was in the meantime carried out and growers in this area were advised to lop and burn all infested coconut branches. Organised lopping of branches was also undertaken by the C.R.I. immediately outside the periphery of the infestations in an attempt to develop a *cordon sanitaire* against the spread of the pest. An effort was also made to establish a laboratory in the Colombo area for the conduct of work on *Promecotheca* and its control.

The untimely death of Dr. Ekanayake in August 1971 left the Coconut Research Institute without a Crop Protection Officer. In September 1971 the Minister of Plantation Industries therefore organized a Campaign Committee consisting mainly of Scientists drawn from the Department of Agriculture, the Tea, Rubber and Coconut Research Institutes and the Universities and the Department of National Museums. The Campaign Committee operated under the Chairmanship of the Minister of Plantation Industries, Dr. Colvin R. de Silva. The author was requested by the Minister to assume leadership of a team of Economic Entomologists to effect control of the pest. The officers in this scientific team in addition to the author were as follows:— Dr. Nallini Wickremasinghe, and Dr. S. Sivapalan Entomologists from the Central Agricultural Research Institute of the Department of Agriculture and the Tea Research Institute respectively who were responsible for chemical control studies, Mr. Y. Elikewela an Entomologist from the Central Agricultural Research Institute who was in charge of the Biological Control Laboratory organised at Havelock Town. Mr. P. A. C. R. Perera, Senior Technical Assistant from the Coconut Research Institute assisted Mr. Elikewela. Coconut Development Officers from the Coconut Cultivation Board, Technical Assistants, Laboratory and Field Assistants and Laboratory Assistants from the Coconut Research Institute, Tea Research Institute and the Department of Agriculture assisted the Entomologists in the various phases of control of the pest. Dr. P. R. Dharmadhikari, an Entomologist from the Indian Station of the Commonwealth Institute of Biological Control joined the team of economic entomologists shortly after work had commenced. Miss T. Sanmugam, Statistician of the Department of Agriculture, rendered valuable assistance in the field evaluations of pest populations and devised statistical techniques for assessing the results achieved in the biological control program.

C. Subsequent Control Action

The course of action planned to achieve control of the pest in September 1971 was as follows:

(1) Lopping of fronds to be stopped.
(2) A D.D.T. spraying program to be conducted immediately outside the periphery of the main infested area and in the outlying isolated pockets as a temporary measure pending parasite introductions.
(3) Research on chemical control to be carried out simultaneously.
(4) *Promecotheca* to be declared a pest under the Plant Protection Ordinance.
(5) A program of education of field staff of the Department of Agriculture and commodity research institutes to be carried out by the Deputy Director Agriculture (Extension) of the Department of Agriculture.
(6) A Biological Control Laboratory to be established at Colombo and suitable parasites imported, bred and liberated for a vigorous biological control program.

This strategy of control was generally endorsed by Dr. V. P. Rao, Director, Commonwealth Institute of Biological Control Indian Station, Bangalore and Prof. Ray Smith, Chairman, Department of Entomology University of California Berkeley and FAO who visited Sri Lanka at the early stages of the control operations. The latter however felt that D.D.T. spraying immediately outside the periphery of pest distribution was not important.

(1) *Lopping of Fronds*

Lopping of infested fronds in an attempt to prevent the spread of *Promecotheca* was first practised in the Philippines. The benefits of this method were highly questionable and it had since then not been repeated in other countries invaded by this pest. It proved of no control value in Sri Lanka too against *Promecotheca* because:—

(*a*) the pest took to the wing at the slighest jerking of the frond when being cut and it continued to disperse while the frond was falling down and after it had reached the ground,

(*b*) few owners either burnt, or of if they did, effectively burnt the fronds to destroy the remaining pest,

(*c*) there was no benefit that could accrue to the coconut palm under these circumstances by inflicting such extensive injury to the palms by lopping fronds in a matter of minutes which damage the pest would take over a year or more to achieve.

This practice of lopping was therefore stopped in September, 1971. Subsequent results proved the wisdom of this step because high mortality was observed in palms where the fronds had been lopped off.

(2) *D.D.T. Spray Program and Insecticidal Control Investigations*

A program of D.D.T. spraying (0.2% D.D.T.) using high volume motorized sprayers was carried out in the outlying pockets by officers of the Coconut and Cocoa Rehabilitation Department. About two gallons of spray was used per palm. Between September and December 1971 a total acreage of about 1000 acres was sprayed at least once with D.D.T. in the Mawaramandiya, Ja-Ela, Kelaniya, Aluthgama, Welisara, Ganemulla, Veyangoda, Kadawata areas etc. The total area sprayed represented only a small fraction of total infested area. The main infested area was not sprayed to avoid the possibility that contamination with D.D.T. sprays might have adverse effects upon subsequent establishment of parasite releases. This really did not happen because *Dimmockia javanica* established rapidly in places like Mawaramandiya which had been intensively sprayed with D.D.T. about 3 months earlier. D.D.T. spraying was discontinued in December 1971 after parasites had been imported and bred in the laboratory for liberation.

During the early stages of the chemical control program a series of insecticides were tested both in the laboratory and in the field to assess both larval and adult control of the pest. In the field spraying tests 0.1% Fenitrothion sprays gave the best results both against adult and larvae in the galleries. In laboratory tests Diazinon 0.2%, Dimecron 0.3%, Lebaycid 0.3%, Carbaryl 0.3%, Dipterex 0.2%, and Fenitrothion 0.2% gave good control of pest larvae inside galleries. Among the organo-chlorine long-residual insecticides Endrin, Chlordane and Hepctachlor gave good control of adults and larvae as 0.1%-0.2% emulsions. A wide range of organochlorine, organo-phosphate and carbamate insecticides such as Heptachlor, Chlordane, Endrin, D.D.T., Fenitrothion, Diazinon, Dipterex, Dimecron, Thiodan, Carbaryl and Lannate gave excellent residual contact control of adult beetles within 3 to 6 hours. Tests for systemic control of the pest gave poor results.

These tests proved that a relatively wide range of insecticides were available, many with the desired low mammalian toxicities and therefore low human hazard ratings, which could be used both in heavily populated areas and in plantation monocultures for the control of *Promecotheca*. These insecticides would have played a major role in the event that the biological control program was unduly delayed or that this method proved to be a failure. Therefore in preparation for the latter eventuality a consign-

ment of high volume sprayers was air-lifted to Sri Lanka from Japan in October 1971 and helicopter spray rigs were ordered from the Bell Helicopter Co. in U.S.A. for use on the Sri Lanka Air Force's Bell helicopters. Fortunately the need for an accelerated chemical control program, which would have involved our Government in enormous annually recurring expenditure of foreign exchange, did not arise on account of the success of the biological control program to be described below.

(3) *Plant Quarantine Enforcement and Education Against Spread of Promecotheca*

Promecotheca cumingi was declared a pest under the Plant Protection Ordinance in September 1971. An intensive program of education on *Promecotheca* of the field staff of the Department of Agriculture and the Tea, Rubber and Coconut Research Institute was conducted by Mr. J. I. Seneviratne, Plant Protection Officer attached to the Extension Branch of the Department of Agriculture. This was intended to assist both the field staff and coconut growers in the rapid identification and reporting of *Promecotheca* infestations.

In the main it may be said that the declaration of *Promecotheca* under the Plant Protection Ordinance prevented movement of infested coconut plant material out of the declared areas and permitted of free access into infested plantations by officers conducting the control campaign.

(4) *Biological Control Program*

By October 1971 a fully equipped Biological Control Laboratory was established at Havelock Terrace in Havelock Town, Colombo, to receive, quarantine and multiply suitable parasites of *Promecotheca* introduced from overseas.

A review of the literature showed that the more important parasites of *Promecotheca* species to be found in Indonesia, Fiji, Philippines and Singapore-Malaysia were as follows:—

(*a*) *Oligosita utilis* (egg parasite)
(*b*) *Elasmus hispidarum* (larval parasite)
(*c*) *Pediobius parvulus* (larval-pupal parasite)
(*d*) *Pediobius painei* (pupal parasite)
(*e*) *Dimmockia javanica* (larval parasite)
(*f*) *Achrysocaris promecothecae* (egg parasite)

Pediobius parvulus had given spectacular control of *Promecotheca* species in Fiji (Taylor 1937) and Papua New Guinea (Gressitt 1959) when introduced from Indonesia. According to Lever (1969) *Pediobius parvulus* which was indigenous to Singapore gave spectacular control of *Promecotheca cumingi* in that country. *Dimmockia javanica* although mentioned as a parasite of Promecotheca in a number of countries is not noted for excellent control of that pest as has occurred in Sri Lanka during the last year. The other parasites listed above were also not known to give excellent *Promecotheca* control.

The earlier efforts of the Commonwealth Institute of Biological Control to obtain *Pediobius parvulus* from Fiji resulted in only three consignments which either failed to survive in transit or could not be established in the laboratory at the Coconut Research Institute in Lunuwila. Meantime the pest was both multiplying and spreading rapidly. Mr. G. P. B. Karunaratne, Curator, Department of National Museums, Colombo, was therefore sent to assist Mr. D. H. Murphy, Lecturer, Department of Zoology, University of Singapore, (contacted through Dr. V. P. Rao, Director, C.I.B.C., Bangalore) in the collection and despatch of parasites to Sri Lanka. By this arrangement we were able to receive several nucleus consignments of both *Dimmockia javanica* and *Achrysocaris promecothecae* in October and November 1971. These were established and multiplied in the laboratory under rigid quarantine to eliminate hyperparasites. *Dimmockia* was bred and multiplied easily by the method of Taylor (1937) but *Achrysocaris* presented difficulties in laboratory rearing.

Small consignments of parasites reported to be *Pediobius parvulus* and *Pediobius painei* were also received through Mr. D. F. Murphy from Singapore and Sabah. These could not be cultured here and it is suspected that the hyperparasite *Pediobius detrimentosus* was involved.

Our observations on the low survival rate of the parasites despatched from Fiji and Indonesia was that the mortality could be attributed to poor packing. Packing materials with detailed instructions were therefore despatched to Dr. S. R. Singh, Principal Research Officer, Kerenivia Research Station, Neusori, Fiji and the authorities in Indonesia. Two shipments which arrived subsequently from Fiji packed as instructed survived the journey well and after quarantine elimination of the hyperparasites provided us with the nucleus culture of *Pediobius parvulus* for laboratory breeding. This parasite was bred easily and in large numbers by the method described by Gressitt (1959).

As a preliminary to parasite releases detailed surveys were conducted in October-December 1971 on pest survival and local parasitisation. Apart from a pocket of what appeared to be a disease or diseases caused by pathogenic micro-organisms in the eggs and larvae of *Promecotheca* located in the Kalubowila area, a very low degree of parasitization by the egg parasite *Achrysocaris promecothecae* was noted in some areas while others were almost free of natural mortality factors.

Between December 1971 and October 1972 the Biological Control Laboratory bred and liberated totals of 130,525 *Dimmockia javanica*, 33,250 *Pediobius parvulus* and 1250 *Achrysocaris promecothecae* in the pest infested areas.

D. Results of Biological Control Program

A sample of the results obtained in the biological control program which extended from December 1971 to October 1972 is presented graphically in Figs. 1-6. These presentations are highly simplified versions of technical data and are intended only to convey to the non-scientific reader the essence of the results obtained.

Early in the project a localized pocket of suspected disease was noted to be afflicting eggs and larvae of *Promecotheca* in the Kalubowila area. Following the liberation and establishment of *Dimmockia* there was a marked increase in the incidence and area affected by this suspected disease.

It was also apparent very early in the program that *Dimmockia javanica* was establishing and multiplying very rapidly in the field and giving good control of Promecotheca larvae. *Pediobius parvulus* on the other hand, which had given spectacular control of *Promecotheca* in Fiji, Papua New Guinua and Singapore did not establish in Sri Lanka despite the fact that over 30,000 specimens had been liberated. The breeding of this parasite should therefore be terminated both for this reason and the difficulty in obtaining host material today even to maintain *Dimmockia* cultures.

The facts that *Achrysocaris promecothecae* occurred locally and caused a very low degree of parasitization of *Promecotheca* eggs and that laboratory breeding of this parasite was difficult led the author to decide to terminate this programme.

Of the parasites introduced, *Dimmockia javanica* aided by local mortality factors has been responsible for the control of the pest in all infested areas today. No hyperparasitization of *Dimmockia* has been observed so far.

E. Conclusions

The following conclusions can be arrived at on the basis of the data presented in Figs. 1-6 and other observations mentioned above.

(*a*) Figs. 1 and 3 show that there was a very high rate of *Promecotheca* egg mortality in all areas. This may be due to low fertility rate or parasitization by pathogenic micro-organisms or both.

(*b*) Figs. 1 and 3 also show that mortality of the other immature pest stages when added to pest egg mortality resulted in 100% control of the pest in areas like Kadawata, Biyagama, Dehiwela, Gampaha, Weligama, Padukka and Bope. In other areas pest survival ranked between 1% and 18% of the original potential population. This gives a picture of excellent control of the pest.

FIG. 1. SURVIVAL & MORTALITY DURING ALL STAGES OF DEVELOPMENT OF P. CUMINGI IN MAIN INFESTATION AREA (OCT. 1972)

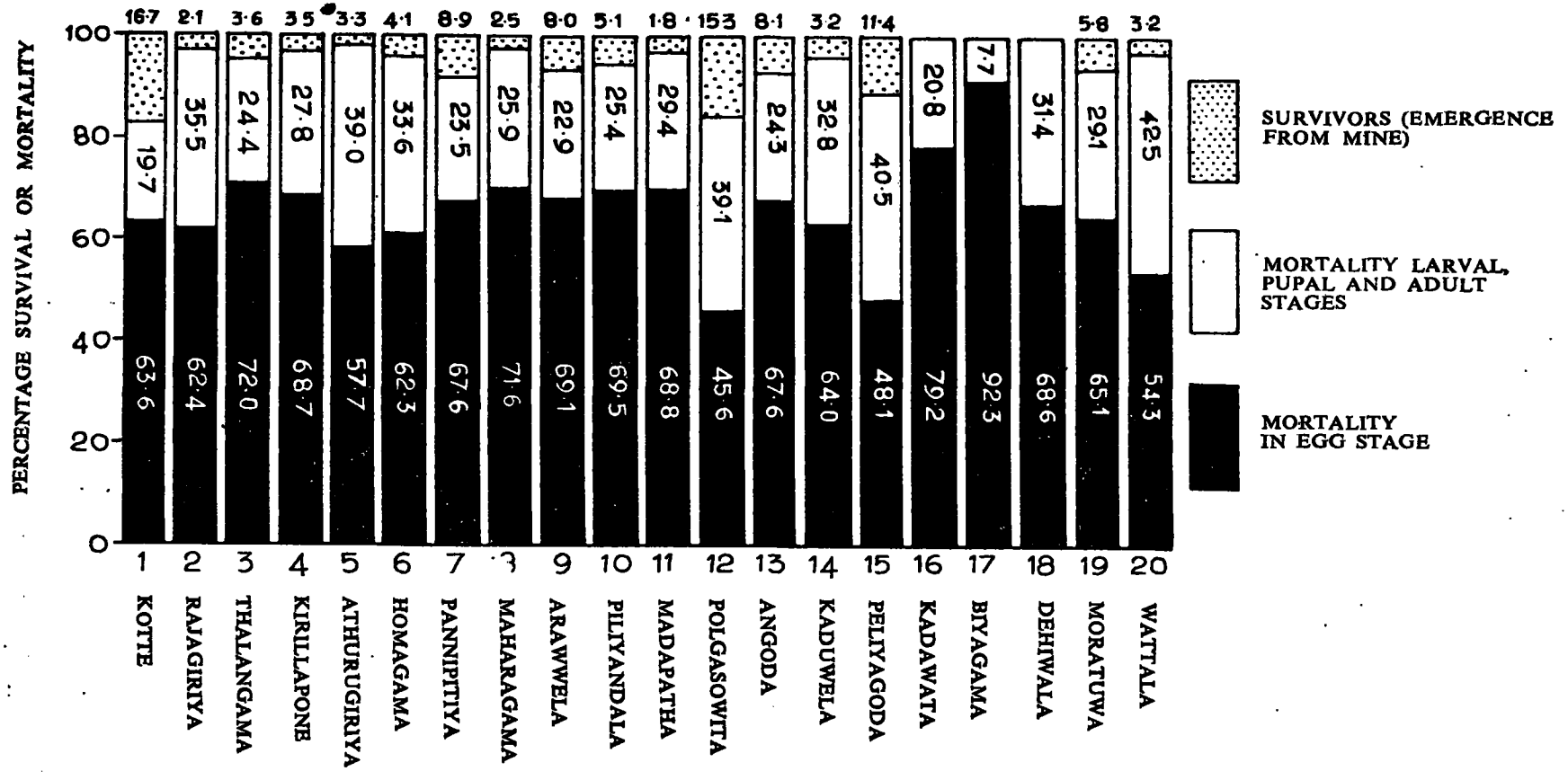


FIG. 2. LARVAL SURVIVAL & MORTALITY OF PROMECOTHECA CUMINGI IN MAIN INFESTATION AREA (OCT. 1972)

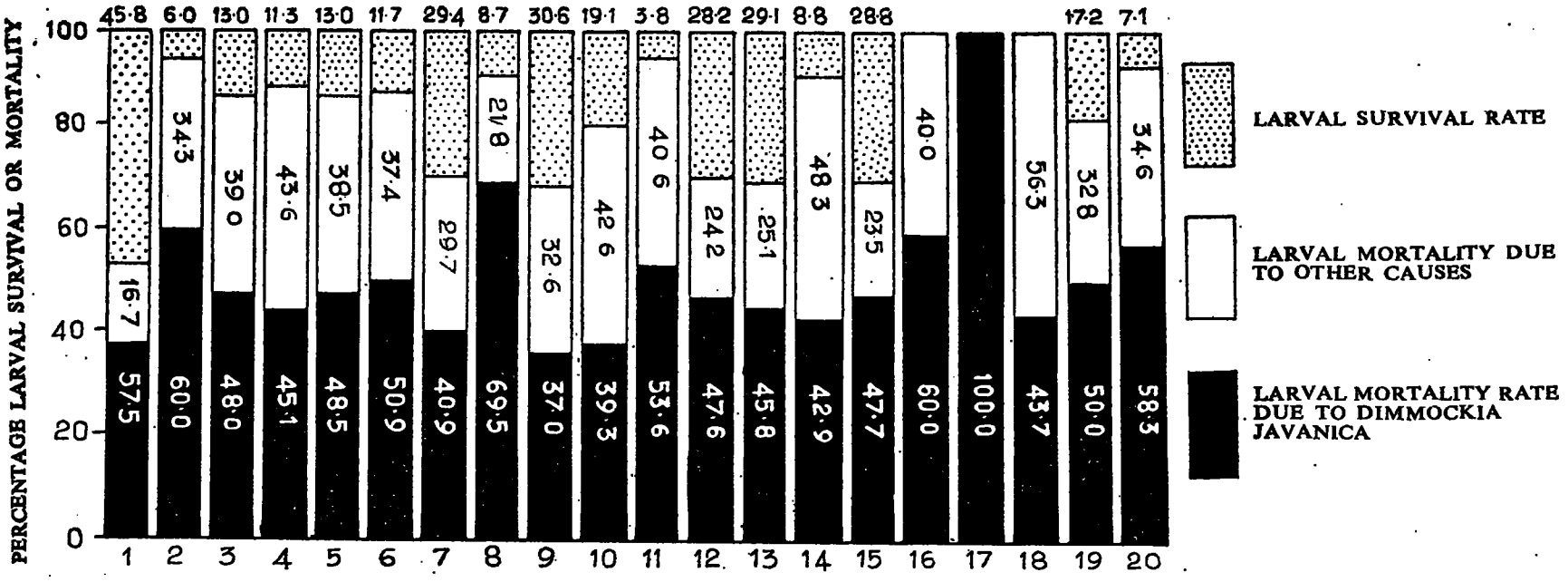


FIG. 3. SURVIVAL AND MORTALITY DURING ALL STAGES OF DEVELOPMENT OF P. CUMINGI IN OUTLYING POCKETS OF INFESTATION (OCT. 1972)

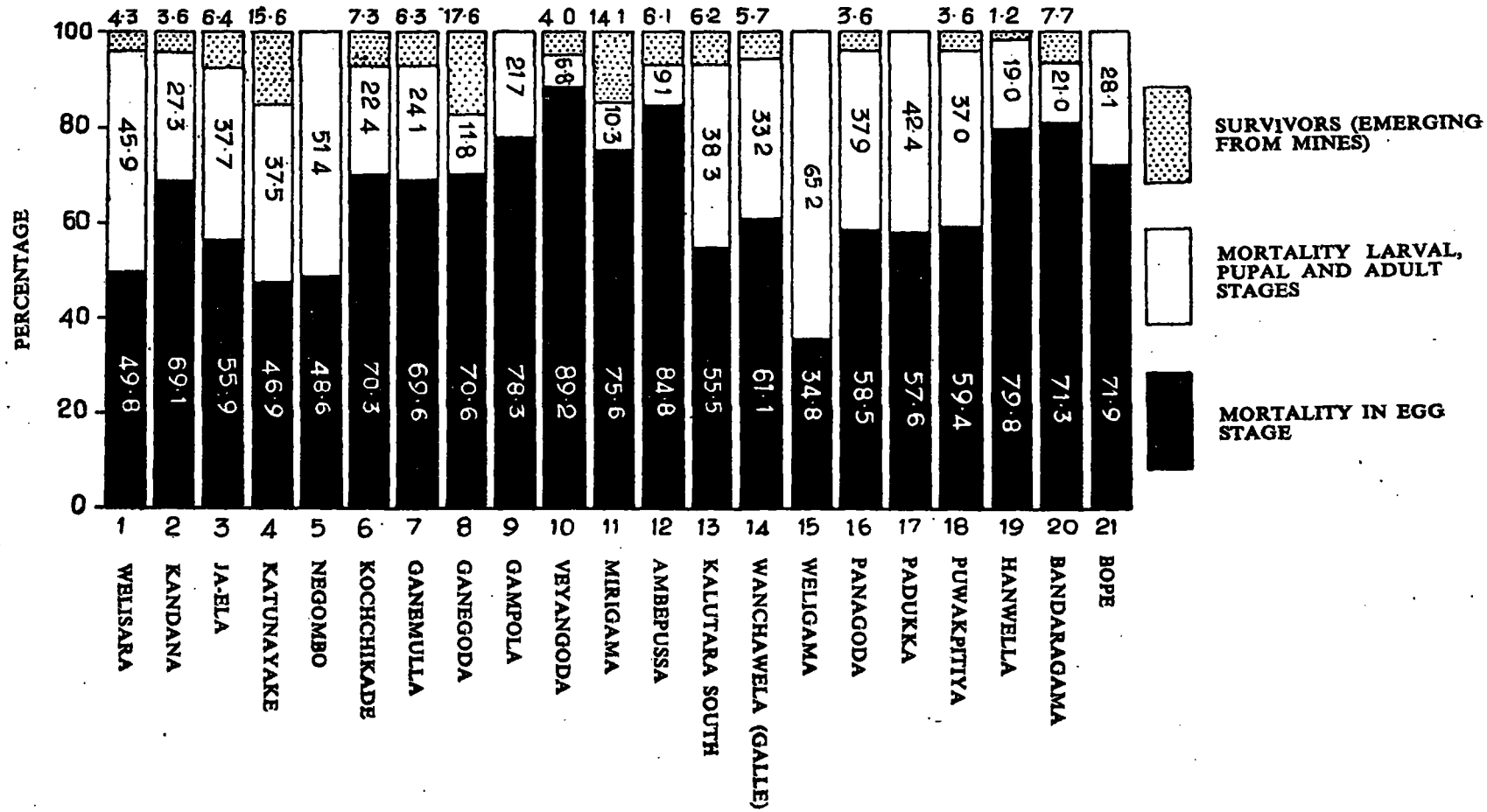


FIG. 4. LARVAL SURVIVAL AND MORTALITY OF PROMECOTHECA CUMINGI IN OUTLYING POCKETS OF INFESTATION (OCT. 1972)

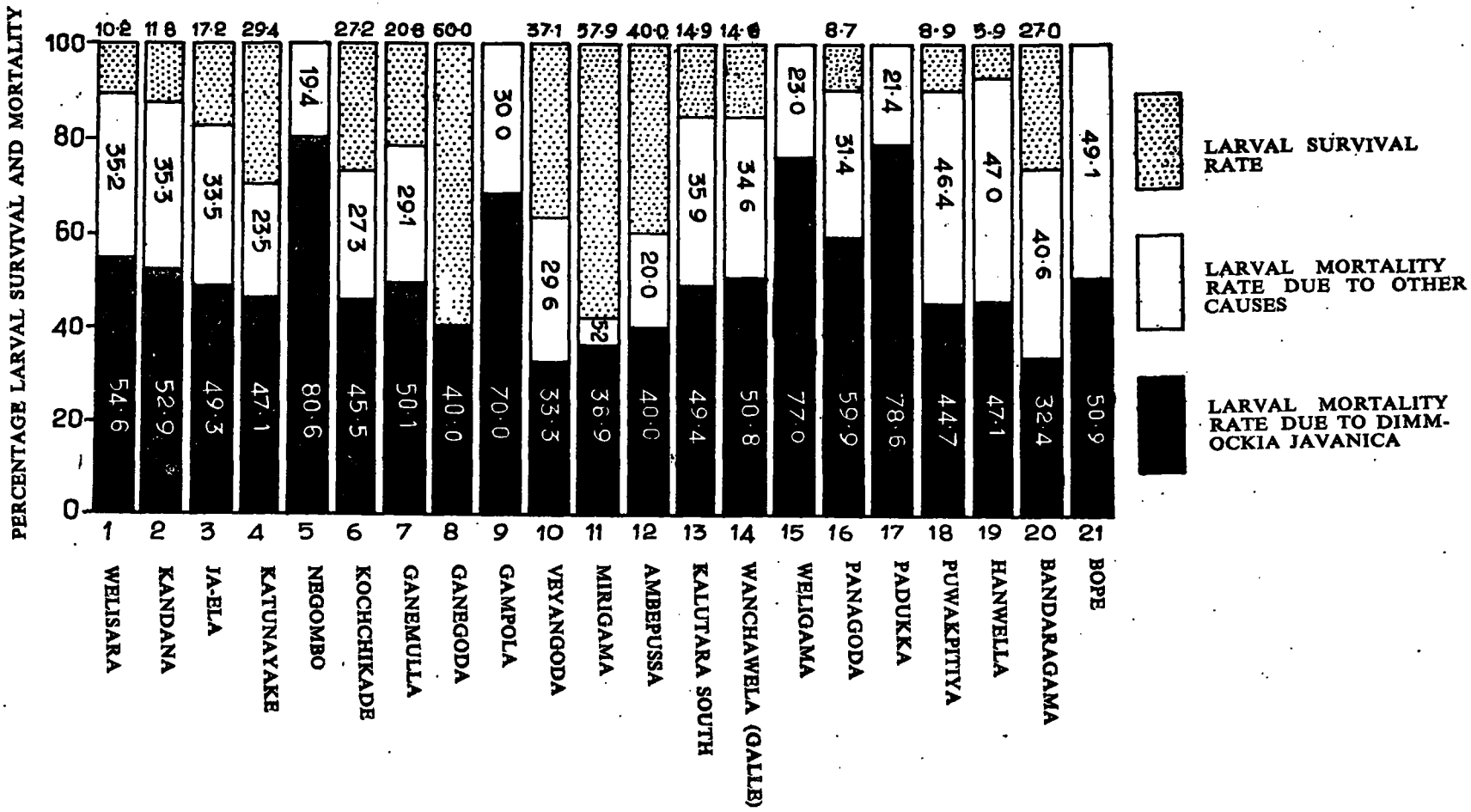


FIG. 5. MORTALITY AND SURVIVAL OF P. CUMINGI NUMBER PER SAMPLING UNIT PER TREE IN MAIN INFESTATION AREA (OCT. 1972)

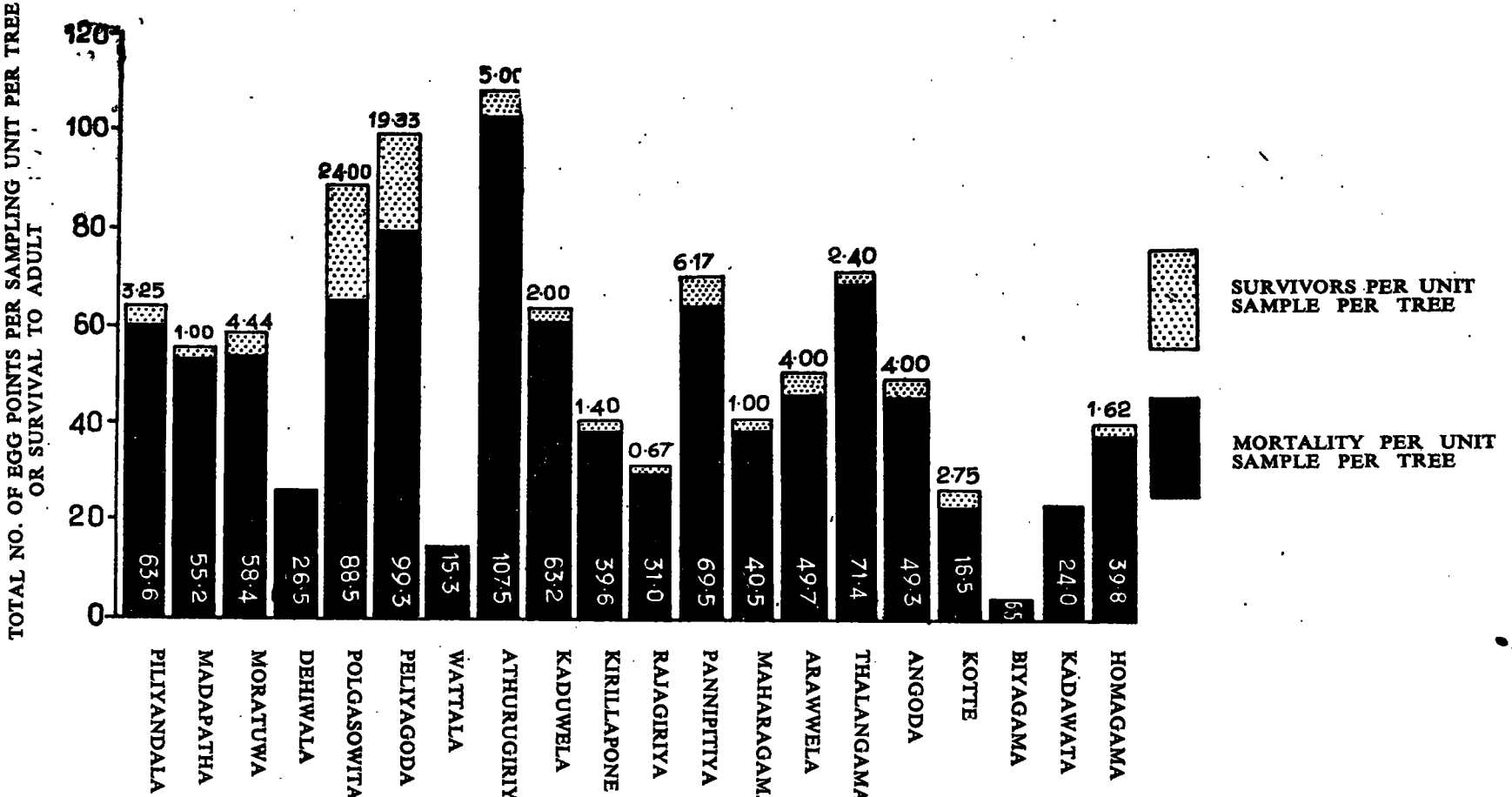
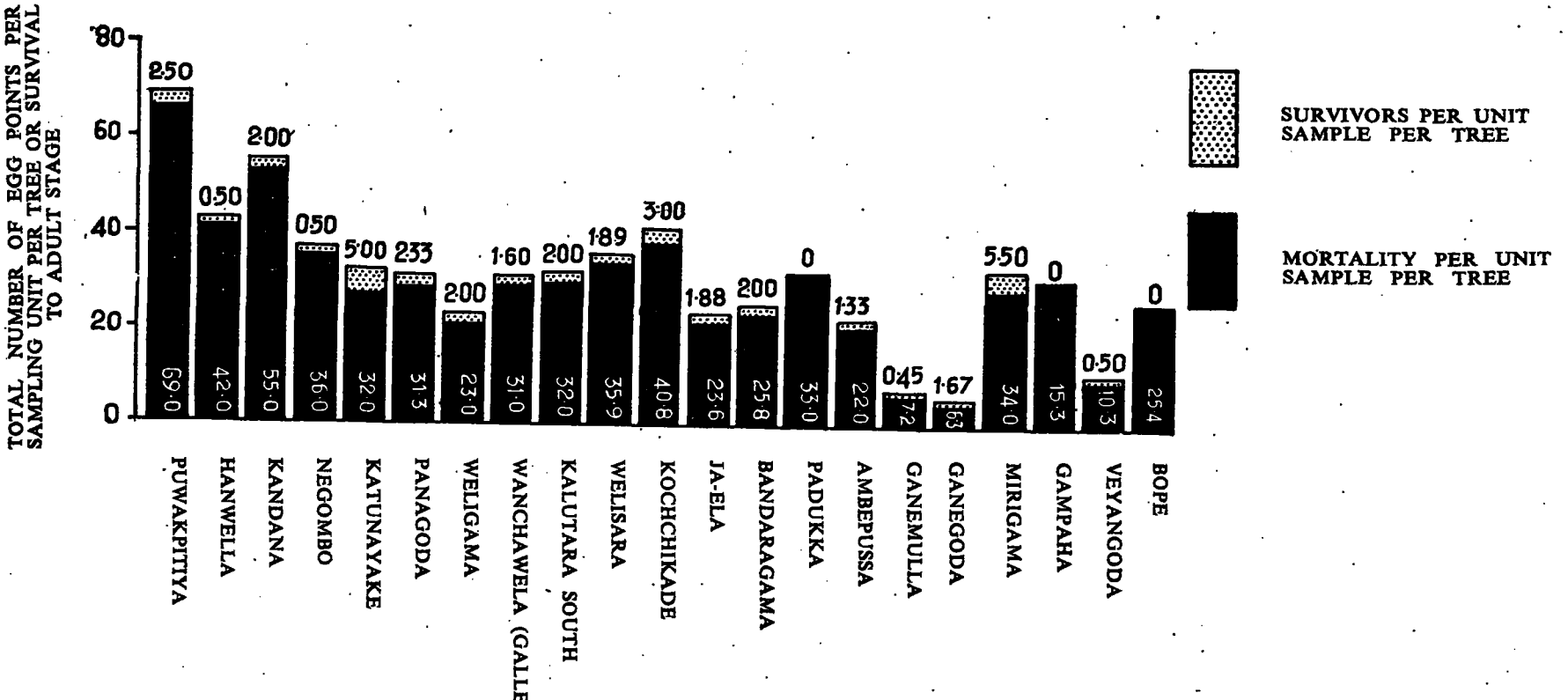


FIG. 6. MORTALITY AND SURVIVAL OF P. CUMINGI NUMBER PER SAMPLING UNIT PER TREE IN OUTLYING POCKETS OF INFESTATION (OCT. 1972)



(*c*) Figs. 2 and 4 prove that *Dimmockia javanica* has been the major contributory factor responsible for the control of the larval stage of *Promecotheca* which is the most destructive stage of the pest. Coupled with the naturally occurring mortality factors this parasite has given excellent control of the pest in Sri Lanka.

(*d*) Figs. 5 and 6 show the actual numerical survival rate of the pest in the infested areas. In the main infestation area survival to the adult stage was zero to about 25 insects per sampling per tree (these are only possible upper limits of survival) while in the outlying pockets of infestation pest survival rate was even lower ranging between zero and 5.5 insects per sampling per tree. This data contrasts markedly with pest populations prior to the release of parasites which ranged between 28 and 50 insects per sample per tree.

(*e*) *Pediobius parvulus* has not established in Sri Lanka despite liberation of over 30,000 specimens. It seems unlikely that this parasite will establish here and *Dimmockia javanica* must remain the parasite of choice for *Promecotheca* control in Sri Lanka.

(*f*) No hyperparasitization of *Dimmockia javanica* has been noted and every effort must be made to keep known hyperparasites out of the present infestation area.

(*g*) *Achrysocaris promecothecae* occurs naturally and need not be bred in the laboratory for releases.

(*h*) Natural mortality at the pest egg stage is very high due to low fertility or diseases or both.

(*i*) *Promecotheca cumingi* can now be regarded as under control in Sri Lanka. Routine surveys for new infestations and liberations of *Dimmockia* in these areas will have to continue.

F. Recommendations

(i) In view of the excellent control of *Promecotheca cumingi* currently achieved the staff of the Coconut Research Institute should take over the responsibility for the routine survey and control program that lies ahead from the scientists of the Department of Agriculture as from 1.1.1973.

(ii) A compact Committee consisting of Dr. Nallini Wickremasinghe, Mr. Y. Elikewela, Dr. P. Dharmadhikari, Dr. W. R. N. Nathanael, Mr. W. Gunasekera, Dr. J. Sivapragasam and Dr. H. E. Fernando under the Chairmanship of the Secretary to the Ministry of Plantation Industries should meet once in six months or more frequently as necessary and review the pest position through 1973 and decide on any required action.

(iii) At least two other parasites of *Promecotheca*, viz. *Elasmus hispidarum* and *Pediobius palnei* may be introduced into Sri Lanka if the need arises.

(iv) All parasite introductions from abroad must be done under the quarantine supervision of scientists of the Department of Agriculture. In any case this is a statutory requirement under the Plant Protection Ordinance.

(v) Coconut pest and plant material should not be moved particularly from the Eastern Province or from uninfested areas into the infested area or to the Coconut Research Institute Laboratories at Lunuwila. This will reduce the chances of the hyperparasite of *Dimmockia, Pediobius detrimentosus* affecting *Dimmockia* populations. It should be mentioned here that in Singapore *Dimmockia* has been quite effective although attacked by *Pediobius detrimentosus*.

G. Acknowledgements

I am thankful to the Minister of Plantation Industries Dr. Colvin R. de Silva, for having given me the privilege of leadership of the scientific team on *Promecotheca* control. On behalf of this team of scientists I must express our sincere thanks to the Minister of Plantation Industries for his vigorous support and encouragement and repeated constructive analysis of the problems involved; to the Secretary,

Ministry of Plantation Industries, Mr. Doric de Souza, his Assistant Secretary, Mr. Balachandra, the Commissioner of Coconut and Cacao Rehabilitation, Mr. W. Gunasekera and the then Chairman of the Coconut Research Board, Mr. R. H. de Mel for their sustained administrative support which ensured speedy implementation of technical decisions and rapid achievement of the project's objectives; to the Director, Coconut Research Institute, Dr. W. R. N. Nathanael, for the excellent cooperation he and his staff gave us, to the Director, Rubber Research Institute, Dr. O. S. Peries, for his help in establishing the Biological Control Laboratory in the shortest possible time; to all officers whose services were loaned to us from the Department of Agriculture, the Department of National Museums and the Tea and Coconut Research Institutes (whose names unfortunately cannot be individually mentioned here) for their dedicated and unstinted services; we are deeply indebted to Dr. V.P. Rao and the institution he represents the Commonwealth Institute of Biological Control, for much valuable assistance and advice; to Prof. Ray Smith of the University of California and FAO for his suggestions and advice gladly given us at short notice; to Mr. D. F. Murphy of the University of Singapore for his very valuable contribution in sending in *Dimmockia javanica* ; to Dr. S. R. Singh of the Fiji Department of Agriculture for his collection and despatch of *Pediobius parvulus* and to Dr. K. Untung of the University of Gadjah Mada, Indonesia for his collection and despatch of *Pediobius parvulus.*

Finally I express my own personal indebtedness to all the members of the Scientific Team for their whole-hearted co-operation with me in ensuring the complete success of the project we undertook.

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