Dengue in Brazil - Situation, Transmission and Control - A Proposal for Ecological Control

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This article discusses dengue in terms of its conceptual and historical aspects, epidemiological and clinical/pathological nature, and evolution up to the present situation in Brazil. The author discusses the ecological relationship in both the production of dengue and its control. Comparison is made between traditional dengue-control programs and a proposed socially-controlled program of an ecological nature without the use of insecticides. Stress is placed on interdisciplinary technical and scientific activity, broadbased participation by communities in discussing methodological aspects involving them, and prospective evaluation comparing the communities selected for intervention and control communities with regard to clinical and subclinical dengue cases and vector infestation rates in relation to climatic, socio-economic, and behavioural factors.

Key words: dengue fever - serotypes 1, 2 - ecology - epidemiology - control - community participation - Brazil

Dengue is an acute febrile disease which is epidemic-endemic in nature and is caused by four types of virus from the genus *Flavivirus* and transmitted by mosquitoes from the genus *Aedes.* Infection can take a number of forms, from light and asymptomatic to serious and fatal. In general, death is brought about by shock that is not directly associated with the haemorrhagic symptoms usually found in such cases. Occasionally, fatalities may occur from shock in the absence of haemorrhage or as a result of encephalopathy. The frequency of serious cases varies between 0% and 10%, both in endemic and epidemic situations, although the latter, given the absolute numbers involved, generally assumes greater significance.

The classic clinical picture for dengue, on which diagnosis is commonly based, involves significant general symptomatology, as observed in Rio de Janeiro (Marzochi et al. 1987, 1991, Marzochi 1992), with fever, headache (usually postorbital), mialgia, arthralgia, weakness to the point of prostration, and anorexia; vomiting and mild diarrhoea are commom; rashes and itching occur in a third of cases; haemorrhagic alterations are found in 20 to 35% of cases, with predominance of positive tourniquet tests, epistaxes and/or petechiae.

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Following the epidemic in Thailand (in 1958), the World Health Organization established precise clinical and laboratory criteria for classifying certain haemorrhagic forms of dengue as dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS), both being classified under the overall heading haemorrhagic dengue. The criteria established for the latter not only included haemorrhaging, which could range in severity from the bleeding induced by the tourniquet test to more significant clinical manifestations, but also encompassed thrombocytopenia equal to or lower than 100,000 platelets and haematocrit levels above 20%. In addition, DSS covered cases showing pre-shock symptoms (WHO 1975, 1986).

However, there are numerous cases reported in the literature which evolved to shock and/or death without presenting the criteria for dengue haemorrhagic fever (Sumarmo et al. 1983, Martinez-Torres et al. 1985, Guzman et al. 1987, Diaz et al. 1988). In practice this classification is rather complex for treating patients during epidemics, and therefore an alternative clinical classification has been proposed for Rio de Janeiro (Marzochi 1991).

The importance of dengue - There are two fundamental reasons: (1) *Epidemic-endemic behaviour* - Even in the absence of its fatal forms, the disease leads to considerable *physical debilitation, absenteism* from work and school, and significant *expenditure of resources* on health staff working at the clinical level, in diagnostic laboratories and on epidemiological assessment and prevention. (2) *Potential for clinical severity* in both epidemic and endemic situations - This implies exposure to a variable *risk to life* and the occurrence of *deaths*, both of which are avoidable. This leads to greater costs in the tertiary health sector in addition to projected social and human costs in dealing with an epidemic or endemic situation.

THE ESTABLISHMENT OF DENGUE IN BRAZIL

Dengue has occurred mainly in Third World countries that have a reduced capacity to control the disease or where control is not a priority.

Asia, Africa, and Europe, together with North and Central America are all thought to have suffered dengue epidemics as far back as the eighteenth century. Today, dengue occurs in Oceania, Asia, Africa, North America (Mexico), Central America and South America, both endemically and/or epidemically, with the number of severe cases on the increase; in South America, dengue exists in Paraguay, Equador, Peru, Bolivia, Colombia, Venezuela and Brazil (Siler et al. 1926, Pinheiro 1989, Martinez-Torres 1990, Halstead 1990, Phillips et al. 1992).

Epidemic haemorrhagic dengue has been described in the Americas, in 1981 in Cuba; in 1984 in Mexico; in 1989-90 in Colombia and Venezuela, and in 1990-91 in Brazil. All four dengue serotypes have been identified; serotype 3, which had not been isolated since the beginning of the 1980's, was recently identified in Venezuela. The serious epidemic forms of the disease have been associated with serotype 2 (Pinheiro 1989, Martinez-Torres 1990, OPAS 1990, Kouri et al. 1991, WHO 1992).

In Brazil, outbreaks of dengue were first reported in 1846, in the States of Rio de Janeiro, Bahia, Pernambuco and some northern provinces; in 1890 a few cases occurred in Paraná. At the beginning of the century, there were reports of the disease in São Paulo in 1916, in Santa Maria, State of Rio Grande do Sul, in 1917, and in Niterói, State of Rio de Janeiro, in 1923 (Ministério da Saúde 1991b).

In 1981-82, after more than fifty years, there was a resurgence of the disease in the State of Roraima, in the town of Boa Vista, where an epidemic involving serotypes 1 and 4 led to 12,000 registered cases (Osanai et al. 1983, Ministério da Saúde 1991b).

In April 1986, the disease resurfaced in Rio de Janeiro in a widespread epidemic involving serotype 1 (Schatzmayr et al. 1986, Marzochi 1987, Miagostovich et al. 1993) which struck other states in the following years (Table I).

In February 1989, dengue 2 virus was isolated for the first time in Brazil, in Belém, State of Pará, from a traveler from Luanda, Angola (Travassos da Rosa et al. 1989). In April 1990, serotype 2 entered Rio de Janeiro (Nogueira et al. 1990), in March-May 1991, an epidemic of the same serotype occurred in the State of Tocantins, municipality of Araguaína, without prior incidence of serotype 1 (Vasconcelos et al. 1993), and more recently, in July 1991, serotype 2 was identified in the State of Alagoas (data from the

TABLE I

Notifications of dengue in Brazil - 1982 - 1992

State/Year	1982	1986	1987	1988	1989	1990	1991	1992
Alagoas	...	9,383	3,225	65	60	294	1,317	285
Bahia	...	---	623	---	---	---	---	---
Ceará	...	4,419	22,513	55	4,126	15,656	6,703	117
Minas Gerais	...	---	527	---	---	---	286	---
M. G. do Sul	...	---	---	---	---	1,606	4,316	846
Mato Grosso	---	---	---	---	---	---	---	981
Pernambuco	...	---	2,118	---	27	---	---	---
Rio de Janeiro	...	35,611	37,214	1,192	1,112	21,005	85,891	1,685
Roraima	12,000[c]	---	---	---	---	---	---	---
Tocantins	...	---	---	---	---	---	2,194	---
São Paulo	...	---	46	10[a]	10[a]	2,081[b]	3,681[b]	31
Total	12,000	49,413	66,266	1,322	5,335	40,642	104,398	3,918

[a]: imported cases
[b]: only confirmed cases
[c]: estimated cases, based on a randomized sero-epidemiological survey.

Source: Ministry of Health, National Health Fundation, Brazil

Epidemiological Coordination Unit, Municipal Health Secretaria, Rio de Janeiro).

Taking the period since 1986 as whole, around 260,000 cases have been reported, of which 68% in Rio de Janeiro (Table I).

In the State of Rio de Janeiro, we observed from case reports the following cycles: the first from May to September 1986, the second from December 1986 to June 1987, the third from April to October 1990, and the fourth from November 1990 to July 1991 (Table II). The first two were associated with serotype 1 (Nogueira et al. 1988, 1992), in the third this same serotype still predominated while the fourth was associated with serotype 2. In the third and fourth cycles serotypes 2 and 1, circulated in small proportions, respectively. If the occurrence of biannual epidemics persists, 1994 would probably be epidemic year. The city of Rio de Janeiro contributed with 65% of cases on the average of the period. Worst hit, in general, were areas characterized by high demographic density and poor socio-economic conditions.

As in other states, the disease in Rio de Janeiro occurred mainly among adults, even in cases involving serotype 2.

Cases of severe disease and death occurred in both epidemics. One death was confirmed in 1986 (Nogueira et al. 1988) and in 1987 at least five deaths were attributed to serotype 1 (Chimelli et al. 1990). During the epidemic involving serotype 2, the State of Rio de Janeiro had 29 recorded deaths and 1,306 cases of DSS (data reviewed by PAHO). Only one child death has been reported: an 11-year-old male which occurred in December 1990. Diagnosis was based on autopsy (Hospital Fernandes Figueira - FIOCRUZ) and serological confirmation (Dr Rita Nogueira - personal communication).

THE VECTOR - The overall distribution pattern of *Aedes aegypti* and *Ae. albopictus* in Brazil has not been definitively established. However, 3,568 municipalities in 17 states, have shown to be infested with *Ae. aegypti* and 880, in six states, with *Ae. albopictus*, with both vectors being found in 208 (data from National Health Foundation, Brazilian Ministry of Health 1992).

The fight to control *Ae. aegypti* is old in Brazil, dating from the period of urban yellow fever, which was eradicated through vaccination in 1942. Vector eradication occurred later, in 1956, following the introduction of DDT and the PAHO campaign in the Americas. In 1967 the mosquito was officially recognized to have reemerged in the cities of Belém and São Luís, and in 1973 it was once more declared to have been eradicated; then, in 1976-77, it was again found in the cities of Salvador and Rio de Janeiro (Ministério da Saúde 1991b). Since then it has been spreading and it can now be found from northern to southern Brazil, and in the middle western region as far as Foz do Iguaçu.

Classically, the habits of *Ae. aegypti* involve a preference for daytime activity, in terms of mating and biting by the bloodsucking, anthropophagous female, with an increase in activity at higher temperatures. After three days of feeding, eggs are laid in a variety of locations, but the flight range does not usually exceed 300

TABLE II

Notifications of dengue in the State of Rio de Janeiro - 1986 - 1992

Month/Year	1986	1987	1988	1989	1990	1991	1992
Jan	...	5,510	199	148	52	26,022	345
Feb	...	4,700	106	89	67	18,365	250
Mar	...	11,504	141	144	166	14,048	232
Apr	69	7,638	85	227	440	7,131	98
May	9,721	1,171	20	115	3,243	3,720	79
Jun	7,372	743	12	120	2,495	1,284	74
Jul	4,701	193	15	41	2,575	594	39
Aug	973	43	11	17	1,320	185	20
Sep	278	10	6	13	653	104	42
Oct	132	---	---	21	462	119	50
Nov	159	29	10	92	1,503	108	56
Dec	2,224	126	21	85	5,821	258	49
Total	25,629	31,667	626	1,112	18,797	71,938	1,343

Source: Ministry of Health, National Health Foundation, State of Rio de Janeiro m due to the mosquitoes' great preference for infesting households and feeding on human blood, but their flight potential can reach 1,000 m (Franco 1976). The eggs are laid on the walls of bodies of clean water, just above the surface of the water, and are visible as small dark dots. After three days, the larva emerge and can be seen swimming actively on the surface, where they come to breathe. The larvae take four or five days to evolve, in stages, into pupae. Then, after seven more days (or longer at lower temperatures), they are transformed into flying adult mosquitoes. *Ae. aegypti* lives for ten to 42 days and is rarely found at over 1,200 m above sea level although it has been sighted at 1,700 m in Mexico (Herrera-Basto 1992) and 2,200 m in Colombia (Nelson 1985 apud Martinez-Torres 1990).

Ae. albopictus is active as a dengue vector in Asia and other parts of the world, and more efficient than *Ae. aegypti*, both in the laboratory and in nature. It feeds on humans, other mammals, and birds; is more resistant to cold, and adapts well both to urban breeding grounds, any utensil or vessel, and to rural and sylvatic locations (hollows in trees and bamboo or folds in leaves, as long as they contain clean water) (Ministério da Saúde 1987, Moura Lima 1988). Furthermore, it appears that in urban areas where vegetation is scarce, *Ae. albopictus* does not compete with *Ae. aegypti* (Schultz 1989). A rural cycle associated with *Ae. albopictus* has been described (Gubler 1987).

DENGUE CONTROL - In recent decades, dengue has constituted an important problem for "the majority of tropical countries", not only because of the rising frequency of epidemics and hyperendemicity, but also because of the emergence, geographical expansion and increased incidence of haemorrhagic dengue; the latter has arisen as a result of increased air transportation, urbanization, changes in life styles and a lack of effective and sustained efforts to control the vector (Audy 1972, Gubler 1989). We believe, however, that the basic cause for the emergence and growth of dengue is the lack of investments in the social structure of these countries, the climatic conditions of the tropics and other aspects referred being absolutely secondary. Economic and socio-cultural development is the basic factor in reducing or eradicating the so-called tropical diseases. Most transmissible diseases are endemic or become epidemic due to political conditions, so they must also be confronted at the political level. At the domestic level in Brazil, this would depend on society's demanding and obtaining economic policies aimed at decentralization and redistribution of wealth.

In spite of the expansion of dengue in the world, including the Americas, and the insufficiency of traditional control programs (Gomez-Dantes 1991), there is scant literature offering alternative approaches to control based on the ecological model of the disease. Instead, as a rule, different aspects of the problem are treated in isolation. Exceptions include studies in 1989-90 on community participation in the control of *Ae. aegypti* in the town of El Progresso, Honduras (Belorin 1991) and in Merida, Mexico (Lloyd et al. 1992). Both studies involved a controlled survey of entomological, anthropological and socio-economic data, in urban communities selected at random, as controls and as targets for intervention. Larval inspections showed significant differences between the intervention and the comparison groups. Attempts at community education in Thailand produced good results (Swaddiwudhipong et al. 1992a, b).

Ministry of Health Program in Brazil - The control program for dengue has the following objectives: (a) to block transmission in areas where dengue exists and to prevent the haemorrhagic form of the disease; (b) to prevent transmission occurring in areas that are infected with vectors; (c) to impede the spread of vectors into non-infested areas.

The program recognizes the value of community participation, accepts biological control as one possible approach, indicates the sampling methods to be used in collection of data on infestation, and considers administrative decentralization a necessary process.

Given the limits on resources, the following order of priorities (P) has been set: PI - controlling the vector in areas that are both epidemic and infested; PII - controlling the vector in infested areas; PIII - keeping the vector out of areas that are not infested.

The following are seen as obstacles to the elimination of the mosquito: lack of sanitation; population growth and migration; rising costs of materials, staff and laboratories; increases in air transportation; possible resistance of *Aedes* to insecticides; the low priority attached to the program, alongside lack of resources, inadequate administration and lack of technicians; lack of community participation; weak implementation of the international sanitary regulation, which aims to prevent reinfestation in countries that are free of the vector (Uribe 1983, Ministério da Saúde 1991b).

Institutional control and social conditions - A survey carried out on household income revealed that, on average, 61.2% of Brazil's population can be classified as "destitute", "indigent", or "poor" and the southeast is in line with the national average; as for services, 33.8% of the nation's homes lack proper water supply and 39.8% have no garbage collection (*IBGE 1984, apud Possas 1989*). In 1990, 82.6% of the towns and 80% of the inhabitants in the State of Rio de Janeiro had access to the supply of running water (CABES 1992). Nevertheless, water supply in poor town districts and slums is often irregular, leading to the necessity for storing water in vessels.

The epidemiological surveillance system is chronically defective, notwithstanding individual efforts. There are only three national laboratories for dengue diagnosis, considered quantitatively insufficient.

The National Health Fundation's vectorial attack and surveillance campaigns have covered 20% of Brazil's municipalities, with 11,000 staff working throughout the country in 1989, and with fewer staff in 1990; this figure increased next due to temporary hising in several municipalities (Brazilian Ministry of Health).

However, it must be realized that to carry out PI alone in all of the affected Brazilian municipalities would involve extremely high costs, considering the urban growth rate, which in turn demands resources for other social priorities.

In the State of Rio de Janeiro, the regional office of the National Health Foundation carried out a dengue control intensification program in 13 municipalities for a period of six to twelve months beginning in October 1991 in which the resources allocated for personnel alone were on the order of 23 million dollars and in which costs of equipment, inputs, and vehicles were some 110 million dollars for the same year (Ministério da Saúde 1991a). The program, which was directed towards combatting the vector, did not include community participation, nor integration with basic sanitation activities.

Unfortunalety, in reality, the traditional dengue control program treats the issue more "symptomatically" than "etiologically". The later approach would mean directly combatting the conditions that favor proliferation of mosquitoes, that is, it would require providing basic sanitation in the form of regular distribution of running water and systematic garbage collection. In view of the high cost of government dengue control programs and the complexity inherent to their implementation (particularly in a country like Brazil, with continental dimensions), it should be acknowledged that to allocate resources for sanitation measures would not only be essential for controlling dengue; it would also help reduce the incidence of other endemic and epidemic diseases associated whith the same deficiencies in the country's sanitary infrastructure.

SOCIAL CONTROL OF DENGUE: A POSSIBILITY

Social development occurs in parallel with political recognition of the rights of citizens. The tendency today is towards the translation of this principle from words into action. Control by the community, like any other form of control, requires planning, and a basic structure is essential.

Health Councils - Given the current drive towards a greater role for local and municipal government and the possibility that health care could be organized at the local level, it may be that social control of diseases will now become more viable, with the support of new political structures and a more workable technical administrative apparatus.

Under the State Constitutions of April 5, 1990, the State Health Councils are seen as consultative institutions representing all levels of society; they are intended to offer avenues for community participation, as provided for in the National Constitution (Article 198, Section III and Article 204, Section II). The chapter on health in the Law on Municipal Institutions lays down "that the Municipal Council is responsible for formulating strategies and for monitoring the pratical implementation of health policies arising from these strategies..." - Act 142, of December 28, 1990. The law adds that the establishment of a Council is an essential prerequisite for municipal participation in the Sistema Único de Saúde, and for receipt of financial resources for health programs. The law adds that 12 of their members (representing the local community and trade unions) should be health service users, and another 12 (representing health professionals and private and public health services) should be health service providers.

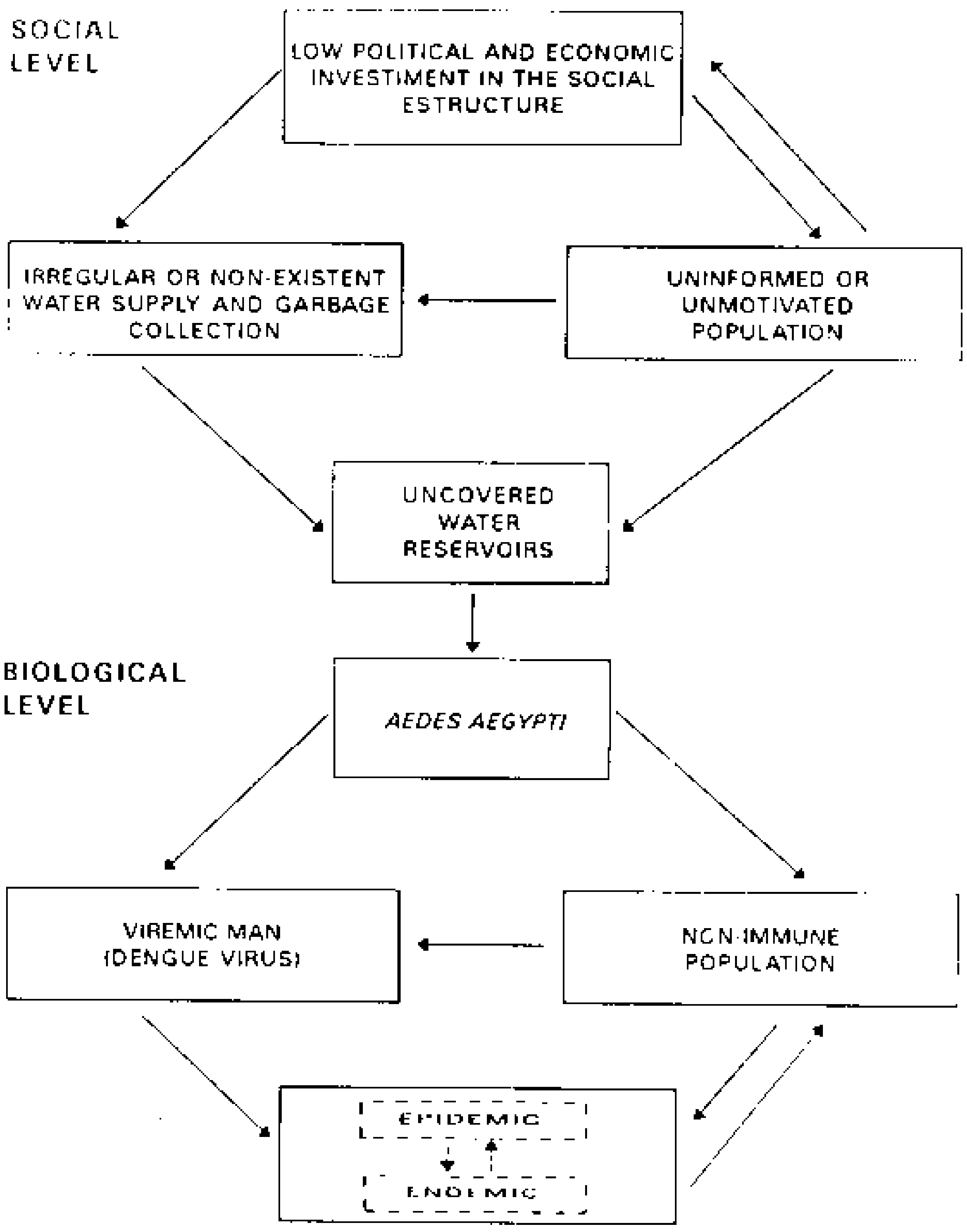
Within the Community - The high frequency of dengue over the last five years, in Rio de Janeiro, mainly in the poorer urban zones, has given rise to work in terms of information and discussion with local communities, yet without any connection to biomedical control studies. In the ward of Leopoldina, the local community association has taken a lead in setting up a program that includes local health professionals and teachers from the National School of Public Health, who, together, have participated in the production of dengue information packages: the community also has its own newspaper (Valla 1992). The participation of representatives from these different groups in future Health Councils would reinforce existing projects and stimulate the initiation of new ones.

ECOLOGICAL INTERRELATIONS AND THE OCCURENCE OF DENGUE - A FEW REFLECTIONS

What do we mean when we speak of ecological models of a infection? We may mean two different things: first, a situation in which exists a controled relation between aspects that are potential determinants of the disease, and in which there is a low probability of clinical manifestation; this ecological paradigm can be called the *ideal ecological model.* Or, second, we may be referring to a modification of the relevant elements and/or of the relations between them, leading to a collective manifestation of the disease; this can be called *ecopathological model.*

Viewed in this light, the presence of the disease in a given community, both endemically (constantly, and non-sporadically) and above all epidemically, presupposes the existence of an "ecopathological model", by definition negative for society, which must be corrected. To this end, the first step is to characterize it in sufficient depth and detail.

The ecological model of dengue, whether in its epidemic or endemic manifestations, includes not only the three elements of the so-called epidemiological chain - susceptible, vector and source of infection (the viremic symptomatic or asymptomatic person), all of which are necessary, though not sufficient, for the model to stand - but also all the "associated elements" acting on and changing each of the three "basic elements"



Basic ecological model of dengue

(Fig.). These basic and associated elements, may present regional peculiarities that are biological, social, politics and cultural in nature (Audy 1972). Hence the need for field and laboratory expertise in these areas here in Brazil.

ACTION ON THE ECOLOGICAL MODEL OF THE DISEASE

To transform the ecopathological model into the ideal ecological model, we must act together on the basic elements in the chain, directly and through their various associated elements, using the appropriate and specific approaches.

Direct action on the "basic elements" - Action on individuals: susceptible or sources of infection - Direct action on susceptible individuals could involve protection against vector bites or work on the immune response. The methods available for protection against the vector - repellents, clothing, screens and/or mosquito nets - are neither sufficient nor practical.

The immune response induced by the natural infection is permanent, but serotype-specific. Theoretically, therefore, full immunity to dengue can only be achieved after four infections, with or without establishment of the clinical disease. As for vaccination, this is a possibility that could start to take shape over the medium run (Rice 1990). Experimental studies, mainly with serotype 2 and 4 proteic antigens, have produced variable results (Deubel et al. 1988, Bray et al. 1989, Falgout et al. 1990, Feighny et al. 1992). Better prospects appear to result from attenuated dengue vaccine (Angsubhakorn et al. 1988). It would be the most efficient method, assuming that the vaccine involved was not only effective against all serotypes and harmless to all age groups, but also gave long-term protection at an acceptable cost when administered in mass immunization campaigns.

The known source of infection, at least in urban areas, is the infected person, but only 10% of infections produce symptoms (WHO 1986). There will always be a greater number of asymptomatic cases, whether or not the situation is epidemic.

Action on the vector - Since are still remotes the production's perspectives of anti-dengue vaccine controlling the disease must depend on achieving a substancial and permanent reduction in the vector population.

In addition to conventional methods using chemical insecticides, direct action on the vector embraces a number of new methods (as yet not fully established) which employ biological insecticides.

Chemical insecticides require monitoring and control of toxicity and vector resistance. In Brazil, the most commonly used chemicals are organophosphates, since the *Aedes* strains that reinfested the country are resistant to organochlorines (Uribe 1983). However, checks are not being carried out on possible resistance to organophosphates, how has occurred with other mosquitoes (Luh & Zhu 1983). As for toxicity, organophosphates administered in the form of Temefos (Abate), granulated at 1%, are considered safe when used to kill larvae in water storage facilities, even in drinking water (one part per million) (Jukes 1983). However, the potential toxicity of these chemicals when applied at higher concentrations, as adulticides, using ultra low volume or thermal mist sprayers, is a matter that requires further investigation on ordinary people and on the environment. Safety controls are only indicated for spray teams.

Recent assessments suggest that these techniques have only been moderately effective in blocking disease transmission (Newton & Reiter 1992), even when carried out as part of a large-scale and carefully controlled program (Eamchan et al. 1989).

Control measures based on biological competition between insect larvae and fish in *Ae. aegypti* breeding grounds have given variable results (Annis et al. 1989, 1990, Wang et al. 1990). The use of *Bacillus thuringiensis var. israelensis* as a larvicide seems promising (Mulla et al. 1986, Mulla & Sing 1991). However, these methods require measures beyond basic intervention by technicians, and also require some level of collaboration from the local population.

In the case of dengue, two factors stand out: knowledge of vector biology and human influence (Frankie & Ehler 1978, Defoliart et al. 1986, Degallier et al. 1988). However, the latter varies from one situation to the next; its necessary to consider the context of each community where control is necessary.

Indirect action on the basic elements of transmission - Causal disease factors are not static. If they were, they could simply be removed. On the contrary, they are part of an overall interaction including the specific laws of biological processes, within broader social life (Breilh 1991). In a given population, significant levels of dengue transmission, after dengue virus introduction can only occur when there is "adequate" density both in terms of the vector and of the susceptible individuals, directly proportional to the density of susceptible vectors and inversely proportional to the concentration of immune individuals.

Aedes proliferation is associated with the presence of bodies of clean water in the environment, and in particular with uncovered stores of water for consumption, as well as with the accumulation of rainwater in discarded/unused containers or in other receptacles (Moura Lima et al. 1988). A high level of human concentration is associated with urban areas and is generally most acutely evident in poorer zones. Poverty, in turn, creates conditions that favour *Aedes* proliferation, namely a precarious service infrastructure, of which the most salient features in this instance centre on water supply and garbage collection.

Another important factor is the level of information and motivation in any particular population. With regard to dengue, information campaigns using local media resources can play a useful role. Motivation, however, depends on the specific social and cultural context of each community. Even when low income communities have been provided with sufficient theoretical information, they are prey to numerous other problems, some of which are more pressing than the possibility of sickness. Daily survival, in particular, imposes a range of priorities, amongst which avoiding sickness is only one of many. We believe that these priorities tend to be ranked as follows: obtaining food, finding somewhere to leave children during working hours, and dealing with sickness. Difficulties in our country arise because of the high cost of food, the lack of daycare centers and schools, and the inadequacy of health services. The dissemination of information to prevent dengue requires changes in educational habits along with an associated assumption of new responsibilities.

In addition, the colonialist imprint on the culture translates as "I give the orders and you carry them out". Or, to put it less starkly, "I will teach you" "you ought to do this". This, between people who are socially and/or culturally distinct and in practice are differentiated according to whether or not they have decision-making power.

In a negative sense, the relationship between "superior" and "inferior" arises from the traditional incapacity of the inferior to express an opinion. The negative reaction of the population in the face of any change whatsoever arises from the fact that it does not have adequate means of participation at its disposal.

Audy (1972) and Dias (1986) make several excellent observations in their discussion on the system of community participation in health programs - the latter quotes Macedo (1984) who drew attention to the fact that, to be effective, participation must be based on "mechanisms that allow all interested parties, at every level, in one way or another, to express their needs and their perceptions of how those needs should be met". The former consider separetely the distinct group of people, actively or passively, involved with programs of vector control and the communication that is essential between them.

Recently, the loss of political references in the world, the exacerbation of social problems lacking any apparent prospect of solution and a general destabilization of our institutions that provide public health care services, aggravate these problems.

In the final analysis, the key word is participation; but, far from being a glib password to solutions, it is a concept that implies an understanding and clear exposure of institutional relations at every level of our culture, whether human, social, or political.

A PROPOSAL FOR ECOLOGICAL CONTROL OF DENGUE

Research with community participation is complex, requiring a professional acceptance of living with uncertainty, confronting differences in social class and culture and daring to seek new ways to make science (Dias 1991). It is not uncommon for health professionals to underestimate the population's potential for action and reaction and to insist on the need for traditional hierarchical structure (Freyens 1993). This can be true for both researchers and community-based health agents; thus the practical difficulty in sizing multidisciplinary interaction and, by inference, multicausality for a given ecological phenomenon.

An active community response to the ecological model of dengue, of which the community itself is a part, implies not only a direct attack on the vector but also a change in the community's attitude towards the surrounding conditions that favor both dengue and other diseases associated with those same conditions, i.e., a shift towards a less passive posture in the face of a precarious environment.

In theory it should be possible to create conditions in which a community could take action against the vector without external assistance. We need to develop an approach that would make this possible. This would bring dividends, not only in the fight against dengue, but also in terms of a wider educational multiplier effect: the community would be better able to respond to other diseases, indeed to any situation involving a range of different ecological interactions, both at the human and biological level.

The first prerequisite for the proposed program is preliminary assessment in the form of a multidisciplinary regional pilot project. The aim, at short term should be to use education, not insecticides, to suppress the conditions that favor transmission; over the medium run, education leading to the exercise of citizenship favors definitive changes in the health infrastructure.

The use of biological insecticides in other projects certainly should not be ruled out. However, biological techniques should only be tried in the context of a different assessment program, which could either be comparative, or, alternatively, could be carried out in parallel to the principal program.

Clearly, social control presupposes prior discussion of the various social roles played by different members of the community, and in particular by health professionals, who may either form part of the community per se or contribute to it as researchers (Smith et al. 1993).

The pilot project should be multi-centred, involving regions with different cultures with emphasis on Rio de Janeiro city.

The project should be carried out by a multidisciplinary team, with interdisciplinary function (Machado 1985) and should include: *Preparatory phase* - Selection of study areas, primarily on the basis of a high incidence of dengue or vector infestation. Other basic information should include knowledge of the sanitary infrastructure, housing conditions, services such as schools, daycare centers, and health clinics, and population density. The study areas would be of two types: (a) communities where social control will be developed, without the use of insecticide; (b) communities with similar socio-economic conditions and incidences of dengue and/or vector infestation, where the institutional type of control program will be developed, using insecticide. *Development phase - Approaching the community* - This would involve assessment of community relations, both internal and external, on the basis of data gathered using whatever methodology was most appropriate to the particular context. Data would include: levels of local information and knowledge concerning transmission and disease sources; the community's principal areas of concern and interest; the extent of local confidence in service providers; data on occupation and unemployment in the community; levels of local representation; the extent of existing channels of information and participation; the history of dengue in the area and the level of popular apprehension in the face of the disease.

Formulating a biosocial methodology, with the participation of community representatives - The aim would be to enhance the community response to dengue control, by increasing participation, by improving the processes of implementation and assessment, and by ensuring the long-term durability of the program.

This would establish the level of correlation in the two types of communities between dengue distribuition - disease (reported cases) and/or infection (established by serological surveys) - and corresponding data on vector distribution (indexes of infestation), and climate, socio-economic conditions and behavioural factors.

Any results would be shared openly with members of the community, in an appropriate form for their level of comprehension, and duly divulged.

Advantages - These include: (1) providing direct information about transmission, clinical manifestations of dengue, and precautionary measures to be taken against this and other transmissible diseases; (2) educating the community how to obtain a better service infrastructure - water supply, sanitation, garbage collection, health care; and equipping the community, with the technical capacity to participate in the Health Councils and other representative institutions;

(3) stimulating community-level epidemiological surveillance, particularly with regard to *Aedes* breeding grounds and suspected cases of dengue, but also including other diseases; (4) facilitating information exchange; (5) creating a multiplier effect for neighbouring communities, either by exploiting their natural proximity and/or by bringing then together through health initiatives that produce results; (6) avoiding community exposure to potentially toxic substances that require systematic control; (7) reducing costs to make the control program feasible and sustainable.

Difficulties - (1) Complexity: field work, especially when it is of an ecological nature, embracing biological, epidemiological and social studies, involves "tackling" a given social context. This requires some level of prior experience, of a kind that can only be expected from a multidisciplinary team. (2) Interdisciplinary activity: this is another challenging area where there is much to be developed, particularly with regard to practical aspects. It must be clear that the specialist should provide his or her especific contribution, but must be aware of this contribution as a part of the whole, to which he or she must be committed and interact with the other parts. (3) Strategy for implementation: a biggest difficulty may lie in obtaining the necessary support for a novel type of research program that breaks with traditional practices. However, there are already signs of a movement in the right direction in government health policies, with these showing a tendency towards delegation of the responsibility for disease control to the community, and towards an abandonment of paternalistic, top-down approches. However, this democratization process needs to be carried out according to clear criteria, in line with the growing capacity of the community to take responsibility. It requires continuous assessment of how much responsibility the community can and should assume at a given time. This is where the technician and the researcher play their roles, supporting policy-makers with their expertise. They need to move in step with political change, or rather, if possible, ahead of it.

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REFERENCES

Angsubhakorn S, Yoksan S, Bhamarapravati N, Moe JB, Marchette NJ, Pradermwong A, Sahaphong S 1988. Dengue - 4 vaccine : neurovirulence, viraemia, and immune responses in rhesus and cynomolgus monkeys. *Trans R Soc Trop Med Hyg 82:* 746-9.

Annis B, Krisnowardojo S, Atmosoedjono S, Jupardi P 1989. Supression of larval *Aedes aegypti* populations in household water storage containers in Jakarta, Indonesia, through releases of fish-instar *Toxorhynchites splendens* larvae. *J Am Mosq Control Assoc 5:* 235-238.

Annis B, Nalim S, Hadisuwasono W, Boewono DT 1990. *Toxorhynchites amboinensis* larvae released in domestic containers fail to control vectors in a rural village in Central Java. *J Am Mosq Control Assoc 6:* 75-78.

Audy JR 1972. Aspects of human behavior interfering with vector control, p. 67-82. In *Vector Control on the Recrudescence of Vector-Borne Diseases*. PAHO, Scientific Publication No. 238.

Bellorin GE 1991. *La participación comunitaria en el control del Aedes aegypti em Honduras durante 1989 a 1990* (Mimeog.).

Bray M, Zhao BT, Markuff L, Eckels KH, Chanock AM, Lai CJ 1989. Mice immunized with recombinant vaccinia virus expressing dengue 4 virus structural proteins with or without nonstructural protein NS1 are protected against fatal dengue virus encephalites. *J Virol 63:* 2853-6.

Breilh J 1991. *Epidemiologia: Economia, política e saúde*. Editora UNESP, São Paulo, 276 pp.

CABES - Catálogo Brasileiro de Engenharia Sanitária e Ambiental, 1992. Situação do Saneamento Básico no Estado do Rio de Janeiro, XVI, Parte I, Informação, 127-131.

Chimelli L, Hahn MD, Barreto Neto M, Ramos RG, Dias M, Gray F 1990. Dengue: neuropathological findings in 5 fatal cases from Brazil. *Clinical neuropathology 9:* 157-162.

Defoliart GR, Watts DM, Grimstad PR 1986. Changing patterns in mosquito-borne arboviruses. *J Am Mosq Control Assoc 2:* 437-455.

Degalier N, Herve JP, Travassos da Rosa AP, Sá GC 1988. *Aedes aegypti* (L.): importance de sa bioecologie dans la transmission de la dengue et des autres arbovirus. Premiere partie. *Bull Soc Pathol Exot Filiales 81:* 97-110.

Deubel V, Kinney RM, Esposito JJ, Ropp CB, Vorndam AV, Monatk TP, Trent DM 1988. Dengue 2 virus envelope protein expressed by a recombinant vaccinia virus fails to protect monkeys against dengue. *J Gen Virol 69:* 1921-1929.

Dias JCP 1986. Participação comunitária em programas de saúde. *Rev Bras Malariol D Trop 38:* 103-110.

Dias RB 1991. Envolvimento comunitário na pesquisa e no manejo das doenças tropicais - a questão da modernidade. *Rev Soc Bras Med Trop 24* (Supl. II): 203-204.

Diaz A, Kouri G, Guzman MG, Lobaina L, Bravo J, Ruiz A, Ramos A, Martinez R 1988. Description of the clinical picture of dengue hemorrhagic fever/dengue shock syndrome (DHF/DSS). *PAHO Bull 22:* 133-144.

Eamchan P, Nisalak A, Foy HM, Chareonsook DA 1989. Epidemiology and control of dengue virus infections in Thai Villages in 1987. *Am J Trop Med Hyg 41:* 95-101.

Falgout B, Bray M, Schlesinger JJ, Lay CJ 1990. Immunization of mice with recombinant vaccinia virus expressing authentic dengue virus nonstructural protein NS1 protects agains lethal dengue virus encephalites. *J Virol 64:* 4356-63.

Feighny R, Burrous J, Mccown J, Hoke C, Putnak R 1992. Purification of native dengue 2 viral proteins and the ability of purified proteins to protect mice. *Am J Trop Med Hyg 47:* 405-412.

Franco O 1976. *História da Febre Amarela no Brasil*. Ed. Ministério da Saúde, Brasil, 208 pp.

Frankie GW, Ehler LE 1978. Ecology of insects in urban environments. *Ann Rev Entomol 23:* 367-387.

Freyens P, Mbakuliyemo N, Martin M 1993. How do health workers see community participation? *World Health Forum 14:* 253-257.

Gomez-Dantes H 1991. El Dengue en las Americas. Un Problema de Salud Regional. *Salud Publica Mex 33:* 347-355.

Gubler DJ 1987. Current research on dengue, p. 37-56. In KF Harris. *Currents topics, in vector research.* New York, Springer-Verlag.

Gubler DJ 1989. Surveillance for dengue and dengue hemorrhagic fever. *PAHO Bull 23:* 397-404.

Guzman MG, Kouri G, Martinez E, Bravo J, Riveron R, Soler M, Vasquez S, Morier L 1987. Clinical and serological study of Cuban children with dengue hemorrhagic fever/dengue shock syndrome (DHF/DSS). *PAHO Bull 21:* 270-279.

Halstead SB 1990. Global epidemiology of dengue hemorrhagic fever. *Southeast Asian J Trop Med Publ Health 21:* 636-645.

Herrera-Basto E, Prevots DR, Zarate ML, Silva JL, Sepulveda-Amor J 1992. First report outbreak of classical dengue fever at 1700 m above sea level in Guerrero State, Mexico, June 1988. *Am J Trop Med Hyg 46:* 649-653.

Jukes TH 1983. *DDT - Retrospective Comments.* In *Integrated Mosquito Control Metodologies.* Vol. 1. Ed. Laird & Miles, London, Academic Press, 396 pp.

Kouri G, Valdez M, Arguelo L, Guzman MG, Valdés L, Soler M, Bravo J 1991. Epidemia de dengue en Nicaragua, 1985. *Rev Inst Med trop S Paulo 33:* 365-371.

Lloyd LS, Winch P, Ortega-Canto J, Kendall C 1992. Results of a community - based *Aedes aegypti* control program in Merida, Yucatan, Mexico. *Am J Trop Med Hyg 46:* 635-642.

Luh PL, Zhu CP 1983. Mosquito control in the people's Republic of China, p. 85-101. In *Integrated Mosquito Control Methodologies.* Vol. 1. Ed. Laird & Miles, London.

Macedo CG 1984. Saúde nas Américas, perspectivas para o ano 2000. *Rev Saúde Públ S Paulo 18:* 67-74.

Machado PA 1985. *Ecologia humana.* S. Paulo, Ed. Cortez/Autores Associados, 173 pp.

Martinez-Torres E 1990. *Dengue hemorragico en niños.* Bogotá, Ed. Ministerio de Salud, Colombia, 141 pp.

Martinez-Torres E, Dotres-Martinez C, Guzman G, Kouri G 1985. *Dengue hemorragico en el niño.* Ed. Universidad Faria - UASD, Santo Domingo, 223 pp.

Marzochi KBF 1987. Dengue - our newest "pet" endemic disease. *Cad Saúde Públ 3:* 137-141.

Marzochi KBF 1991. Dengue - Classificação Clínica, 1991. *Cad Saúde Públ 7:* 409-415.

Marzochi KBF 1992. Dengue - *JBM 62:* 116-131.

Marzochi KBF, Carneiro MB, Schatzmayr HG, Nogueira R, Ewerton E, Souza RV 1987. A dengue no Rio de Janeiro - modelo clínico-laboratorial. *Rev Soc Bras Med Trop 20* (Supl.): 29.

Marzochi KBF, Simões S, Souza R, Nogueira R, Schatzmayr H, Soares AM, Fernandes N, Cuba J, Campos D, Carneiro M, Rocha R, Ewerton E 1991. Dados clínico-laboratoriais de dengue tipo 1: comparação entre 562 casos confirmados e 120 não confirmados do Hospital Evandro Chagas - FIOCRUZ, Rio de Janeiro. *Rev Soc Bras Med Trop 24* (Supl. II): 121-22.

Miagostovich MP, Nogueira RMR, Cavalcanti SMB, Marzochi KBF, Schatzmayr HG 1993. Dengue epidemic in the state of Rio de Janeiro, Brasil; virological and epidemiological aspects. *Rev Inst Med trop São Paulo 35:* 149-154.

Ministério da Saúde, Brasil, 1987. *Combate aos Vetores de Febre Amarela e do Dengue. Aedes aegypti/Aedes albopictus.* Brasília, Ed. Superintendência de Campanhas, Ministério da Saúde, 103 pp.

Ministério da Saúde, Brasil, 1991a (março). *A situação epidemiológica do Dengue no Brasil.* Brasília, Fundação Nacional de Saúde (Mimeog).

Ministério da Saúde, Brasil, 1991b. *Programa de Controle de Febre Amarela e Dengue.* Brasília, Fundação Nacional de Saúde. Centro Nacional de Epidemiologia (Mimeog).

Moura Lima M 1988. Biologia e Controle do *Aedes albopictus,* p. 215-217. In *Simpósio Internacional sobre Febre Amarela e Dengue.* Fundação Oswaldo Cruz, Ministério da Saúde, Rio de Janeiro.

Moura Lima M, Aragão MB, Amaral RS 1988. Criadouros de *Aedes aegypti* encontrados em alguns bairros do Rio de Janeiro, Brasil, em 1984-86. *Cad Saúde Públ 4:* 293-300.

Mulla MS, Darwazeh HA, Aly C 1986. Laboratory and field studies on new formulations of two microbial control against mosquitoes. *Bull Soc Vector Ecol 11:* 255-263.

Mulla MS, Sing N 1991. Delayed mortality and morfogenetics anomalies induced by the microbial control agent *Bacillus thuringiensis* ser. (H-14) in *Culex quinquefasciatus. J Am Mosq Control Assoc 7:* 420-423.

Newton EAC, Reiter P 1992. A model of the transmission of dengue fever with an the evaluation of the impact of ultra-low volume (ULV) insecticide applications on dengue epidemics. *Am J Trop Med Hyg 47:* 709-720.

Nogueira RMR, Miagostovich MP, Cavalcanti JMB, Marzochi KBF, Schatzmayr HG 1992. Levels of IgM antibodies against dengue virus in Rio de Janeiro, Brazil. *Res Virol 143:* 423-427.

Nogueira RMR, Miagostovich MP, Lampe E, Schatzmayr HG 1990. Isolation of dengue virus type 2 in Rio de Janeiro. *Mem Inst Oswaldo Cruz 85:* 253.

Nogueira RMR, Schatzmayr HG, Miagostovich MP, Farias MFDB, Farias Filho JC 1988. Virological study of a dengue type 1 epidemic at Rio de Janeiro. *Mem Inst Oswaldo Cruz 83:* 219-225.

OPAS - Organización Panamericana de la Salud 1990. *Febre hemorrágica del dengue en Venezuela.* Bol Epid., 11 (Edición especial).

Osanai CH, Travassos da Rosa APA, Tang AT, Amaral RS, Passos AD, Tauil PL 1983. Surto de Dengue em Boa Vista, Roraima. Nota Prévia. *Rev Inst Med trop São Paulo 25:* 53-54.

Phillips I, Need J, Escamilla J, Collan E, Sanchez S, Rodriguez M, Vasquez L, Seminario J, Beltz T, Da Rosa AT 1992. First documented outbreak of dengue in the Peruvian Amazon region. *Bull Pan Am Health Organ 26:* 201-207.

Pinheiro FP 1989. Dengue in the Americas, 1980-87. *Epidem Bull Pan Am Health Organ 10:* 1-8.

Possas C 1989. *Epidemiologia e sociedade, Heterogeneidade Estrutural e Saúde no Brasil.* Ed. HUCITEC, São Paulo. 271 pp.

Rice CM 1990. Overview of flavivirus molecular biology and future vaccine development via recombinant DNA. *Southeast Asian J Trop Med Public Health 21:* 670-677.

Schatzmayr HG, Nogueira RMR, Travassos da Rosa APA 1986. An outbreak of dengue virus at Rio de Janeiro. *Mem Inst Oswaldo Cruz 81:* 245-246.

Siler JF, Hall M, Hitchens AP 1926. Dengue, its history, epidemiology, mechanism of transmission, etiology, clinical manifestations, immunity and prevention. *Philippi J Sci 29:* 1-302.

Schultz GW 1989. Cemetery vase breeding of dengue vectors in Manila, Republic of Philippines. *J Am Mosq Control Assoc 5:* 508-13.

Smith SE, Pyrch T, Lizardi AO 1993. Participatory action research for health. *World Health Forum 14:* 319-324.

Sumarmo SPJ, Wulur H, Jahja E, Gubler DI, Suharyono W, Sorrensen K 1983. Clinical observations on virologically confirmed fatal dengue infections in Jakarta, Indonesia. *Bull WHO 61:* 693-701.

Swaddiwudhipong W, Chaovakiratipong C, Nguntra P, Koonchote S, Khumklam P, Lerdlukanavonge P 1992a. Effect of health community participation in control of dengue hemorrhagic fever in an urban area of Thailand. *Southeast Asian J Trop Med Public Health 23:* 200-206.

Swaddiwudhipong W, Lerdlukanavonge P, Khumklam P, Koonchote S, Nguntra P, Chaovakiratipong C 1992b. A survey of knowledge, attitude and pratice of the prevention of dengue hemorrhagic fever in an urban community of Thailand. *Southeast Asian J Trop Med Public Health 23:* 207-211.

Travassos da Rosa APA, Vasconcelos PFC, Travassos da Rosa JFS, Guerreiros SC 1989. Isolation of dengue 2 virus from a human travelling from Luanda, Angola, and first isolation of this virus in Brazil. *Anthropod Borne Virus Information Exchange,* December, p.1.

Uribe LJ 1983. El problema del control de *Aedes aegypti* en Americas. *Bol Of Sanit Panam 94:* 473-481

Valla VV 1992. Educação, saúde e cidadania: investigação científica e assessoria popular. *Cad Saúde Públ 8:* 30-40.

Vasconcelos PFC, Travassos da Rosa ES, Travassos da Rosa JFS, Freitas RB, Degalier N, Rodrigues SG, Travassos da Rosa APA 1993. Epidemia de febre clássica de dengue causada pelo sorotipo 2 em Araguaina, Tocantins, Brasil. *Rev Inst Med trop São Paulo 35:* 141-148.

Wang CH, Hwang JS, Lay JR 1990. Preliminary study of the biological control of dengue vectors by fish in Liouchyou Prefecture Pisingthung County, Taiwan. *Kao Hsiung I Hsueh Ko Hsueh Tsa Chin 6:* 382-388 (abstract).

WHO - World Health Organization 1975. *Technical guides for diagnosis, treatment, surveillance, prevention and control of dengue haemorrhagic fever.* World Health Organization. Geneva.

WHO - World Health Organization 1986. *Dengue haemorrhagic fever, diagnosis, treatment and control.* World Health Organization. Geneva.

WHO - World Health Organization 1992. *Dengue: Venezuela.* Weekly Epidemiological Record, No. 4, jan.