VECTOR BIONOMICS
IN
THE EPIDEMIOLOGY AND CONTROL
OF MALARIA

PART II

THE WHO EUROPEAN REGION
AND
THE WHO EASTERN MEDITERRANEAN REGION

VOLUME II
APPLIED FIELD STUDIES

SECTION I: AN OVERVIEW OF THE RECENT MALARIA SITUATION
AND CURRENT PROBLEMS

SECTION II: VECTOR DISTRIBUTION

PREPARED BY A.R. ZAHAR
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SECTION II: VECTOR DISTRIBUTION

PREPARED BY

A.R. ZAHAR

FORMER WHO ENTOMOLOGIST

*Literature search ceased at end December 1988.

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VOLUME II: APPLIED FIELD STUDIES

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FOREWORD

The present series, PART II of Vector Bionomics in the Epidemiology and Control of Malaria covers a very wide geographical area comprising two of the WHO Regions: The European and the Eastern Mediterranean. VOLUME I of this series which has already been issued, dealt with Vector Laboratory Studies.

This is to introduce VOLUME II, Applied Field Studies consisting of this and two subsequent documents. In a special section, the recent information on imported malaria and its implication in continental Europe and non-European countries of the Mediterranean Basin, is presented. Actions taken to overcome the problem and prevent the consequences of imported malaria, including those taken by WHO to assist countries have been reviewed.

From field studies in different countries of the geographical area under review, a wide spectrum of aspects of vector bionomics has been compiled and gaps in knowledge have been outlined. Likewise, epidemiological studies and control experiences as well as information on the malaria situation in countries of the two Regions have been amply summarized. Thus, epidemiologists and entomologists, particularly those assigned at a central or district level of the Primary Health Care system in countries undertaking antimalaria activities, can find background knowledge from their own or neighbouring countries in the two Regions. This will assist them in planning or reorientating malaria control at peripheral and district level, avoiding duplication of studies or repeating unsuccessful attempts. The background will also assist central planners and consultants to pursue the tasks assigned to them without spending much time on tracing previous information.

The whole series represents a valuable material for training courses in malaria epidemiology and control to be conducted at national or international level.

Dr J.A. Najera
Director of the Division of Control of Tropical Diseases (CTD)
INTRODUCTION

VOLUME I of the present series has been devoted to "VECTOR LABORATORY STUDIES" (Document VBC/88.5 - MAP/88.2). VOLUME II has been designed to compile "APPLIED FIELD STUDIES". Despite the fact that the present series deal with the geographical area covered by the WHO European Region and the WHO Eastern Mediterranean Region combined, it has been found more appropriate to divide this area into: the European Region and the Mediterranean Region irrespective of the WHO Regional boundaries. Also for the purpose of the present series, the latter Region has been further divided into two sub-regions: The Mediterranean Basin and Asia West of India as shown in Fig. 1 and explained in detail in the text.

The present document is the first issue of VOL. II comprising two sections.

- SECTION I: dealing with the status of malaria eradication in the European Region, the situation of imported malaria and associated problems including induced and accidental malaria. Since the early 1970's, reports of malaria cases associated with international airports in Europe (for brevity termed "airport malaria") have been increasing and all point to infection being effected by exotic mosquito vectors carried by aircraft coming from malaria endemic areas. These records are retabulated and updated. Also, action taken by countries involved and by WHO as substantiated from meetings and conferences dealing with the problem of imported malaria and protection of international travellers is reviewed. In this section too, synopses of the malaria situation and current problems were given for countries of the Mediterranean Basin and Asia west of India. More details on the malaria situation in these two sub-regions will be shown in subsequent issues of VOL. II: as shown below.

- SECTION II: This section deals with vector distribution in the whole geographical area of the WHO European and the WHO Mediterranean Regions. The range of distribution of each species is illustrated on a series of maps, supplemented with notes showing the areas where a species is acting as an active vector. More details will be given on the local spatial distribution of potential and active vectors in the forthcoming issues of VOL. II: SECTIONS III(A) The Mediterranean Basin, (in press), and III(B) Asia West of India, (in preparation).

A few errors have so far been found in VOLUME I, for which a corrigendum is shown in this document as ANNEX 1.

Acknowledgements of the cooperation of all persons and institutions who contributed to the preparation of this and subsequent documents, are shown in SECTION III(A): Document VBC/90.2 - MAL/90.2.

As from 8 January 1990, the Division of Vector Biology and Control (VBC), the Malaria Action Programme (MAP) and the Parasitic Diseases Programme (PDP) have been disestablished, and a new set up: Division of Control of Tropical Diseases (CTD) has been established. As the present and subsequent documents were near finalization towards the end of 1989, it has been decided to retain in the text the names of the old units, but the names of the units of the new Division will appear in the Acknowledgements in SECTION III(A) (in press).
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FIG. 2 EPIDEMIOLOGICAL ASSESSMENT OF THE STATUS OF MALARIA, 1985

- Areas in which malaria has disappeared, been eradicated or never existed
- Areas with limited risk
- Areas where malaria transmission occurs
SECTION I: AN OVERVIEW OF THE MALARIA SITUATION AND CURRENT PROBLEMS

Information compiled here is derived from WHO sources. Authors' views are also incorporated. In the present compilation, the WHO Regional boundaries are not strictly adhered to, because Algeria is now with WHO/AFRO, Morocco with WHO/KMRO, and Israel with WHO/EURO. Thus, the area under review is arbitrarily divided into: The European Region comprising continental Europe, and the Mediterranean Region comprising the Mediterranean Basin and the zone of Asia west of India which extends from the eastern shores of the Mediterranean to the east up to and including Pakistan (see Fig. 1). The epidemiological assessment of the malaria status in the area under review in 1985 is mapped in Fig. 2.

1. The European Region

1.1 Status of malaria eradication and control: Malaria eradication has been achieved in the European Region except in the Asian part of Turkey. Of a total population of 820 million in this region as estimated in 1985, 383 million live in originally malarious areas (a country or territory is considered malarious when indigenous cases were still reported after 1953). Table 1 shows the countries on the WHO Official Register of areas where malaria eradication has been achieved, and Table 2 provides a supplementary list of malaria-free areas where malaria never existed or has been eliminated before 1953 without specific malaria eradication measures.

An excellent well-documented book was prepared by Bruce-Chwatt & Zulueta (1980) on behalf of the WHO Regional Office for Europe to give the history of malaria in the continent and to commemorate the centenary of the discovery of malaria parasites by Alphonse Laveran in 1880. In a brief introduction the book presented the theories of the origins of malaria in Europe since the last glacial period, followed by a historical account of development of knowledge on malaria and its vectors since ancient Greek and Roman times. The book further dealt with the history of malaria and its disappearance in 24 continental countries including European Turkey and two Mediterranean islands (Malta and Cyprus), either through ecological changes and socioeconomic factors or under specific antimalarial measures. Data of imported malaria and the risk of reintroduction of the disease into malaria-free areas have been shown. For country by country information, the book should be consulted. In concluding chapters, the role of the international organizations in the eradication of malaria from Europe and the future prospects have been well described.

It is worth noting that despite eradication of malaria in the large part of continental Europe by the 1970's, malaria transmission persisted or was renewed in certain countries. From data communicated to WHO by health authorities 20 indigenous cases were reported from Greece, and 2 from Corsica, France in 1972 (Zulueta, 1973, and Postiglione, 1974). [See more recent information under 1.2.1(i) below] The cases from Corsica were reported at the end of an episode of malaria transmission that resulted from imported cases among North African immigrants (see details below).

Table 1.2 WHO Official Register of areas where malaria eradication has been achieved in the European Region

<table>
<thead>
<tr>
<th>Country or area</th>
<th>Date of registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hungary</td>
<td>Mar. 1964</td>
</tr>
<tr>
<td>Spain</td>
<td>Sept. 1964</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>July 1965</td>
</tr>
<tr>
<td>Cyprus</td>
<td>Oct. 1967</td>
</tr>
<tr>
<td>Poland</td>
<td>Oct. 1967</td>
</tr>
<tr>
<td>Romania</td>
<td>Oct. 1967</td>
</tr>
<tr>
<td>Italy</td>
<td>Nov. 1970</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Nov. 1970</td>
</tr>
<tr>
<td>Portugal</td>
<td>Nov. 1973</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>Nov. 1973</td>
</tr>
</tbody>
</table>

1. Extracted from Wld hlth statist. quart. 40 (1987), p. 144, with the adjacent areas of the Afrotropical Region and West India added.
Table 2.1 Supplementary list of malaria-free areas in the European Region

<table>
<thead>
<tr>
<th>Country or territory</th>
<th>Date of notification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Feb. 1963</td>
</tr>
<tr>
<td>Denmark</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td></td>
</tr>
<tr>
<td>Iceland</td>
<td></td>
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<tr>
<td>Ireland</td>
<td></td>
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<tr>
<td>Malta</td>
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<tr>
<td>Monaco</td>
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<td>Norway</td>
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<tr>
<td>San Marino</td>
<td></td>
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<tr>
<td>Sweden</td>
<td></td>
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<tr>
<td>Switzerland</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
</tr>
<tr>
<td>Czechoslovakia</td>
<td>Apr. 1963</td>
</tr>
<tr>
<td>Gibraltar</td>
<td>July 1963</td>
</tr>
<tr>
<td>Austria</td>
<td>May 1963</td>
</tr>
<tr>
<td>Federal Republic of Germany</td>
<td>Feb. 1964</td>
</tr>
</tbody>
</table>

As the USSR has not been shown on the Official WHO Register (Table 1) despite the great advances made in the study of the epidemiology and control of malaria, an attempt is made here to assemble some information on the malaria situation from certain publications written in English. Due to the language problem, the wealth of Russian literature on malaria and its control could not be explored. Bruce-Chwatt (1982) explained that although an official certification of malaria eradication has not been sought from WHO, the virtual eradication of malaria was declared in 1960, citing Sergeev (1968). Zulueta (1973) and Postiglione (1974) who reviewed the data of malaria reported to WHO by countries of Europe in 1972, pointed out that the areas under the consolidation phase were located in the Republics of Azerbaijan, Georgia, Tajikistan, Kazakhstan and Uzbekistan of which only the first two could be considered as part of continental Europe, but no information on the malaria situation in the USSR was received since the first semester of 1970.

From information communicated to WHO by USSR (WHO, 1977 - Wkly Epidem. Rec.) there were 2155 cases of malaria imported into the USSR from 64 countries during 1963-1973. Nearly all these cases were recorded in areas of the USSR which were considered receptive to malaria: 63.4% of these cases were detected in areas where climatic conditions favour the annual transmission of malaria, and the remaining cases were recorded in areas where transmission was occasional. However, it was emphasized that 79.5% were located in towns where the re-establishment of local transmission was unlikely and the remaining 20.5% of cases were seen in suburban and rural areas. Reference was made to experiments showing that local malaria vectors were refractory to exotic P. falciparum strains but susceptible to P. vivax. In the area of annual receptivity to malaria, there were 24 cases of P. vivax caused by local transmission in 10 localities where autochthonous malaria had been eradicated long ago. As a result of prompt antimalarial measures, transmission was interrupted in eight foci in the first year and in the remaining two in the second year.

Measures to counteract the problem of importation of malaria in the USSR were outlined. All Soviet citizens leaving the country for malaria endemic areas are briefed on how to protect themselves from malaria including the use of chemoprophylaxis, house screening, the use of repellents etc. Organized groups such as ship crews, geologists etc. receive regular prophylaxis. All persons entering the USSR from malarious countries such as students, are routinely examined for malaria and other parasitic diseases. All individuals returning from tropical countries are instructed to inform their general practitioners of their medical history and any travel or residence abroad. As soon as imported or induced malaria cases are detected, notification is made by telephone to the responsible Sanitary Epidemiology Station, and by cable to the Ministry of Health of the respective Republic. The extent of preventive measures to be undertaken is determined by the epidemiologist of the station. In areas of high malarial potential (high receptivity coupled with high vulnerability), case detection and vector control measures

are carried out on a regular basis. Training and refresher courses for medical and
laboratory personnel in malaria pathology and laboratory diagnosis and treatment are
regularly organized particularly for staff working in vulnerable areas. Post-graduate
training in medical parasitology including malariology and medical entomology, as well as
in tropical medicine, is organized for medical personnel who are to be sent abroad to work.

Detailed data communicated to WHO on the malaria situation in the USSR in 1981 (WHO,
1983 - Wkly Epidem. Rec.) were as follows: (population in millions)

(a) Total population 267.70
(b) Population in areas originally malarious 253.32
(c) Population in areas claimed to be free from malaria 252.86
(d) Population in areas where transmission is claimed to be interrupted 0.46
(e) Number of malaria cases detected in areas of (c) and (d) -
(f) Population and number of cases in areas under attack phase of
an eradication or a control programme -
(g) Total number of cases reported (imported cases only) 304

More recent information communicated by the USSR to WHO [Mr J. Hempel, Epidemiological
Methodology and Evaluation (EmE), MAP] showed the following data for 1986:
Number of imported cases: 537 of which 516 were detected in areas of the maintenance
phase, and 21 in non-malarious areas. In addition, one introduced case and five
induced cases were detected.
Parasite species: P. falciparum 43.4%
P. vivax 41.2%
P. ovale 11.7%
P. malariae 0.6%
Mixed infections 1.5%
Undetermined 1.1%

Views of Soviet authors on imported malaria in the USSR and recommended measures to
prevent the reintroduction of malaria are shown under 1.2.1 below.

1.2 Imported malaria in Europe and associated problems

Since the early 1970's when the last foci of malaria transmission in continental
Europe were coming to an end, several authors published articles dealing with the extent
of the problem of imported malaria and the related infections of induced and accidental
malaria as well as infections raised by imported anophelines. Some of these publications
are selectively summarized as shown below. In addition, action taken by WHO to assist the
efforts made by countries of Europe to overcome the problem of imported malaria is also
reviewed.

1.2.1 Authors' views

1.2.1 (i) The extent of the problem of imported malaria

It is more appropriate to give first the views of certain authors who dealt with the
problem of imported malaria in continental Europe in general.

Bruce-Chwatt (1970) presented the problem of imported malaria as a growing world
threat. With the increase in international travel, the chances for importation of the
infection into areas free or freed of malaria in various parts of the world are
increasing. The data of imported malaria hitherto reported in France, Germany, Great
Britain, the USSR and USA were reviewed. The problem of induced malaria due to blood
transfusion was also discussed. Regarding Britain, Bruce-Chwatt, Southgate & Draper
(1974) reviewed the records of imported malaria during 1960-1972 and found that the
country had the second highest number of imported cases among the European countries.
During 1970-1972, there was a substantial increase in imported cases, but this may have
been due to improved notification. The average mortality among 323 P. falciparum cases
during those three years was 6.5%. Attacks of P. vivax may occur several months after the
traveller's return from a malarious country.
Zulueta (1973) summarized the data of the malaria situation in continental Europe received by WHO at the end of 1972. The total number of positive cases during that year was 1285, and their classification reported to WHO was as follows:

- **Imported**: 1240
- **Indigenous**: 22 (20 from Greece, 2 from Corsica, France)
- **Relapses**: 4
- **Induced**: 19
- **Introduced**: 0

As can be seen from the above, the imported cases constituted the majority of the reported cases (96.5%). The importation of malaria into Europe has been increasing with the continued increase in air travel as well as the recruitment of labour from outside Europe, coinciding with the resurgence of malaria in recent years in many tropical areas. Zulueta considered that the risk of reintroduction of malaria in northern Europe, despite the presence of An. atroparvus as a potential vector, is nil unless the ecological and socioeconomic conditions are drastically changed. In contrast, the risk of reintroduction of the disease in southern Europe is a real one, as it could result from movement of the population including migrant workers. The small outbreak of malaria that occurred in Corsica during 1971-1972 which was attributed to the presence of infected persons among immigrant workers from North Africa (see details below), points to the high probability of reintroduction of malaria into the Mediterranean countries of Europe. Nevertheless, the receptivity of southern Europe is not well understood, but it must be dependent on such factors as vector density, the degree of vector/man contact, and vector longevity under the prevailing ecological conditions. Zulueta further examined the records of imported cases in Europe received by WHO for the period 1967-1972. The number of imported cases reported by Portugal was nearly half the total number of imported cases reported from Europe. This was due to the return of military personnel and other groups from Portuguese overseas territories who either presented relapses or first infections after their arrival in Portugal. These represented true imported cases. However, the reports from Portugal included these and another group defined as "communicated from overseas territories but found negative in Portugal", and these do not fall within the definition of imported cases. For example in 1972, the number of true imported cases was 584 plus 4400 communicated from overseas territories but found negative in Portugal. Despite the fact that a total of 2447 true imported cases was recorded in Portugal during 1967-1972, no introduced indigenous cases were found in the country. Of the above total of imported cases, there were 434 P. falciparum of tropical origin. In this connection, Zulueta recalled the work of Shute (1940) in the UK, who showed that the English strain of An. atroparvus was not susceptible to P. falciparum of tropical origin but could be infected with Italian P. falciparum. Thus, the refractoriness of local anophelines to tropical strains of P. falciparum may have prevented the reintroduction of this infection in areas of southern Europe, where vector densities and man/vector contact would have been otherwise sufficient for resumption of malaria transmission.

Zulueta further remarked that with the high number of imported P. falciparum recorded in Europe during 1967-1972 (1709 of 5704 cases) deaths should be expected, and in fact 62 deaths were reported to WHO during that period. A delay in establishing the correct diagnosis explains the occurrence of most of these fatal cases. So far, there have been no records of P. falciparum resistance to chloroquine in Europe, but the risk of introduction of such strains from South East Asia and tropical America is increasing, for which clinicians and public health administrators should be alerted.

In his review of the malaria situation in Europe, Postiglione (1974) also presented records of imported malaria cases reported to the WHO Regional Office, EURO, by countries of continental Europe for the period 1967-1972. He considered that these records were generally underestimates for the following reasons:

(a) some benign cases become spontaneously cured without being diagnosed;
(b) certain fatal cases also escape diagnosis;
(c) certain cases escape detection;
(d) in certain countries, the diagnostic facilities were insufficient;
(e) certain countries did not send their reports regularly.
Of a total of 5685 cases reported in 1972, 5640 were imported, 4 relapses, 19 induced and 22 indigenous (20 in Greece and 2 in Corsica, France). The most frequently observed parasite species was P. vivax, followed by P. falciparum, but P. malariae and P. ovale were quite restricted. In 1972, P. falciparum constituted one third of the positive cases. As the infection with P. malariae is long-lived, it poses a particular problem for blood transfusion. P. ovale is probably difficult to identify, and a certain number of cases were shown as "unclassified" because no complementary examination was carried out. The data also showed that the level of imported cases remained approximately identical except in UK and Portugal. The latter country showed a very marked increase in imported cases from 1969. As explained above by Zulueta (1973), Postiglione pointed out that Portugal added to the imported cases those cases which were communicated from overseas territories but found negative when checked in Portugal, although these do not correspond strictly to WHO definition of imported cases. As mentioned above, these cases amounted to 4400 in 1972. Like Zulueta (1973), Postiglione considered the risk of reintroduction of malaria into southern Europe to be high as a result of movement of the human population, giving also the outbreak of Corsica as an example.

To conclude, Postiglione suggested the following measures to deal with the problem of imported malaria in Europe:

- At a national level: The type of action depends on the existence of receptive and vulnerable zones in the country concerned. It is essential to ensure the detection, diagnosis, notification and treatment of imported cases, without being hindered by large numbers of travellers. These activities should be entrusted to the medical and sanitary staff who should receive the appropriate training for applying correctly the diagnostic and treatment procedures. For diagnosis, it is necessary to collect information on the past and present history of suspected cases, and record the time spent in malarious areas. It is necessary also to repeat the parasitological examination of the blood (particularly when the first sample is negative) and to identify the species of the malaria parasite. Regarding treatment, it is important to utilize the antimalarial drugs appropriate to the parasite species for obtaining radical cure which should be confirmed by parasitological examination, and for ascertaining the non-infectivity of the person to mosquitoes. It is also equally important to apply rapidly and correctly the treatment of serious complications of P. falciparum infections which can be fatal particularly in children, if not promptly dealt with. In this respect too, it is necessary to have available antimalarial drug preparations of rapid action and to have facilities for intensive care. Moreover, the receptive countries should organize surveillance particularly for the groups at high risk, and conduct epidemiological and entomological studies. For this, it is necessary to maintain a small group of trained and well-equipped antimalaria personnel. Health education for informing the public particularly the international travellers is an essential measure which requires excellent coordination with companies of sea and air travel, ministries concerned for disseminating information on: malarious zones in the world, preventive measures (chemoprophylaxis), the diagnosis and treatment of malaria, and on the necessity for consulting rapidly a physician in case of an illness that could resemble malaria symptoms. Finally, countries concerned in Europe should conduct periodic evaluation for reassessing the receptivity and vulnerability of different zones and for assessing the effect of the methods adopted.

- At an international level: The principal measures to be undertaken by international agencies should be the collection and dissemination of information, establishment of standard terminology, promoting research, establishing standards for international methodology, coordination of efforts for preventing the resumption of malaria transmission, organizing meetings for exchanging experiences, and assisting countries in conducting training courses.

In the light of their experimental study that demonstrated the refractoriness of the Italian An. atroparvus and An. labranchiae to P. falciparum from East and West Africa, Zulueta, Ramsdale & Coluzzi (1975) [see also Ramsdale & Coluzzi (1975) in VOLUME I, under 2.8.2 (ii), pp. 158-161] discussed the relevance of the findings to the malaria situation in Continental Europe, where 31.5% of the imported cases recorded during 1967-1974, were P. falciparum from tropical countries. Historically, the refractoriness of An. atroparvus must have prevented the spread of P. falciparum in Europe for a considerable time in the past. Only after a long process of selection, the exotic strains of the parasite brought to Europe from Africa or southwest Asia may have become adapted to transmission by the most widespread vector.
In his review of the problem of malaria in the world, Bruce-Chwatt (1979) pointed to the presence of a large reservoir of endemic malaria in most tropical countries. Consequently there is increasing concern about malaria being one of the tropical diseases now frequently reported from Europe, USA and other areas of the temperate zone. The constantly increasing international travel at moderate cost has led to massive importation of communicable diseases into countries where these infections were absent or gradually disappeared with public health developments. About 3000 cases of malaria were imported into Europe in 1977 and more in 1978.

Bruce-Chwatt (1982) devoted a whole review for the world-wide problem of imported malaria with special emphasis on Europe, citing many relevant references. New information on air travel in the world showed that the total number of passengers on scheduled flights exceeded 800 million in 1980, and with the addition of unscheduled (charter) flights, the number was probably over 900 million. Of this total number, about one-quarter were tourists, and this group of travellers is exposed to the risk of contracting tropical diseases. Significant increases in air travel to Asia, Far East, Middle East, Africa and Latin America would point to the future epidemiological problems. Although air travel is the most important route of population movement, the role of land transport is not negligible and more difficult to control. In Europe alone, the number of migrant workers from various countries was about 12 million during the 1970's.

Bruce-Chwatt tabulated the yearly data of imported cases received by WHO from various countries of continental Europe covering the period 1971-1980. The problem of malaria imported from various endemic areas in the world into Europe has become more serious since 1970. The data showed that the total number of imported cases steadily increased from 2868 in 1975 to 4531 in 1978 and 4041 in 1979 while in 1980 it was 3170, but the data for that year were only preliminary. For the whole of Europe, the number of deaths due to malaria during 1971-1979 was 246. The overall mean fatality rate is difficult to calculate. In this calculation only cases of P. falciparum should be used as denominator, as P. vivax and other species rarely cause death. Unfortunately, reliable statistics of P. falciparum cases are not recorded in all European countries. Regarding Britain, the information presented by Bruce-Chwatt, Southgate & Draper (1974) was updated by Bruce-Chwatt (1982). The data of 1973-1980 showed a further rise in the number of imported cases reaching a peak in 1979, but for the first time during the decade, there was a decline in 1980. Over the whole decade, 87.9% of the imported cases in the UK were P. falciparum originating in Africa, while 5.9% of the cases came from other parts of the world. With regard to P. vivax, 73% of the cases came from Asia, but most of P. malariae and P. ovale originated in Africa. Bruce-Chwatt found it difficult to present a meaningful picture of the circumstances of fatal cases of P. falciparum recorded in UK, since the available information of the illness is often scanty and unreliable. During 1974-1980 the total number of fatal cases due to P. falciparum was 38 out of 1966 infections of this species: 30 British, five born in the Indian subcontinent, three foreign visitors, and two of unknown origin. There were two deaths of elderly, Indian-born patients due to P. vivax with ensuing complications. Ten imported cases of congenital malaria were recorded during the period under review and these represent a new phenomenon in the UK. Regarding the time-interval between the return of travellers to the UK and the onset of malaria symptoms, the data of 1395 selected imported cases during 1970-1974 were analyzed. This showed that 92% of P. falciparum patients presented their first clinical attack less than one month after returning to the UK, while only 8% of the patients had their first attack within 2-6 months. With P. vivax and P. ovale infections, 43% of the patients presented the first symptoms within one month after returning, 38% within 2-6 months, 23% within six months to one year, and 4% after more than one year. With P. malariae infections, 76% of the patients presented the first symptoms within 2-6 months after their return, but 23% within 12-18 months. Cases of post-operative malaria not arising from blood transfusion, though being rare, may belong to this group of delayed attacks, and such recurrences of an old infection was reported by other workers. Such delayed attacks particularly in infections with P. vivax may contribute to errors in the diagnosis and treatment. A delayed attack of P. vivax infections may occur after a year or more in strains characterized by a long incubation period, which are common in the temperate zone of the world, but they also occur in some tropical areas. The data of imported malaria in other countries of Europe (viz: France, Belgium, Federal Republic of Germany, Switzerland, Poland, and USSR) as well as USA and Australia were discussed and relevant publications cited. Finally Bruce-Chwatt underlined the importance of surveillance of imported malaria. He explained the risk of renewed transmission by local
vectors as being the product of two epidemiological factors: the receptivity and vulnerability of an area. Receptivity reflects the transmission potential by the local vector during the warm and rainy season, when transmission is likely to occur. Vulnerability expresses the amount of the plasmodial parasite brought into a defined area, either as human carriers, or rather exceptionally, as infected Anopheles. In order to assess the two factors and to protect the human population, the main task of health authorities is to organize epidemiological surveillance. The first-degree prevention would be to undertake measures against importation of carriers of plasmodia or infected vectors. Ideally, this type of prevention would necessitate screening and/or treatment of all persons coming from malarious areas and also the follow-up of their health, but practically this is impossible, although some countries such as Mauritius has applied this measure with some success. The second-degree prevention would be to concentrate on measures against re-establishment of malaria transmission, and this is more applicable in practice. Bruce-Chwatt further stressed the importance of alerting the medical and other professional staff. Equally important is the provision of diagnostic facilities and the availability of an epidemiological surveillance service within the general national health organization which should be able to carry out speedily and efficiently other more specific tasks whenever necessary. One of the best ways of preventing the importation of malaria by tourists and other travellers is the provision of adequate and individual prophylaxis by appropriate antimalarial drugs. This has now become less reliable because of the increasing incidence of strains of plasmodia, especially P. falciparum, resistant to antifolic compounds (proguanil and pyrimethamine), to 4-aminoquinolines (chloroquine and amodiaquine) and even to some newer drug combinations of antifolates and sulphonamides. It is extremely important that information on malaria risk for travellers such as the one published periodically by WHO should be widely distributed not only to the medical and allied professions but also to the travel agencies and general public.

Having shown the views of certain authors on the problem of imported malaria in continental Europe in general, the extent of the problem in several countries as described by various authors is given below starting from the east and moving to the west.

In the USSR, Chagin et al. (1975) indicated that during 11 years (1963-1973) 2155 malaria imported cases from 64 countries were notified. Analysis of data of 1927 cases showed that 976 were P. vivax, 762 P. falciparum of whom 543 were foreign students, 56 P. malariae, 115 P. ovale, and 18 mixed infection (falciparum and vivax). As a result of these imported cases, malaria transmission was re-established and 23 indigenous cases were recorded in 10 localities, where malaria had been absent for many years. The system of malaria prophylaxis in the USSR is effective, but further perfection is needed. Great attention must be paid to the education of medical personnel on malaria peculiarities.

Dašhkova et al. (1978) analyzed the data of 294 cases of malaria (122 in Soviet residents and 172 in foreign residents) imported into Moscow during 1974-1976 from 45 countries. P. falciparum constituted 60.6% of these imported cases. This species came mainly from West Africa and were mostly found in indigenous residents. Among the persons visiting the USSR for the first time, 72.9% were parasite carriers. Patients with acute manifestations of this infection present practically no danger as possible sources for infecting mosquitos, but those who prove to be gamocyte carriers are epidemiologically important in the southern parts of the country where An. sacharovi and An. subalpinus occur. P. vivax malaria (17.2% of the cases) was detected mostly in Soviet citizens infected mainly in South Asia. This parasite is the most dangerous for infecting local vectors and renewal of malaria transmission.

Duhanina et al. (1979) suggested that to deal with problems arising from imported malaria in the USSR, it is necessary to improve and rationalize prophylactic measures, and to intensify scientific investigations as follows:

(a) to study the malarialogenic potentials in areas of agricultural and industrial development as well as those of land reclamation;
(b) to study the ecology of malaria vectors;
(c) to compile the accumulated experience of preventing malaria and its morbidity among the Soviet citizens during their stay abroad;

1. The summaries of this paper and the papers of Kouznetsov & Neulinkin (1984) and Soprunov (1984) have been made through the kind cooperation of Dr R.L. Kouznetsov, WHO Malarialogist, MAP/PAT, WHO, Geneva, by translating parts of the original text.
(d) to apply serological methods for detecting malaria infections among those who return to the USSR;
(e) to determine the susceptibility of local vectors to imported malaria parasite strains.

(f) to continue testing the susceptibility of local vectors to insecticides;
(g) to develop criteria for assessing the natural and socioeconomic factors that would determine the possibility of resumption of malaria transmission;
(h) to develop methods for determining the prognosis of malarialgenic potentials;
(i) to develop and introduce various combinations of antimalarial measures including the integrated approach for vector control.

Kouznetsov & Neuimin (1984) reviewed the problem of imported malaria in the USSR. Most P. falciparum imported cases come from Africa, while P. vivax cases originate in Asia. During the past two years a considerable increase in imported cases going to rural areas in the USSR was observed. In the 1960's, 7.5% of the total imported cases were recorded in rural areas, and in 1982 this percentage increased to 29%. The epidemiological consequences of the importation of malaria into rural areas has been a great increase in the introduced cases, principally P. vivax. While there was only one case of introduced P. vivax during 1974-1979, there were 32 introduced cases detected during 1980-1982. Transmission was effected by the local members of the An. maculipennis complex.

Soprunov (1984) pointed to the large increase in introduced cases in Daghestan ASSR and Tajikistan, all of which were P. vivax. In Tajikistan the number of introduced cases increased to as many as 3-fold and 2.8-fold the total number of indigenous cases in 1981 and 1982 respectively. Of the urgent tasks to deal with the problem of introduced malaria is the need for development of an all-Union special programme for the prevention and control of malaria in order to undertake the following:

(a) to draw a uniform map of malaria foci, and to develop models of epidemiological patterns in foci of different types which should assist in the prognosis of malaria;
(b) to develop differential measures for control of vectors and malaria parasites;
(c) to study anthropogenic changes of landscapes and the changes in the malaria situation especially in the southern republics where intensive work on irrigation and land reclamation is taking place;
(d) for territories where there is a risk of malaria transmission: to develop a uniform system for monitoring the changes in vector density and susceptibility to insecticides as well as the response to various control measures;
(e) to provide instructions for the use of different insecticides;
(f) to provide radical treatment for malaria cases;
(g) to initiate different types of research;
(h) to seek international cooperation for studying the malaria situation abroad.

It should be recalled that Diskova & Rasnicyn (1982) summarized and reviewed the studies carried out in the USSR on the susceptibility of members of the An. maculipennis complex to different imported strains of human malaria parasites. An. atroparvus, An. messeae and An. sacharovi were highly susceptible to strains of P. vivax from tropical Africa, Asia and South America. The first two anopheline species were refractory to tropical strains of P. falciparum from Africa and Asia. An. subalpinus could be infected with an African strain of P. falciparum as sporozoites were found in the salivary glands. Results of experiments with tropical P. falciparum in An. sacharovi were contradictory, because in most experiments infection failed to develop, while in five experiments sporozoites were seen in the salivary glands. [see Vol. I, under 2.8.2 (ii), pp. 160-161].

In Hungary, Wärnä & Banhegyi (1986) pointed out that autochthonous malaria has not been encountered since 1960, and that the number of Hungarians working in malaria endemic areas abroad has been increasing gradually since the 1960's, but the numbers have suddenly increased in recent years. In 1962, compulsory chemoprophylaxis was introduced concurrently with an information programme for all persons assigned to foreign service and compulsory screening examination upon their return to Hungary. The information programme consists of:
- providing the travellers with information on the epidemiological situation in the country of destination stressing the importance and possible ways of protection against mosquito bites.

- supplying the travellers with chemoprophylactic drugs. Chloroquine is provided for travellers going to non-chloroquine P. falciparum resistant endemic areas. The recommended dose for adults is two tablets weekly, containing 300 mg chloroquine base. In cases of long-term service in areas with high chloroquine resistance (R II, R III), the adult traveller is given one tablet of pyrimethamine. Travellers to multi-resistant regions are provided with two separate drugs, to be taken on two separate days of the week. Taking the drugs must be started two weeks before travelling in order to detect any possible side-effects, in which case alternative drugs are provided. Chemoprophylaxis must continue for four weeks after returning home. As part of malaria surveillance compulsory screening examination consists of:

(a) an interview to obtain details of taking the chemoprophylactics (regularity, possible intolerance), previous illness accompanied by fever, malaria history and antimalarial drugs taken for treatment, and the results of parasitological examinations;

(b) physical examination to exclude hepato-splenomegaly.

Parasitological examination of blood is compulsory in Hungary; it is carried out within two days of returning home. The specific IgG type antitest method with Falciparum Spot Test was introduced in 1982 to obtain retrospective data on P. falciparum infection. Since 1981 in-vitro drug sensitivity test for P. falciparum infections has been introduced.

About 20 000 travellers have been provided with chemoprophylactic drugs in Hungary since 1962. Data of 12 780 travellers who spent at least one year in malaria endemic areas were analyzed. The prevalence of malaria infection among 12 300 who took the drugs regularly was 1.2%, while the rate among the remaining 480 who did not take the drugs was 12%, i.e., the risk of contracting malaria infection was 10 times greater in the case of people not taking the antimalarials. For travellers to chloroquine-resistant regions, the combined dosage of chloroquine and pyrimethamine has been recommended since 1981, but data collected so far has not been sufficient to draw a final conclusion. There has been no serious side effects. Individuals provided with chloroquine chemoprophylaxis have had regular ophthalmological examination; in 20 years no chloroquine-induced retinopathy has been observed. As the people screened had taken chloroquine for no longer than four or five years, the total doses of that drug has not exceeded 100 g. In vitro chloroquine-resistance tests made on five cases of P. falciparum detected in the course of three years showed no chloroquine resistance. Finally the authors stressed that malaria infection can occur even with the most thorough chemoprophylaxis. For this reason travellers are provided with therapeutic doses of combined antifolic compounds (Fansidar), and they are advised to take it (6 tablets in 3 days) when they have fever, in the absence of physicians.

In Romania, Teodorescu (1953) discussed the risk of reintroduction of malaria in the light of her experimental infection studies with An. atroparvus using strains of malaria parasites originating from different geographical areas [see VOLUME 1, under 2.8.2 (11), pp. 160-161]. In Moldavia under the maintenance phase, An. atroparvus is very receptive to P. vivax originating from Asia and West India, and to P. ovale from tropical Africa. Bearing in mind also the lack of immunity in the human population, the resumption of natural malaria transmission is highly likely, especially when the detection of imported cases and gametocyte carriers stationed in this zone during the warm season is delayed. The failure to infect An. atroparvus with foreign P. malariae does not exclude this possibility also, bearing in mind that this vector was rarely experimentally infected with a local strain of this parasite. The experiments showing the refractoriness of An. atroparvus to African P. falciparum conform with the findings of other European investigators.

In Bulgaria, Petrov (1977) reported that during 1966-1975 132 cases of imported malaria were registered comprising Bulgarian citizens and foreigners from Africa and Asia. Of 127 cases, there were 68 cases (53.5%) with P. vivax, 48 (37.8%) with P. falciparum, 10 (7.7%) with P. ovale, and 1 (0.8%) with P. malariae. Asymptomatic carriers were prevalent among foreigners, while Bulgarian persons suffered from the acute
disease. Among Bulgarian citizens 50% lived in tropical countries up to one month, and of these there were two who spent only one day. A complex of measures are being applied to protect Bulgarian travellers leaving for tropical countries, and to prevent the spread of malaria from imported cases. Despite favourable climatic conditions and the presence of a high density of potential vectors, no introduced cases have been detected.

In Greece, Belios (1976) presented the history of malaria and its control and the reorientation of its programme towards eradication starting from 1957. He indicated that by 1964 the malaria programme of Greece had achieved its goals, but the application of the WHO criteria for eradication was expected to be applied in 1976. Violaki, Avramidis & Trichopoulos (1976) reported the results of a study of 215 malaria imported cases detected during 1963-1975. Of these, 130 cases were recorded during 1971-1975. The parasite species were: *P. vivax* (45.6%), *P. falciparum* (35.5%) and *P. malariae* (18.1%). The age-group 21-30 years constituted 32.1% of the cases. The geographical distribution of the cases showed that seamen were most affected (46.9%). Most of the imported cases originated from the African Continent. Although Greece is susceptible to the reintroduction of malaria due to its receptivity by the presence of anopheline vectors, the probability of the reappearance of the disease is low because the efficient malaria surveillance network of the public health service is able to detect early and treat the malaria cases entering the country.

From the book of Bruce-Chwatt & Zulueta (1980) it was realized that most of the cases reported in 1973 in Greece originated from Macedonia and Lesbos. A sero-epidemiological survey was carried out in September 1973 in Hemathia, a nomos (prefecture) of Macedonia, using indirect fluorescent antibody test (IFA test), by Bruce-Chwatt et al. (1975). A total of 4605 blood samples were collected representing about 20% of the population of Hemathia, and tested against *P. vivax* and *P. falciparum*. As discussed by these authors, the apparent absence of malaria antibodies detectable by the IFA test in 2965 serum samples from the population of Hemathia under 20 years of age, born since the commencement of intensive malaria control followed by surveillance activities, justifies the conclusion that there has been very little or no malaria transmission in the area in recent years. This conclusion, though plausible, is not absolute; first, because the sample was limited in size, although it covered about 35% of the relevant age-group of the population studied, and secondly, because it is possible that some of the antibodies resulting from recent infections may already have been lost. Bruce-Chwatt & Zulueta (loc. cit.) indicated that epidemiological investigations suggested that most of the cases previously reported from Hemathia were either relapses or not of local origin. Drug administration was applied to a group of gypsies residing in some areas of Hemathia and there were no new cases reported during 1973-1974. Bruce-Chwatt & Zulueta believed that the nomos of Hemathia represented the last focus of indigenous malaria and that its elimination has led to the eradication of malaria in Greece.

From a report of a WHO mission to Greece (S. Goriup, unpublished report to WHO, 1978) the number of malaria cases detected during 1975-1977 was as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Total cases</th>
<th>Indigenous</th>
<th>Relapses</th>
<th>Imported</th>
<th>Introduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>34</td>
<td>2</td>
<td>0</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>1976</td>
<td>41</td>
<td>3</td>
<td>2</td>
<td>32</td>
<td>4</td>
</tr>
<tr>
<td>1977</td>
<td>48</td>
<td>0</td>
<td>3</td>
<td>39</td>
<td>6</td>
</tr>
</tbody>
</table>

The species distribution was: *P. vivax* 41.5%; *P. falciparum* 32.5%; *P. malariae* 16.3%; undetermined 9.7%. Most of the imported cases were found in Athens, Piraeus, East and West Attikis. The imported cases were detected among sea and air personnel, workers, students and tourists originating or having stayed for certain periods in Africa, Asia and the Middle East. The five indigenous cases detected in 1975 and 1976 were all located in four villages in the nomos of Evros in Thrace, very close to the Turkish border. No more positive cases were found in this nomos during 1977. With the exception of Evros, indigenous cases of malaria have not been observed in Greece since 1973, when the last cases were detected in Hemathia nomos. It was recommended that in areas of high receptivity especially in Evros, where malarial potential has increased considerably through the proximity of the Turkish foci, vigilance should be strengthened and
supplemented where appropriate by active case detection through monthly house visits, at
least during the favourable season of anophelines.

In Italy, Coluzzi & Monzali (1979) drew attention to the increasing risk of
reintroduction of malaria with the increase of imported cases. The annual mean number of
imported cases was 33 during 1966-1970, and 51 during 1971-1975. In 1975 and 1976, the
total number of imported cases was 103 and 140 respectively. About 80% of the cases
originated in Africa with the majority being P. falciparum infection, although the
proportion of P. vivax tended to increase in 1976 and 1977. Imported malaria poses two
major problems: first, the delay in diagnosis of P. falciparum infection causes deaths of
those untreated cases; secondly, the delay in adequately treating the imported cases
increases the risk of resumption of malaria transmission in receptive areas. However, the
risk is very low with regard to transmission of P. falciparum because of the poor
receptivity of anophelines in Italy to this infection, but this is not valid for P. vivax.

Coluzzi (1980) indicated that entomological investigations carried out recently in
Italy demonstrated that in certain areas Anopheles vectors of malaria particularly
An. sacharovi and An. labranchiae disappeared or became very rare. This has not resulted
from anti-vector measures but from environmental changes. Thus, high
densities of An. labranchiae have been reported from some sectors in Lazio of Viterbo
province and Toscana in Grosseto province, as well as in Calabria, Sicily, and Sardinia.
The author reiterated that the risk of transmission arises from the delay of diagnosis of
imported cases or in giving the appropriate treatment. Poor receptivity of
An. labranchiae to exotic P. falciparum reduces the risk of transmission of this
infection, unlike imported P. vivax, but on the whole receptivity is low due to the fact
that the Anopheles population has shown marked deviation from endophily and anthropophily
coupled with reduction in longevity.

Entomological surveys carried out by Bettini et al. (1978) in San Donato locality and
surroundings in central Italy, provided evidence that the newly introduced rice
cultivation has greatly increased the density of An. labranchiae populations from unknown
pre-existing breeding foci [see more details in SECTION III(A) under (1) 1.2 in document
VBC/90.2 - MAL/90.2]. The situation was viewed with concern as resumption of malaria
transmission appeared to be a possible event in view of the following factors:

(a) the very high density of the potential local vector and the extension of rice
fields;

(b) the proximity of the breeding places to human settlements; the town of Albinia
with 1500 inhabitants as well as camping sites having a capacity of 10 000 visitors are
situated at about 2 km from the town;

(c) the high rate of exchange of the summer camping populations;

(d) the constant increase of microscopically confirmed imported cases; and

(e) the absence of acquired immunity to malaria of the local population under 30 years
of age.

Referring to the experiments of Zulueta, Ramsdale & Coluzzi (1975) and Ramsdale &
Coluzzi (1975) [see VOL. I as noted above] in which the P. falciparum strain from Kenya
could not infect the Italian An. labranchiae, Bettini et al. suggested that more
experiments should be carried out to test the susceptibility of An. labranchiae to strains
of P. falciparum from other tropical regions, or with P. vivax. Examples of
reintroduction of P. vivax malaria in Corsica and European USSR were given, citing
Zulueta, Ramsdale & Coluzzi (1975), and in Sardinia arising from an imported case, citing
Coluzzi (1965). Careful monitoring of conditions of man-made breeding places such as rice
cultivation in Maremma region, central Italy was recommended.

Oddo & Piccardo (1982) reviewed the history of the campaign against malaria in Italy
since 1947 until eradication was achieved and certified in 1970. With malaria continuing
to be endemic in large areas of the world, imported malaria represents a permanent menace
for reintroduction of the disease into malaria-free areas. Of 895 imported cases recorded
in Italy during 1974-1979, 76% were infected in tropical Africa, 16% in the Middle East, 6% in Central and South America, and 2% in the Indian subcontinent. Of these infections, 64% were P. falciparum, 34% P. vivax and 1.4% P. malariae and 0.4% P. ovale. Of the imported cases, 54% were tourists who went to malaria endemic areas, 35% were persons undertaking diverse activities (working, commerce, professional activities etc.), 8% were air pilots and maritime navigators, and 3% diplomats, students, missionaries etc. The study of the distribution of the imported cases by region in Italy demonstrated that high vulnerability occurred in regions which are less receptive (towns) and vice versa. However, the notified cases of imported malaria represent only the tip of the "iceberg", because many cases are not diagnosed or not reported to health authorities. Two important factors are influencing the importation of malaria in Italy:

(a) a large proportion of Italian travellers especially tourists are not informed of the risk of contraction of infection in endemic areas, and have not been given sufficient information on prophylactic measures.

(b) The diagnosis of a large proportion of imported cases is delayed.

The actions taken by the Ministry of Health are:

- improvement of information to travellers by making wider distribution of translated WHO publications concerning international travellers, also making use of tourist agencies;

- better information to medical officers and health authorities at airports and seaports;

- giving instructions to regional health authorities to monitor the densities of potential vectors, and if necessary to carry out anti-vector measures;

- organizing training and refresher training courses for health workers concerned.

Oddo, Onori & Goriup (1987) reviewed the problems of malaria in the world with special reference to importation of malaria in Italy, for which new data were provided. During 10 years (1974-1984) there were 1644 imported cases, and among these there were 27 deaths (1.7%). The distribution of the imported cases was similar to previous years with the northern part of the country being more vulnerable, but less receptive. The parasite species were: 65% P. falciparum, 30% P. vivax and P. ovale, 4.9% P. malariae, and 0.1% mixed infection of P. falciparum + P. vivax. The type of people involved in importation of malaria has a new element, the immigrants and refugees constituting an appreciable proportion as shown in the following:

- Italian expatriates, 34%; Italian and foreign tourists, 31.7%;
- Religious persons, 5.5%; Air and maritime personnel, 5.5%;
- Immigrants, 18%; Refugees, 5.3%

The distribution of the origin of the 1644 imported cases was:

76.2% from tropical Africa.
18.3% from Asia.
4.5% from Central and South America.

Some countries from which the imported cases originated, reported chloroquine resistance in P. falciparum. For this reason four centres were established to carry out in vivo and in vitro tests respectively in: Rome, Milano, Torino and Pavia. The preventive measures remain the same as reported above. Some data were given on induced malaria and infection among drug addicts [see under 1.2.1(ii) of this SECTION below].

In France, several authors reported on imported malaria; only selected papers are presented here. Sautet & Ouilici (1971) reported on the malaria situation in Corsica. The malaria eradication campaign which was launched during 1948-1952 maintained its gains

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1. Summaries of this paper and the papers of Coluzzi & Monzali (1979), Coluzzi (1980), Oddo & Piccardo (1982), and Oddo, Onori & Goriup (1987) were made through the kind cooperation of Dr F. Oddo, former WHO Malarialogist, MAP, Geneva, by translating parts of the text of these papers.
as evidenced by the disappearance of autochthonous [= indigenous] cases of malaria up to 1965. This favourable situation allowed, in part, the exploitation of littoral plains, previously known to be malarious, and also led to a substantial increase in tourism to the seaside which had been abandoned in the past due to malaria. However, this situation did not last, for a new element appeared as a consequence of cultivation of the vast coastal plains. Repatriates from North Africa having faced the shortage of the local manpower, resorted to employment of North African workers who often came from the poorest parts of the Maghreb which are endemic for malaria, thus constituting a danger of reintroduction of malaria in Corsica. During 1965-1967 five cases were detected in the north of Corsica; the epidemiological investigation hitherto carried out revealed the presence of P. vivax infection among North African workers. Antimalaria measures were applied immediately (HCH house spraying and chemoprophylaxis) which led to elimination of this small focus, and the years 1968 and 1969 passed without any incident. This experience showed the repercussions that arose from reorientation of control measures after malaria eradication was achieved: the antilarval measures were largely directed to the control of Aedes and Culex, being the source of mosquito nuisance to tourists, while the control of the Anopheles vector of malaria [An. labranchiae] lost its exclusive character. In 1970, revival and extension of this focus was observed with the following cases reported (with a certain number contracting the infection in the northern focus): 20, of whom four were Europeans who came for vacation; 11 detected among North Africans, of whom nine were found in the same northern area, and two from other regions, indicating the high mobility of the labourers. Measures were applied towards the end of 1970, and reinforced in 1971 in order to eliminate this focus, thus preventing the re-establishment of malaria endemicity. Attention of the medical practitioners was drawn to the present experience with malaria cases which have so far been P. vivax, constituting a risk if not diagnosed in time.

Practitioners were also reminded of the standing regulations necessitating compulsory notification of malaria indigenous cases, as this would lead to the discovery of the affected zones.

Ambroise-Thomas, Quilici & Ranque (1972) reported the results of a sero-epidemiological investigation of malaria carried out in Corsica during February-March 1971 before the onset of the transmission season. A total of 1275 persons were examined: 1054 Corsicans and 221 North African workers. As far as possible, the sample represented the two sexes and different age-groups: less than 2 years, 2-5, 6-14 and 15+ years. From each person, two thick smears were taken for direct microscopical examination, and two blood samples for the indirect immunofluorescent test (IFA test). It was not possible to carry out spleen examination at the same time. All the slides examined microscopically were negative, but there were 81 immunofluorescent positive reactions using Plasmodium cynomolgi bastianelli antigen. Of these, 68 showed very weak reaction (1/20), while the remaining 13 gave a very strong reaction. It was surprising to observe that reactions were less frequent and less intense among the North African workers than in the Corsicans. It was realized that the North African immigrants upon their arrival in Corsica were submitted in an almost systematic manner to malarial treatment by amodiaquine. This treatment obviously re-mixed in appreciably reducing the fluorescent antibody titre in this group. The authors considered, however, that the IFA test is undoubtedly an important tool in regions such as Corsica where people are well aware of malaria symptoms. As soon as they get fever episodes which they themselves recognize as due to malaria, they resort to taking antimalarial drugs. Enquiry by the authors during the present investigation showed that this phenomenon is quite widespread. This explained the negative results of the microscopical examination. On the contrary, this treatment only causes a reduction in the fluorescent antibody titre, but does not lead to complete disappearance of the reaction. In conclusion, the results of the present investigation permitted anticipating the spread of malaria in the southern area of Bastia and in the central part of the eastern plain, while the southern part of the island remained malaria-free. The records tabulated by the authors for the whole island showed that indigenous cases continued to be detected in 1971 in addition to imported cases: 10 and 9 respectively. The authors noted that the reappearance of malaria in Corsica created diverse reactions in the medical press of Britain. They were, in fact, pointing to a report by Brit & Hutchinson (1971) who diagnosed P. vivax infection in a 24-year old British citizen after his return from a summer holiday in southern Europe, including 12 days in Corsica where he stayed at a camp site by the sea and slept some nights in the open at St. Florent, experiencing numerous insect bites. Although the exact place at which the infection was contracted in southern Europe could not be ascertained, it was thought that St. Florent, Corsica was the most likely place. Attention was drawn to the need for increasing awareness of the possibility of malaria among people returning to
Britain from southwest Europe. Bruce-Chwatt (1971) commented on the above communication, pointing out that reliable information from WHO indicated that autochthonous malaria in southern Europe no longer exists. However, this does not exclude the possibility of sporadic cases of malaria being imported from elsewhere into areas where the disease has been eradicated. Such cases may infect local anophelines which may transmit the disease to some visitors. Attention was drawn to *P. falciparum* infection which may develop rapidly with serious complications. For this reason, the possibility of malaria in any febrile patient who had returned from any tropical or subtropical area should always be kept in mind.

Brunet, Petithory & Giacomini (1978) pointed out that malaria observed in France is often mortal. In 1973 alone, there were 186 malaria cases with eight deaths as declared by 13 out of 28 regional hospitals including those of Paris. These records are most incomplete; malaria morbidity and mortality rates are, in fact, much higher than those reported. Extrapolating from these figures and taking into account that only the more severe cases are hospitalized, it can be deduced that a figure of about 2000 malaria cases per year (with 20 deaths) is a reasonable estimate, with 2/3 of it being *P. falciparum* cases. It is a regrettable situation because the effective means of prevention are available, the most important of which is chemoprophylaxis. Although the term imported malaria is well defined, a clearer definition is required for the terms of autochthonous and introduced malaria. According to modern terminology, the term autochthonous should be reserved for cases of permanently endemic foci. Therefore, this term does not apply now, because autochthonous malaria has disappeared from continental France since the first decade of the century and more recently from Corsica. It follows that autochthonous malaria should not be confused with introduced malaria which is observed only from time to time. The anophelines are always present in France which could become infected by feeding on gametocyte carriers among travellers and immigrants, but the local potential vectors are not adapted to the tropical strains of *P. falciparum*. From a study of 226 imported cases in 1975, about half were seen in September and October. This period corresponds to the return of French people and also the Africans who went on holidays. The latter group represents students and immigrant workers who usually pass their holidays in their original countries. They have lost their immunity to malaria after residing in France for some years, hence they become very susceptible to malaria infection. More susceptible also are their children who were born in France and go to Africa with their parents without any precautions. An investigation showed that their prophylaxis was insufficient during their stay in Africa or was interrupted for two months after their return to France. For prevention of importation of malaria, it is necessary to disseminate the relevant information to travellers, tourists and the Africans going to their homeland. In this respect, assistance should be sought from holiday clubs, tourist offices and air companies. It is also important to inform physicians; it is regretted that parasitology is becoming reduced during medical studies. For this reason the authors assisted in postgraduate studies by distributing about 6000 slides containing blood parasites to physicians, biologists and technicians since 1943. On the other hand, the legislation of obligatory declaration of autochthonous cases of malaria needs to be modified and ameliorated. As mentioned above, the obligatory notification under the decree of 29 January 1960 does not solve the problem since primary autochthonous cases of malaria sensu stricto has disappeared from France a long time ago. The facultative declaration by laboratories as required by the circular of 25 September 1972 is ineffective as can be reflected from its name. To conclude, the authors underlined the need for obligatory notification of all malaria cases whether autochthonous, introduced, induced or accidental, as a basis for epidemiological follow-up. This represents an important step in the right direction for solving the problem of imported malaria, since the other measures have not so far been sufficiently effective.

Bastin & Charmot (1980) studied 100 imported cases of malaria hospitalized at Claude-Bernard Hospital, Paris, France. These were 73 men and 27 women aged 20-50 years. Of these, 77 were French, 21 from tropical Africa, 1 Cambodian and 1 Vietnamese. Of the French nationals, 33 travelled to a malaria endemic area for professional reasons and 38 for tourism, but six cases were undetermined. Of the Africans, 16 spent their holidays in their country of origin. Chemoprophylaxis was absent in 66 cases, discontinued on return to France in 21 cases, correctly administered in 11 cases, and undetermined in the remaining cases. The Africans lose their immunity to malaria, as they lived in France for a long time. The majority originated from areas of the West African savanna and their holidays are taken in summer, coinciding with the wet season which is a period of intense
malaria transmission in their country of origin. With regard to parasite species of these imported cases, 83 were P. falciparum, 10 P. ovale, and 7 P. vivax, while P. malariae was totally absent. The period of time between departure from an endemic area and the appearance of the first fever was determined for the 100 cases examined as follows: less than one month for 77 cases of P. falciparum, 1 case of each of P. ovale and P. vivax; 1-2 months for 6 cases of P. falciparum, 1 case of P. vivax, and 3 cases of P. vivax; 2-8 months for 8 cases of P. ovale, and 3 cases of P. vivax. Difficulties and limitations of drug prophylaxis were outlined, notably chloroquine resistance in P. falciparum strains existing in South East Asia and Latin America, which is extending to tropical Africa as well as resistance to antifolic compounds (pyrimethamine and proguanil). Suggestions were made for the types and dosages of drugs to be taken by travellers to endemic areas for chemoprophylaxis. The possibility of reintroduction of malaria into France from imported cases infecting potential local vectors such as An. maculipennis and An. claviger in the Paris area was discussed. The risk was considered to be very low or nil in the case of African P. falciparum, based on the experimental evidence provided by Zulueta, Ramsdale & Coluzzi (1975). On the contrary, the risk is high in the case of Mediterranean strains of P. vivax, bearing in mind the episode of Corsica in 1970.

Delmont et al. (1980) pointed out that until recently [March 1980 – see below], it has been difficult to estimate the annual incidence of clinical cases of imported malaria because medical practitioners declared only cases considered as primary autochthonous infections. Consequently, notifications conveyed to national and international health authorities have not permitted the evaluation of the true frequency of imported malaria cases. In view of this deficiency, an investigation was carried out in some hospitals in large towns to estimate the number of imported malaria cases, and to study their epidemiological characteristics. From the whole of metropolitan France, 45 imported cases were officially reported to WHO during 1973-1975, while a retrospective study revealed 64 cases in hospitals of a single city, Marseille. On the whole, enquiry at all hospitals showed an increase in the annual incidence of the imported cases, but did not reflect a valid estimate of the real frequency. Recently, the Ministry of Health and Social Security requested the departmental directorates of Health and Social Affairs to enquire from the specialized services of universities and the principal hospitals about the number of malaria cases that have been confirmed parasitologically. This retrospective enquiry revealed that 535 imported malaria cases were recorded in a single year, 1978. This figure gave a better representation of the situation than the results of an enquiry directed to 500 private general practitioners working in the Provence-Côte d'Azur and in Corsica. From 319 replies, it could be established that in 1978, at least 40 imported cases were diagnosed parasitologically by the private medical sector, and that hospitalization was not required except for five cases. To estimate the number of imported cases the following formula was utilized: 

\[ ax = by, \]

where:

- \( x \) = the number of imported cases seen in hospitals
- \( y \) = the number of imported cases seen outside hospitals.
- \( a \) = the percentage of cases confirmed before hospitalization
- \( b \) = the percentage of cases transferred to hospitals among those detected outside.

Through enquiry at hospitals, it is fairly easy to determine \( a \) and \( x \).

In Marseille the results obtained from hospital enquiries and those derived from the theoretical calculations were fairly identical; they showed that about 3/5 of the imported cases were diagnosed outside hospitals. Extrapolation from these results on metropolitan France, taking into account the population and the number of physicians in private practice, it was estimated that there were more than 2000 cases of imported malaria [in 1978?]. In making this estimate, only clinical cases which were parasitologically confirmed were taken into account, as the microscopical examination was not always demanded by the treating physician. Moreover, some patients decided to take antimalarial drugs before medical consultation. When estimating the number of imported cases, it is also necessary to bear in mind that a large number of persons are asymptomatic carriers. While imported malaria has become a real problem, it was surprising to obtain the following answers from general practitioners who were asked to give views on the variation in the annual incidence of imported cases during the past five years: 46.1% had no opinion, 34.2% affirmed the stability of the incidence, 17.2% pointed to its diminution, and only 2.5% indicated that the incidence increased. In conclusion, it is necessary to make the notification of imported malaria obligatory and that efforts be made by national
and international authorities to inform the medical corps about the recrudescence of the imported infection.

Genitlini et al. (1981) indicated that during 1970-1979, 433 malaria cases were diagnosed at the Pitie-Salpetriere hospital group in Paris. The annual figure showed a steady increase, rising from 7 in 1970 to 93 in 1974. The parasite species were:

- **P. falciparum** 66.7%
- **P. ovale** 13.9%
- **P. vivax** 14%
- **P. malariae** 5.2%
- **P. cynomolgi bastianelli** (1 case)

There were mixed infections as follows: P. falciparum + P. malariae (7 cases), P. falciparum + P. ovale (3 cases), P. falciparum + P. vivax (12 cases), and P. malariae + P. ovale (1 case). The monthly breakdown of the cases showed the occurrence of a regular peak from August-October. The increase coincides with the return to France of many summer holidaymakers from malaria endemic areas where intensive malaria transmission takes place during the rainy season in most of tropical Africa and Asia. Nevertheless, there has been an increase in the number of cases observed throughout the year, and this was explained by the increase in intercontinental business travel and winter holidays and the frequently observed long incubation period of species other than P. falciparum.

Of the 443 patients diagnosed, 192 were observed by the authors and their medical reports analyzed as summarized in the following:

- **Nationality**: French citizens 60.9%; persons from tropical Africa 33.4%; North Africans 1%; Asians 1.6%; Latin Americans 2.1%; Europeans excluding France 1%. Most of the people from tropical Africa were from French-speaking countries, and 80% of them were immigrants, workers and students who stayed in France for periods varying from two to 16 years, while the remaining 20% were living in Africa before their stay in France.

- **Origin of the infection**: The majority of the cases (83.3%) originated in tropical Africa, particularly in the French-speaking countries of West and Central Africa, virtually associated with the important economic and cultural exchanges between France and these countries. From Asia 8.9% of the cases with most of the infection contracted in Indo-China and Thailand. Only 3.7% of the cases originated in Latin America. Three cases (1.5%) originated in France: the first was an infant suffering from congenital malaria [the origin of infection of the mother not shown]; the second adult probably infected near Orly Airport by an exotic Anopheles carried by an aircraft from a malaria endemic area (citing Genitlini et al. 1978); and the third case was a laboratory technician who was accidentally infected by P. cynomolgi bastianelli (citing Druilhe et al., 1980) – see under 1.2.1 (ii)a, below.

- **Age and sex**: Young adults (20-29 years) constituted 56.5% of the French patients compared with 41.9% of immigrants of the same age.

- **Incubation period**: It was difficult to establish with accuracy the incubation period because of the large variation in the duration of stay in endemic areas. The authors considered the time that elapsed between the departure from the endemic area and the first appearance of clinical symptoms as representing the minimum incubation period. In the case of P. falciparum, this period was less than 15 days in 83.2% of the cases, and over two months in only 4.5%, with the maximum being eight months. With P. ovale, the onset of symptoms was observed in a period of less than two months in 21.2% of the cases, during the third or fourth month in 42.4%, and after a longer period in 36.4%, with the maximum being 15 months. With P. vivax, the first symptoms appeared before two months in 58% of the cases, during the third or fourth month in 10.5%, and after a longer period in 31.5%. Of nine cases of P. malariae, five presented the first symptoms within one month, and the remaining four during the third and tenth month.

- **Conditions of chemoprophylaxis**: Almost all cases of P. falciparum infection were due to lack or incomplete chemoprophylaxis. However, in three cases infection occurred despite taking their chemoprophylaxis correctly. The strains of this infection originated from South East Asia or the Amazon region of Brazil and were probably resistant to
chloroquine. A large proportion of patients with *P. ovale* and *P. vivax* infections had followed their chemoprophylaxis correctly. Taking into account the length of the incubation period and the possibility of relapses, it can be inferred that although the period of two months normally recommended for continuing chemoprophylaxis after return can prevent attacks of *P. falciparum* in almost all cases, it cannot give protection from the more delayed attacks of the other species of *Plasmodia*. The authors further discussed their findings in relation to those previously reported by other authors in France and elsewhere in Europe with respect to the distribution of parasite species of imported malaria, the origin of patients and the incubation period. With regard to incidence in France, it was pointed out that the declaration of imported malaria became obligatory only in March 1980, hence the previous evaluation of the annual number of imported cases was fortuitous. Reference was made to Brumpt, Pétithory & Giacomini (1978) who estimated that the annual number of imported cases was 2000 with 20 deaths. It is possible that the current incidence in France is much higher. In the group of cases observed by the authors there were no fatal cases, even though 11 patients had cerebral malaria. Rapid diagnosis and treatment are essential for preventing deaths. In conclusion, the authors pointed out that the recent increase in imported malaria in Europe calls for establishing an improved information service for physicians, who, in general, are not familiar with this disease. Similarly, an efficient information service is needed for travellers to maintain drug prophylaxis correctly and to avoid interrupting it prematurely. Airlines can provide the necessary information to travellers going to malaria endemic areas, in the form of booklets, information sheets placed in the aircraft and information broadcasts on loudspeakers or through individual earphones.

Gentilini & Danis (1981) summarized the records of autochthonous or introduced malaria which were reported by various workers in the European territory of France during 1969-1978. The term autochthonous was meant to cover cases considered to have been infected by local or imported anophelines, thus it excludes cases of imported, induced and congenital malaria. The authors grouped the reported autochthonous cases into three types:

**Type I**: Introduced, as exemplified by the malaria outbreak in Corsica during 1970-1971 where *P. vivax* transmission was effected by the local vector, *An. labranchiae* under favourable climatic conditions, and the original infection was attributed to North African immigrants (see above).

**Type II**: Undetermined, the mode of transmission of which remains inexplicable. These were seven cases (5 *P. falciparum* and 2 *P. vivax*). Half of these cases were recorded in the north of France where the climate varies from less favourable to quite suitable for malaria transmission. These cases were:

**P. falciparum**

- 2 cases (a male and a female) detected in Bretagne in August 1969. [The two cases were determined later as airport malaria - see below.]
  - a case of a female aged 27 years detected in Sologne in August 1977, reported by Chavanne et al. (1979).
  - a case of a male aged 70 years detected in Paris in December 1978, reported by Guillausseau et al. (1980).
  - a case of a male aged 23 years detected in Yvelines (Plaisir) in September 1978, reported by Cassaigne, Bruaire & Léger (1980).

**P. vivax**

- a case of a male aged 82 years detected in Val de Marne (Saint-Mandé), in August 1977, reported by Saliou et al. (1978).
- a case of a female child aged 6 years detected in October 1978 in Normandy (Elbeuf), reported by Morin et al. (1980).

Gentilini & Danis (loc.cit.) explained that with the exception of the case of *P. falciparum* detected in the Paris region in December, all other cases as shown above
were observed in summer or autumn, a period during which An. maculipennis complex and An. claviger are usually present. Theoretically, these species are susceptible to P. vivax infection, while their capacity to transmit P. falciparum is doubted, particularly the strains of this parasite originating in tropical Africa and frequently encountered among immigrants in France. In this connection reference was made to experiments showing the refractoriness of European An. maculipennis complex to exotic P. falciparum, carried out by Shute (1940), Zulueta, Ramsdale & Coluzzi (1975) and Ramsdale & Coluzzi (1975). Moreover, temperature conditions required for completion of sporogony in P. falciparum (19-300 C in 10-30 days) are rarely met in the northern and central regions of France. However, the source of infection of these anophelines with P. falciparum could not be established with certainty (see further information below).

Type III: "Airport" malaria, examples were given of incidents of malaria transmitted by exotic anophelines transported by aircraft.

Recently, Bégué et al. (1984) described a case of a 7-year old child who was submitted to surgical intervention (for décollement biauriculaire) on 26 March 1983 and had a febrile episode on 11 April 1983. Microscopic examination of a blood smear revealed the presence of P. malariae. The fever subsided after chloroquine treatment. The mode of transmission in this case was puzzling in that the child has never had any blood transfusion since birth. Moreover, neither he nor his parents left Metropolitan France. They live in the Paris region, but not near any international airport. Accidental infection through infected needles was entirely excluded. The only possibility was that the child contracted the infection during his summer vacation in Aisne department in France when the temperature was above 180 C for a fortnight which is the period necessary for sporogonic development in a local potential vector. The effect of the first parasite invasion must have passed unnoticed, but the surgical intervention in March 1983 must have reactivated the infection. As there was no evidence to support this hypothesis, the authors were inclined to consider this case undetermined following type II of Gentilini & Danis.

Gentilini & Danis though included among the five cases of P. falciparum classified under Type II, two cases detected in August 1969 in Brittany (Bretagne), north of France, 15 days after their arrival from Paris, suggested that their infection may have been of Type III. In fact, Doby & Guiguen (1981) who were directly responsible for the parasitological diagnosis of the two cases objected to their classification under Type II, and gave a full account of their history as well as details of epidemiological and entomological investigations. The two cases were in fact a couple who were living and travelling together in Brittany. Fifteen days after their arrival in Brittany they suffered from fever and the man died after four days. P. falciparum infection was identified on post-mortem. The woman whose blood examination showed P. falciparum infection was febrile spontaneously. Four possibilities were considered:

- the presence of infective cases in the area of Brittany where the couple resided: investigation on the spot excluded this possibility;

- the existence of species of anophelines that bite man: entomological searches revealed the presence of An. claviger which is essentially anthropophilic but mainly bites man outdoors. An. atroparvus was found in the coastal area. This species is essentially zoophilic but still can bite man;

- the degree of receptivity of the European anophelines: the experimental evidence demonstrating the refractoriness of An. atroparvus to exotic P. falciparum strains was cited (as shown above);

- the meteorological conditions in Brittany during the period preceding the arrival of the couple may have permitted the sporogony of P. falciparum to be completed in a local anopheline: checking the available local meteorological data showed this is not absolutely impossible, but seems to be highly improbable;

- the possibility of contracting the infection in Paris in the days preceding the arrival in Brittany: having been unable to confirm any of the three above-mentioned possibilities with absolute certainty, the authors found it more plausible to consider that the two patients were infected in the Paris area before departure to Brittany. This
assumption was supported by the fact that they must have shared the same house situated a few hundred meters from Le Bourget airport where probably an infected vector from a tropical area was brought by a passenger or cargo airplane. Therefore, the two cases should be considered examples of airport malaria infections.

The risk of resumption of malaria transmission in France was discussed by Rodhain & Charnot (1982). After reviewing the cases of malaria that had been recorded in the past, reference was made to cases that have been detected in recent years as follows:

- 11 cases (10 P. falciparum and 1 P. vivax) were observed during 1969–1978 in persons having contact with international airports in Paris, including the two cases in Brittany (shown above).

- five cases (3 P. falciparum and 2 P. vivax) were reported between August 1973 and October 1978 (citing several authors as has already been shown by Gentilini & Danis, 1981). These cases could not be explained by their association with international airports. From their history, four of these cases were recently hospitalized and the fifth was a nurse in a hospital. It was difficult to draw a firm conclusion on whether an unrecognized carrier could infect a local susceptible Anopheles which transmitted the infection within the hospital. However, the rare occurrence of such cases contrasts with the large number of imported cases reported annually in France (1500–2000) including an appreciable number of gametocyte carriers. The potential vectors that can be responsible for malaria transmission are three species of the An. maculipennis complex:

  - An. atroparvus, previously recognized as a principal vector. It is widely distributed in coastal areas breeding in brackish waters particularly in northern Europe (e.g., northern France and the Netherlands).

  - An. messeae is usually zoophilic but was connected with epidemics at times.

  - An. labranchiae breeds in swamps with vegetation in the western part of the Mediterranean basin (e.g., Italy, Sicily, Sardinia, Corsica and Tunisia).

With regard to receptivity of these species to malaria infection, reference was also made to the experimental evidence that demonstrated the refactoriness of the European members of the An. maculipennis complex to the tropical strains of P. falciparum, although these species remain quite susceptible to P. vivax. Thus, P. vivax from North Africa or Turkey where its vectors belong to the An. maculipennis complex, can be considered a potential source for re-establishing P. vivax transmission in western Europe as was the case in Corsica. This would necessitate organizing careful surveillance of malaria, notably in the Midi, France. The factors necessary for creating a focus of malaria transmission were outlined as follows:

(a) the presence of a sufficient anopheline density having adequate contact with man;

(b) introduction of a sufficient number of gametocyte carriers during the favourable season;

(c) compatibility between the parasite introduced and the local potential vector - as mentioned above the strains of P. vivax from the Mediterranean basin are quite compatible;

(d) the presence of favourable climatic conditions, particularly temperature suitable for P. vivax (not less than 17° C);

(e) inadequate or absence of a surveillance system.

To conclude, the authors consider it highly improbable that arrival in France of gametocyte carriers from tropical regions would lead to resumption of malaria transmission. However, foci can be established only in the case of massive introduction of P. vivax of Mediterranean origin as it was observed in Roussillon in 1939–1943 with the arrival of more than 200 000 Spanish people. This type of foci, however, is unstable malaria which is relatively easy to eradicate.
Some cases of congenital malaria were reported in France as related to imported infection. Vernes et al. (1973) described the clinical aspects and blood picture of a female infant born on 17 November 1977 and was hospitalized on 7 December 1977 as she was suffering from fever. Examination of a thick blood smear during the fever episode revealed the presence of asexual and sexual forms typical of P. vivax. She was immediately treated with chloroquine and was successfully cured. The mother of this small infant was a Cambodian refugee who arrived in France on 22 September 1977. Her pregnancy was normal but she was suffering from severe anaemia. The birth was normal, but on the following day she suffered from an attack of fever with rigor; examination of her blood revealed the presence of P. vivax. The congenital characteristics of the malaria infection in the infant and its occurrence in winter in northern France, makes the assumption of post-natal transmission by a local Anopheles improbable. The authors indicated, however, that cases of congenital malaria in France are quite rare.

Excier (1980) reported on a case of congenital malaria in an infant who suffered from intermittent fever for 28 days since his birth on 5 June 1974 at the hospital in Lyon and was referred to medical examination on 2 July 1979. The results of all clinical and laboratory investigations including serological tests were described. Microscopical examination of a blood smear taken from the infant on 3 July 1979 revealed the presence of asexual stages of P. vivax but an IFA test was negative. The infant was successfully treated by the appropriate dosage of chloroquine. His mother, a Cambodian refugee, aged 25 years, lived in France for a year previously during which she became pregnant. During her pregnancy she suffered from frequent episodes of fever particularly during the last three months, but none of these episodes presented itself during her prenatal examination, and no blood examination for malaria parasites was made. She delivered normally, but in the week that followed she suffered from bouts of fever. Microscopical examination of her blood and a serological test by IFA were negative. She was given antimalaria and antihelminth treatments, the latter was indicated by the high eosinophilia. To explain the infection in the infant, three hypotheses were discussed. The first was that the infection resulted from an infective bite by Anopheles, but this was excluded on account of absence of autochthonous malaria cases in the hospital in Lyon during June 1979. The second was neo-natal infection passed by the mother's parasitized blood to the infant through cutaneous excoriation, but the delivery was normal without using forceps. Even if this happened, the infant should have had his first fever after 2-3 weeks, which was not the case. The third possibility was a congenital malaria and this was supported by the fact that the mother had episodes of fever particularly during the last three months of pregnancy, the immediate appearance of fever in the infant upon birth, and his advanced clinical picture (enlarged liver and spleen plus anaemia). It is regretted that neither the placenta nor the cord were examined. It is clear that the mother had been infected in Cambodia with P. vivax. The immunological status of the mother and her child was discussed.

The recent situation of imported malaria in France was cited in the WHO (1987 Wkly Epide. Rec.) from the "Bulletin Épidémiologique hebdomadaire, (BEH), Direction générale de la Santé, No. 23/1987". In 1985, 49 laboratories attached to university and regional hospitals agreed to take part in prospective data collection on malaria as from the month of June. The results showed that during the first six months 47 laboratories notified 631 cases of malaria diagnosed microscopically, to the National Reference Centre for Imported Diseases (response rate 90%). The species most frequently encountered was P. falciparum (76% of the cases), which was attributable to the fact that a high proportion of patients (79%) were infected in Africa where P. falciparum predominates. In six cases, infection occurred in Metropolitan France. Four patients were infected through blood transfusion (2 with P. falciparum and 2 with P. malariae) and there were two indigenous cases: one was a P. malariae infection contracted in Languedoc-Roussillon and one a P. falciparum infection contracted close to Marseille airport. Comparison of data of 1985 with those recorded in 1986 is shown below.

Jeannel et al. (BEH, 1988) presented an account of the most recent records of imported malaria in France. As from 1985, the preparation of individual cards for each patient presenting a malaria fever was pursued in 1986 and 1987. It was through the collaboration of 46 laboratories belonging to university and regional hospitals that 1025 cases of malaria were reported in 1986, for which detailed data were given as summarized in the following:
Species and country of origin of infection: P. falciparum was the most frequent infection encountered (83%). P. vivax, P. ovale and P. malariae (not associated with P. falciparum) constituted 8%, 8% and 1% of cases respectively. Of P. falciparum cases 91% originated in tropical Africa. A total of 34 cases contracted the infection in Asia, of which only eight were P. falciparum. Similarly 34 cases contracted the infection in Latin America, of which 23 were from French Guiana. In Metropolitan France, there were four cases attributed to blood transfusion (1 P. falciparum, 1 P. malariae, 1 P. vivax and 1 P. ovale).

Distribution of patients by nationality, age and sex: 59% of the cases were Europeans (439 French of 523 Europeans) and 38% Africans. The mean age was 28.4 years; the patients in the age-group 20-39 years represented 53% of the cases and of less than 20 years of age represented 25% of the cases, but the age distribution varied according to the geographical origin of the patients. There were more males than females (68% among Europeans and 62% among non-Europeans).

Chemoprophylaxis: There were 275 persons (34%) who followed the chemoprophylaxis correctly. About half of the European patients properly administered the prophylactic drugs, but 23% took nothing. Among non-Europeans, 61% took no prophylactic drug, while 13% apparently followed complete chemoprophylactic regimen. Of the 275 patients who took a complete course of chemoprophylaxis, 222 exhibited a secondary P. falciparum infection. Of these, 151 were reported as drug-resistant (91 proved by in vitro test, and 60 considered suspected).

Interval between return to France and the diagnosis of P. falciparum: Information was available for 539 cases. It was less than one month in 76% of these cases and two months in 89% of the remaining cases. In 20 cases, the attack was delayed for more than six months.

Pernicious malaria: Of 847 cases of P. falciparum, 50 exhibited pernicious manifestations, of whom 41 were Europeans. Drug resistance was proved or suspected in 19 cases (2 Africans and 17 Europeans).

Drug resistance: In vitro tests confirmed the presence of chloroquine resistance in 107 patients (12.6% of 846 P. falciparum cases). The origin of the infections was: Central Africa (76 cases), West Africa (6 cases), South Africa (6 cases), East Africa (6 cases), French Guiana (3 cases), and undetermined origin (3 cases). Drug resistance was suspected in 114 cases (13.5% of P. falciparum cases) on the basis of clinical and therapeutic criteria.

Distribution of cases in France: P. falciparum was the species frequently encountered in all regions or departments, but the nationality of the persons was not the same. Of all reported malaria cases, 61% were diagnosed in the Paris region, mostly Africans, while 24% of the cases were recorded in all other regions.

Comparison between the results of 1985 and 1986: Although the results of 1985 covered only six months, comparison of the results of the two years points to the following: P. falciparum constituted the majority of imported cases in 1985 and more so in 1986; the origin of infection has been essentially African. The number of Africans exceeded that of the Europeans (52% Africans vs 44% Europeans) in 1985, but the reverse was seen in 1986 (38% Africans vs 59% Europeans). Chemoprophylaxis was absent or incomplete in the majority of cases (78% in 1985 and 66% in 1986) particularly among non-Europeans. This partly explains the appearance of a large number of persons with malaria attacks. An increase in proven and suspected cases of chloroquine resistance was an important development in the two years. Of 482 P. falciparum cases reported in 1985, 2.7% presented proven chloroquine resistance, 5.5% suspected. Of 846 P. falciparum cases reported in 1986, the percentages of proven and suspected resistance were respectively 12.6% and 13.5%, i.e., the incidence of chloroquine resistance proved by in vitro test increased more than 4-fold.

In conclusion, the extent of the area of chloroquine-resistant P. falciparum in Africa is a major concern. The pernicious manifestations of P. falciparum infection is also worrying, as these may lead to death. In 1986 as in 1985, the proportion of cases that exhibited pernicious manifestations was 6% of all P. falciparum cases. This is
probably an underestimate, since laboratories do not always have access to the clinical findings. This is why an investigation on deaths due to malaria has been ordered by the directorate general of health.

In Britain, Morgan (1987) explained that the Malaria Reference Laboratory (M.R.L.) is the main surveillance centre for malaria cases in the country. It monitors countries where there is a malaria risk and the spread of chloroquine resistance, and advises on malaria prophylaxis to be given accordingly. The laboratory also acts as reference centre for blood films suspected of having malaria. The laboratory receives its notifications from three main sources: the first source is the M.R.L. standard form completed by the doctor treating the patient; the second is the blood slide which would be accompanied by a standard form; and the third are copies of the Office of Population Censuses and Surveys (O.P.C.S.) Notifiable Disease form sent by the Health Authority where the case is diagnosed. "Foreign visitors ill with malaria in Britain" category was first used by the M.R.L. in 1975, and is now the second largest group after "immigrants visiting country of origin". These foreign visitors are important because their proportion out of the total number of cases is increasing, and also they have a higher proportion of P. falciparum, the potentially fatal infection. The author reviewed the data of 1985 notification to the M.R.L. and studied in detail those reported as foreign visitors. In 1985, there were 2212 notifications of which 427 (19.3%) were classified as foreign visitors ill while visiting Britain. Of these foreign visitors, 47.5% were reported as having P. falciparum, and one third of the cases (143) were in the 20-29 age-group. Classifying the cases of the visitors by country of birth showed that 30.5% (130 cases) were born in Nigeria, of whom 112 had P. falciparum malaria. This represented 53.2% of P. falciparum cases among visitors and 16.3% of all cases of P. falciparum reported. About 29.3% (125 cases) of the visitors were born in India, of whom 110 had P. vivax malaria and this represented 60.4% of P. vivax cases among visitors and 8.2% of all P. vivax cases reported. Occupation was given for 172 foreign visitors, these included 66 cases whose occupation was stated as students, of whom 43 were from Nigeria. Three hundred and one foreign visitors were recorded as not having taken antimalarial drugs, 53 did take malaria prophylaxis, but information was lacking for 73 cases. The interval between arrival in Britain and the date of onset of the illness was studied in relation to the type of malaria, the age and the country of birth of the foreign visitors. Analysis of these data showed that 66% of P. falciparum cases were presented within one month of arrival, whereas 37.4% P. vivax cases came within this period. This was probably due to the more acute and severe nature of P. falciparum compared with the relatively more chronic and relapsing P. vivax. It was also observed that 11% of the 427 foreign visitors were sick before arrival. In his discussion, the author suggested that foreign visitors coming from malaria endemic areas who are reported as having malaria, would probably fall into three categories:

(a) Those who by virtue of living in Britain for a substantial length of time, lose some of their immunity to malaria and become reinfected while visiting their native country, e.g., students studying in Britain.

(b) Those persons who are semi-immune to malaria, but suffer a recrudescence of their chronic parasitaemia while in Britain.

(c) Those persons who for unknown factors suffer from a disruption in the host-parasite equilibrium which results in a malaria attack. This would explain the large proportion of foreign visitors (68.6% of 427) with the onset of malaria symptoms within one week of arrival in Britain.

Phillips-Howard et al. (1988) analyzed the data of malaria recorded in Britain during 1977-1986, as summarized in the following:

- Incidence: Over the past decade, 18 374 malaria cases were reported to the Malaria Reference Laboratory, of which 27% were P. falciparum infections. After falling in the early 1980's, the number of cases progressively increased reaching 2 212 in 1985 and 2309 in 1986. In 1978-1979, the number of cases reached a peak coinciding with the advent of new immigrants entering Britain, whereas recent data suggest that the groups who are importing malaria are already resident in Britain and travel for short visits to malaria endemic areas. A parallel increase in the number of P. falciparum cases has been observed in recent years reaching 738 in 1986 compared with 258 in 1977. With regard to P. vivax, an average of about 1200 cases are reported each year, constituting 65% of all
Infections. P. ovale cases are few, having increased from 1% to 3% of all cases (mainly from Nigeria), while P. malariae cases have been consistently less than 1% of all cases.

- Malaria acquired in Africa and south Asia: Over 80% of P. falciparum infections were contracted in Africa south of the Sahara. The number of cases originating from Anglophone West Africa remained steady between 1977 and 1982 but doubled by 1986 constituting 60% of P. falciparum cases from Africa. There has been a 5-fold increase in the number of cases from Southern Africa, a 3-fold increase in the number of cases from East Africa and a 2-fold increase in those originating in Central Africa and other parts of West Africa. Kenya is the main country in East Africa where non-immune British residents who go for holiday or business, contract malaria, and have shown the highest mortality. Over the last decade 104 cases of P. vivax were recorded in travellers from Nigeria, some of which were confirmed by the Malaria Reference Laboratory. The origin of the infection is not yet clearly understood. Also from Nigeria, 86 cases of P. ovale were reported during the period under review, half of these were in the last two years. Malaria cases from South Asia constituted over half of all imported cases into Britain each year; 84% of all P. vivax cases are imported from South Asia, mainly in settled immigrants who travelled to visit friends and relatives. During 1979-1984, the incidence of P. vivax from India declined, but rates for P. falciparum increased 20-fold. During the same period, the rates of both P. falciparum and P. vivax increased 10-fold in travellers returning from Pakistan. P. falciparum rates from South Asia are still low compared to those from tropical Africa, but this trend follows the epidemiological pattern in South Asia, indicating a relative increase in P. falciparum infection. The spread of chloroquine-resistant P. falciparum through Asia is of concern.

- Population groups and reason for travel: The pattern of imported malaria in different population groups in Britain has changed over the past decade. In 1977, cases were distributed equally between foreign and British residents. During the early 1980's there was, proportionately, a higher incidence in British residents. The incidence in various groups was presented as follows:

British residents: The incidence of malaria in British residents has doubled since 1977. The largest increase is among settled immigrants who travelled to visit friends and relatives. P. vivax infection is predominant in residents of South Asian origin. The number of malaria cases in British residents travelling for other reasons has remained under 500/year, constituting about a quarter of all cases, most of them are tourists and business travellers. The incidence in other groups such as British residents who live overseas, schoolchildren visiting parents abroad, civilian air and sea crews, and military personnel have increased 3-fold to about 100 cases/year.

"Autochthonous cases": The authors used this term to cover cases classified as congenital, transfusion, and "airport malaria", totalling 24 cases. During the past decade, congenital malaria was reported in 14 babies, of whom two were infected with P. falciparum of African origin, and eight with P. vivax of Asian origin. Of 10 cases of malaria recorded in patients who had not travelled to malarious areas, six were associated with hospital treatment. Of these, four received blood products and were found infected with P. falciparum. The authors further referred to two cases of P. falciparum reported near Gatwick airport in 1983 and were classified as "airport malaria", probably the infection was caused by imported infective mosquitoes. Reference was also made to two other cases of P. falciparum diagnosed in two women returning to Britain from Italy; their outgoing plane had originated from Ethiopia, and an infected "commuter" mosquito was assumed to have caused the infection. - see also under 1.2.1 (iii) below.

Foreign residents: There has been a 5-fold increase in the number of malaria cases reported in foreign visitors arriving in Britain reaching 28% of all cases in 1986. Fewer cases of imported malaria are seen in new immigrants, probably reflecting the reduced rate of migration to Britain from South Asia.

- Deaths from P. falciparum: During 1977-1986, there were 67 deaths associated with P. falciparum. The fatality rate in P. falciparum infection declined from 2.7% to 0.5% in 1986, but this should not be taken to indicate a declining trend because in 1982, the death rate was 2.6%. Of 63 cases for which nationality was recorded, 54% were white British non-immune persons, nine were of Asian origin and four were of African descent. Of the total number of cases, 56 travelled to Africa, five to India, and six did not state.
the country visited. Information on compliance with prophylaxis in travellers who have
died has not always been complete. Of the 67 patients who died, 16 were reported to have
taken pyrimethamine alone, although the Ross Institute, for several years, has not
recommended this drug for prophylaxis. It is of concern that of nine deaths reported in
1985 and 1986, three were travellers who had been prescribed pyrimethamine.

- Use of prophylaxis by travellers: The use of prophylaxis is poorly documented in
the report forms of malaria cases. In 1986, no information was given in 39% of cases. Of
the remaining 1521, 70% of patients had taken no chemoprophylaxis. Of the 457 patients
who had taken chemoprophylaxis, 8% gave no details of the drug used, 8% took chloroquine,
4% used proguanil, 3% took proguanil and chloroquine, and 8% had taken other drugs
including pyrimethamine, Fansidar, Maloprim, or amodiaquine. Lack of information on drug
regimens, compliance, or drug use in the denominator travelling population has prevented
measurement of drug efficacy. Moreover, drug sensitivity tests on parasites have not
routinely been carried out. Thus, it is not known whether the reported drug failures
truly reflect resistance to the prophylactic or non-compliance.

- Attack rates in different categories of travellers: Travel data from the Office of
Population Censuses and Surveys, and the International Passenger Survey (compiled by the
Department of Employment 1979-1986) were reviewed to provide denominators of the
population groups who travelled to malarious areas. Because data on the duration of the
visits are not adequate, attack rates were calculated per 100 000 visits overseas. The
calculated rates are preliminary figures. The calculated attack rates suggest that men,
young adults and children are at greater risk of malaria than women and older people.
Rates are highest in immigrants who have settled in Britain but visit relatives in
malarious areas: 316 and 331 per 100 000 for Africa and Asia respectively; 120 and 39 in
tourists in the same two regions; and 228 and 38 in business travellers to those regions.

In their discussion, the authors pointed to the increase in the number of imported
P. falciparum cases over the past decade as being associated with increased travel, more
malaria in visitors from overseas, especially from Nigeria, and increased transmission of
P. falciparum in South Asia. The rising incidence of P. falciparum infections in East and
Central Africa can be related to the spread of chloroquine resistance. The increase in
P. falciparum cases from South Asia may also in part be due to drug resistance. To
determine the efficacy of different prophylactic regimens and changing pattern of drug
resistance, accurate reporting of the chemoprophylaxis taken by the patients is needed.
Malaria reports should specify the name, dose and duration of the antimalarial drug and
the compliance of the patient with the regimen. The authors further underlined that the
use of pyrimethamine by non-immune has been considered unsatisfactory for some years.
Although a knowledge of drug use in the general travelling population is required to
establish the true associating risk, the available data suggest that pyrimethamine taken
alone is inadequate. Calculating attack rates helps to define the groups of travellers at
highest risk of contracting malaria. More detailed studies are required to define the
travellers at highest risk, and to determine the efficacy of the prophylactic drugs in
use. Children under age 15 had the highest attack rate (176 per 100 000 travellers), more
than double the rate in the age-group 35-54 years. Susceptibility to infection may be
due to the absence of prophylaxis, poor compliance, or the use of drugs of low efficacy.

In conclusion, malaria continues to impose a threat to international travel. Doctors need
to be vigilant in diagnosing and treating the malaria patients. Reporting malaria cases
to the Malaria Reference Laboratory and suspected adverse reactions of antimalarial drugs
to the Committee on Safety of Medicines is essential to balance the risks and benefits of
prophylactic drugs.

In the Netherlands, Wetsteyn & Geus (1985) carried out an investigation on chloroquine
resistance in P. falciparum imported cases. During January 1979-January 1983, a total of
461 imported malaria cases were registered in the Netherlands, 136 of which were diagnosed
in Amsterdam and 89 of these were infected with P. falciparum. In 41 patients (53% of 77
patients), decreased sensitivity to chloroquine could be confirmed. Signs and symptoms in
these patients differed from the classical picture. The place of origin of the 41 cases
was as follows: Tanzania: 14; Kenya: 9; several countries in East Africa: 2; Surinam:
3; Indonesia: 2; and South America: 1. Resistance to sulfadoxine-pyrimethamine (Fansidar)
was established in six patients. Parasitaemia was found twice during
dapsone-pyrimethamine (Maloprim) prophylaxis. Thus, full protection can no longer be
insured. Resort was made, therefore, to a combination of proguanil, 100 mg per day, and
chloroquine, 300 mg base per week. This combination was suggested for prophylaxis in areas with \textit{P. falciparum} chloroquine-resistant strains, but has not been tested extensively. In case of failure, cases should be treated with sulfadoxine-pyrimethamine in a single dose of 3 tablets, if possible to be combined with quinine, 600 mg t.i.d. for 3-4 days. To conclude, the authors considered that close observations of patients with chloroquine-resistant \textit{P. falciparum} are of value in relation to the situation in malaria endemic areas. A low grade of resistance will emerge first in the non-immune traveller or expatriate, while the indigenous population will continue to be protected by the acquired partial immunity. An increase in the level of resistance will also first be observed in non-immune persons.

In Spain, the receptivity to malaria was assessed by entomological surveys carried out during 1973, 1978 and 1979 using searches for adult mosquitoes supplemented by larval searches as reported by Blazquez & Zulueta (1980). The surveys revealed that \textit{An. labranchiae} has disappeared from its former area of distribution in the southeastern part of the country. This was thought to have been due to modified agricultural practices and the widespread use of residual pesticides in agriculture. On the other hand, \textit{An. atroparvus} was still found in most parts of its previous distribution in the country – see SECTION III(A), under (1), 1.5 in document VBC/90.2 – MAL/90.2.

Blazquez (1982) reviewed the receptivity to malaria in Spain. Based on this paper and on an English summary in the Review of Applied Entomology, Series B (1983, 71 (7) Abst. No. 1942)¹, malaria eradication was achieved in Spain in the early 1960's. Since 1973 surveys have been carried out in several areas of the country to monitor the populations of potential vectors, and their susceptibility to insecticides. Referring to the disappearance of \textit{An. labranchiae} as shown above, \textit{An. atroparvus} remains a unique potential vector. Only imported malaria cases have been reported in Spain. \textit{An. atroparvus} has become almost exclusively zoophilic. Moreover, it is unlikely that it can transmit \textit{P. falciparum} strains from tropical Africa as was shown experimentally (citing Zulueta, Ramsdale & Coluzzl, 1975).

Fernandez Maruto, Lorenzo & Blazquez (1982) reviewed the malaria situation in Spain. Based on this paper and on an English summary in the same issue of the Review of Applied Entomology (Abst. No. 1941)¹, malaria eradication in Spain was officially declared in 1964. Between 1975 and 1980, there was an annual increase in the number of imported cases. In 1981, there were fewer cases than in 1980. This reduction was explained as being due to the information transmitted to travellers by the Spanish health services on the recommended chemoprophylaxis. The origin of imported cases was shown to be tropical Africa, Asia and America. Particular reference was made to Equatorial Guinea as being the origin of 80.2% of the total number of imported cases from Africa and 65.8% of the total cases recorded in 1980. Regarding the frequency of the parasite species, while the proportion of \textit{P. falciparum} showed a decline from 58% of the total imported infections in 1979 to 37% in 1981, the proportion of \textit{P. vivax} increased from 34.8% in 1979 to 57.6% in 1981. The imported cases were detected in 30 provinces and this indicates that vigilance covers the totality of the country as part of the work of the provincial health services. Under the vigilance scheme, all imported cases are reported immediately by health institutions (dispensaries and hospitals) to the provincial directorate of health. When cases are confirmed, a parasitological investigation and an epidemiological enquiry are undertaken. The declaration of malaria cases is obligatory in Spain. Studies carried out on the receptivity of the previous endemic zones to malaria showed that \textit{An. atroparvus} has regained the same level of density as that which existed before malaria was eradicated. Susceptibility tests showed that this species is resistant to DDT and dieldrin, probably resistant to malathion and highly resistant to carbamates including propoxur. [Laboratory studies reported in 1982-1983 confirmed the presence of a broad spectrum of resistance to DDT, dieldrin, organophosphate and carbamates as well as permethrin in a strain of \textit{An. atroparvus} that originated from the Cadiz area, Spain – see VOL. I, under 2.6.1, pp. 90-93].

Alvar et al. (1985) communicated a brief report recording the first case of imported chloroquine-resistant \textit{P. falciparum} detected in Spain. A 48-year-old male returned to Spain on 18 April 1984 after having lived in Malawi for 20 years in Kasungu in the

¹ Permission to use this abstract from the Review of Applied Entomology – Series B, was granted by C.A.B. International.
Lilongwe region, an active zone for malaria transmission. During the previous 12 months, he took pyrimethamine on his own as malaria prophylaxis. His clinical picture and chloroquine treatment given to him following the onset of malaria symptoms on 8 April were described. He was hospitalized in Spain on 28 April when chloroquine resistance was suspected. His clinical condition and response to further treatment were described. A blood sample revealed the presence of an extraordinary parasitaemia showing $1.5 \times 10^6$ parasite/1 blood. In vitro (macro) chloroquine resistance test of *P. falciparum* following the WHO standard technique was performed. The test indicated the presence of chloroquine resistance at RII level.

In Portugal, Bruce-Chwatt & Zulu eta (1977) reviewed the early history of malaria and steps undertaken for its control until eradication was achieved and officially certified by WHO in November 1973. Previously the programme of active case detection which started in 1964 was discontinued in 1965, since the number of new cases detected was 146 and most of them were already reported by passive case detection. Besides which, the cost of active case detection was very high. Since then the malaria eradication programme was in the maintenance phase, which was considered by the national health authorities as the stage of vigilance. During this stage (1966-1973), attention was focused on the detection and treatment of imported cases with intensive control of immigrants and coordination of surveillance with overseas services. The antimalaria services which were established in 1938 were reorganized in 1945 under the name "Serviços de Higiene Rural e Defesa Anti-Sezonatica" (SHRDAS). This organization had a certain degree of technical and administrative autonomy. The antimalaria campaign carried out by this organization was the foundation upon which malaria eradication in Portugal progressed. The SHRDAS had a central directorate in Lisbon and ten peripheral units. These units represented a network covering the whole country. They carried out blood examinations of persons presenting febrile symptoms, or carried out such examinations at the request of medical practitioners. Additionally, they made epidemiological enquiries in relation to each confirmed case, treated and followed up the patients, and inspected groups of seasonal workers and overseas immigrants. The units also applied residual house spraying, wherever a focus of malaria transmission occurred. Information on imported malaria came from the Directorate General of Health which received from the military authorities and civilian official organizations a list of persons that returned from overseas with their addresses. These were contacted by the appropriate zone inviting them to report directly or through their doctors to the nearest SHRDAS unit for examination. Most people responded to the invitation, and records of imported malaria cases were based on the results of blood examination. Any positive case was treated accordingly. The other source of information on imported cases were the medical practitioners, as malaria has been a notifiable disease in Portugal since 1938. The notifications used to be forwarded to the Director General of Health Services and were subsequently transmitted to SHRDAS. The efficiency of surveillance activity carried out by this organization can be illustrated by the fact that during 1970-1972 over 110 000 persons were examined, and 1536 imported malaria cases were diagnosed and treated. Since 1972 the administrative organization of SHRDAS underwent some changes related to replanning of all medical and social services, based on a network of health centres which, in turn, were foreseen to be related to the network of all existing hospitals. Integration of SHRDAS and other similar units into the health centres was proceeding.

In their conclusions, Bruce-Chwatt & Zulu eta (loc.cit.) emphasized that since 1973, in spite of a large number of imported cases following the independence of former Portuguese overseas territories, there has been no evidence of local transmission, although one case detected in 1975 at Beja might have been contracted locally. It was fortunate that about 80% of the people returning settled down in urban areas where conditions for local transmission of malaria did not exist. The number of potential malaria carriers in former military personnel who were returning to civilian life and settling down in rural areas was relatively small. This alone reduced the possibility of introduction of malaria into rural areas where the vector is abundant. With the satisfactory coverage of the country by health units and the easy availability of treatment as well as a supporting health education system, any major degree of malaria transmission was most unlikely. From past studies, there is a wealth of evidence that malaria transmission in Portugal by *An. atroparvus* much depended on high vector densities related to rice fields. This vector is generally zoophilic, but under special conditions of high density coupled with poor housing and low standards of living, malaria transmission can occur. Recent entomological observations have confirmed a striking reduction in vector density. This combined with a
possible lack of receptivity of the local An. atroparvus to tropical P. falciparum (citing Shute, 1940 and Zulueta, Ramsdale & Coluzzi, 1975) may explain the absence of malaria transmission in recent years, despite the large number of imported cases. However, the possibility of resumption of malaria transmission was discussed in view of the new situation that was created in 1975 by the repatriation of large numbers of both civilians and military personnel from the former Portuguese territories (some estimates showed one million or more). Malaria transmission could be re-established only if the standard of living is lowered, people migrate from urban to rural areas, and the medical and health facilities are reduced. This does not apply only to Portugal but to other countries of Europe where malaria has been eradicated.

Cambournac (1978) also reviewed the development of the antimalaria campaign in continental Portugal until eradication was achieved and certified. He also explained the surveillance scheme applied to detect imported cases of malaria among civilians and military personnel returning from overseas territories. After blood examination for malaria parasites and taking into account the place of origin, the person was classified and registered in the unit of the Services of Rural Hygiene and Protection against Malaria (SHRDAS) as:

(a) unlikely carrier (no recent indication of a febrile disease);
(b) probable carrier;
(c) very probable carrier.

Based on this classification, action was taken as follows: persons of group (a) were not visited unless they themselves requested; those of group (b) were visited at an interval of 1–2 months during the first year and in March–April of the following year; those of group (c) were visited monthly until they are shifted to one of the above groups depending on the results of follow-up observations. Military personnel were examined upon their arrival in Portugal, or during the return trip when they travelled by sea. Starting from 1974 and as a consequence of the exodus of personnel from the new independent countries which were formerly Portuguese territories, special action was adopted. Personnel of the Services of Rural Hygiene and Protection against Malaria went to examine and treat the returning persons in their place of residence which was provided by the authorities concerned (Commissariat for Displaced Persons or Returnees). Patients were treated locally or if necessary in special sections in hospitals in various parts of the country. The system was carried out efficiently and proved to be highly satisfactory. It included not only malaria but also other tropical diseases. Additionally, malaria has been a notifiable disease in Portugal, and private doctors all over the country have been greatly cooperating. Some cases of introduced malaria were detected, the last case of which was reported from the south coastal region in Aljustrel area in 1975. It was a case of a child with P. falciparum infection who was radically treated in time, and an epidemiological investigation was carried out followed by application of residual spraying in houses and animal shelters. No more cases were detected later despite a very active search in the area. From the tabulated data, cases observed by the SHRDAS in 1975–1976 were:

<table>
<thead>
<tr>
<th>Year</th>
<th>P. vivax</th>
<th>P. falciparum</th>
<th>P. malariae</th>
<th>P. ovale</th>
<th>Undetermined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>713</td>
<td>119</td>
<td>11</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>1976</td>
<td>393</td>
<td>58</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

Among armed forces there were 669 cases of P. vivax and 229 cases of P. falciparum detected in 1975. The possibility of introduction of malaria in Portugal was discussed. Reference was made to the experimental evidence indicating the refractoriness of An. atroparvus to the tropical P. falciparum strains. Cambournac also added that Almeida Roque in 1974 (citing personal communication) provided similar evidence using An. atroparvus from Aguas de Moura, Portugal. At field level, the present density of An. atroparvus is much lower than that which prevailed in the former malarious areas, possibly due to the presence of Gambusia in rice fields and as a result of application of agricultural pesticides and herbicides. In some areas of the south, however, An. atroparvus exhibited a certain degree of resistance to DDT and the cyclodiene group of insecticides. Among other factors that may militate against the introduction of malaria is that the highest proportion of imported cases usually reside in urban areas where the risk of malaria transmission is very low. Cambournac, however, thought that it would be safer to consider that the receptivity to malaria continues to exist despite some adverse
factors. With regard to vulnerability, the number of imported cases was expected to decrease, but it would be prudent to consider that vulnerability will continue to be high in future.

Antunes et al. (1987) in a brief communication reviewed the recent records of imported cases in Portugal. They recalled that in 1974, there were 903 imported cases among thousands of civilian and military personnel returning home following the independence of former Portuguese overseas territories. Nevertheless there was no evidence of an epidemic surge of autochthonous malaria, apart from a single case in Aljustral in the southern part of the country (see above). From the tabulated data of imported cases recorded during 1977-1985, there were 137 cases in 1977 representing less than a quarter of those recorded in 1974. Thereafter the number of imported cases gradually decreased reaching 19 in 1982, but appreciably increased reaching 57 in 1985. Details were given of 65 imported cases diagnosed and treated in the Department of Infectious and Parasitic Diseases of Santa Maria hospital, Lisbon, from 1977 up to September 1986. Of these cases, 61 came from different countries of tropical Africa, and one from India which was due to blood transfusion, and one P. falciparum caused by accidental infection. P. falciparum and P. vivax constituted 81% of the imported cases. Severe and complicated malaria was seen in seven patients, one of whom died, even though treated with quinine as chloroquine resistance was suspected. Another patient developed serious renal failure that required dialysis. The authors considered that malaria, whether imported or caused by blood transfusion, or due to accidental infection has again become a serious problem in Portugal, as is the case in other countries of Europe (citing several authors).

1.2.1 (ii) Induced and accidental malaria

The Terminology of Malaria (WHO, 1963) defined the term induced malaria as: "Malaria infection properly attributed to the effect of a blood transfusion or other form of parenteral inoculation, but not to normal transmission by the mosquito. The course of infection may be different from that observed in the normal case. Induced malaria may occur accidentally or may be produced deliberately for therapeutic or experimental purposes." For convenience, the available information on induced malaria is compiled here under two main subheadings: transfusion-induced malaria (or simply transfusion malaria), and accidentally-induced malaria (or simply accidental malaria). Deliberately-induced malaria for therapeutic or research purposes is not dealt with here.

a. Transfusion malaria

In a comprehensive and well-documented review of blood transfusion and tropical diseases, Bruce-Chwatt (1972) incorporated a section on malaria, a summary of which follows. During the 1940's the use of stored blood gradually replaced the old technique of direct blood transfusion when there was no barrier between the circulation of the donor and that of the recipient. The incidence of transfusion malaria decreased as more attention was given to the selection of donors. However, with the increasing use of blood transfusion in medicine and surgery, transfusion induced infection increased. This became evident when the problem of detection of imported, introduced and induced malaria came within the framework of surveillance activities of malaria eradication programmes coordinated by WHO in 1956. The fact that the incidence of transfusion malaria has been increasing in several countries reflects not only the better diagnostic methods and improved reporting, but also the rising trend of malaria imported into some countries from many tropical malaria endemic areas in the world. Apart from the data provided by surveillance activities of the [previous] malaria eradication programmes under consolidation or maintenance phases, the reliability and accuracy of information from other countries on transfusion malaria have not improved, and most of the available data are gleaned from publications or occasional reports. There is no doubt that many cases have not been recorded and there is a consensus amongst several authors that transfusion malaria is grossly under-reported, since any such episode may imply some negligence on behalf of the institution concerned. The blood transfusion centre represents only the first link in the long chain of events subsequent to a blood transfusion, and a number of observations remain confined to hospital files.

From the available information, Bruce-Chwatt tabulated data of induced malaria that occurred in 49 countries during 1950-1970, including parasite identification and the respective references. These data showed that 1247 cases of induced malaria recorded
during the above period was much higher than the number of 350 cases reported during the first 50 years of this century. This was due to the greater use of blood transfusion and to the improved methods of case detection and diagnosis. The majority of the cases (64%) were identified as P. malariae. This was explained by the change to the technique of blood transfusion using stored blood, and to better selection of blood donors. At the same time this also emphasizes the growing concern about long-term infections with P. malariae. In five countries of southern Europe, infections (especially P. malariae) related to blood transfusion as recorded in the 20-year period under review were: Bulgaria (14 cases), Greece (84 cases), Italy (60 cases), Romania (148 cases), and Yugoslavia (54). The fact that quartan malaria may remain a latent infection for many years explains the high number of cases of transfusion malaria in these countries. It was estimated that in the Macedonian part of Yugoslavia with a population of 1.5 million, there were about 550 symptomless carriers of P. malariae. In the USSR, much attention has been given to transfusion malaria. During 1958–1964, 47 cases of induced malaria were reported: 42 had been given blood and five received plasma. Transmission of malaria by plasma was probably due to the contamination of syringes. P. malariae was identified in 39 cases, P. vivax in seven cases and there was one case of P. falciparum. Among P. malariae infections, there were 22 cases due to the practice of intramuscular blood injection for prevention of measles in children. In a special survey made in the USSR among blood donors, repeated and prolonged microscopical blood examinations revealed only two asymptomatic carriers of P. malariae. In Spain, where a small number of induced malaria cases had been reported in the past, the year 1971 witnessed an unusual outbreak of 43 cases of P. vivax subsequent to whole blood transfusion, and 11 cases of the same species following plasmapheresis. It was thought that in the latter technique, the recipients were not given their own blood cells but those of other donors. Most of these cases originated from a blood bank in Barcelona which used workers from North and Central Africa as donors.

Bruce-Chwatt further pointed out that the incubation period of blood induced infection is quite different from that of mosquito transmitted malaria, as no tissue stages in the liver are involved. Thus, the pre-patent and pre-symptomatic (= incubation) periods depend to a large extent on the number of parasites introduced, the method of inoculation, and on the susceptibility of the recipient. Much information on this subject has been gathered by those who have been undertaking malaria therapy and several publications were reviewed. In this connection, many authors pointed to delays and errors that occur in the diagnosis and treatment of malaria. Thus, the attention of the medical profession must be drawn to the possibility of malaria as a complication of blood transfusion. In the case of any unexplained fever in a patient who received a blood transfusion up to three months previously, the possibility of malaria must be considered, and microscopical examination of the blood, and if necessary serological tests carried out.

For prevention of induced malaria, three possibilities were considered and various experiences reviewed:

- Exclusion of suspected donors: This may be based on the elimination of anyone who has ever had malaria. Few people would know with certainty if they have had malaria, as the illness may have been in the form of simple transient pyrexia, particularly if the person was on a chemothapeutic regimen. Regulations governing the acceptance of donors of whole blood among countries were reviewed. In many countries the regulations prescribe the acceptance, as donors for whole blood transfusion of persons who have had malaria less than three years or less than five years before presenting for blood donation. It is difficult to obtain fully reliable information from the prospective donors in a system of commercialized donation. This is self-evident and need not be emphasized. When the long-lasting and often asymptomatic infection of P. malariae is considered, no reliance can be placed on the past history of the most sincere and truthful donor. This risk will have to be accepted in some parts of the world, but the use of immunological screening would contribute to solving this problem.

- Detection of malaria infection: Detection of malaria in a suspected donor may prove very difficult. Microscopic examination of a blood smear is of little value for detection of asymptomatic parasitaemia which is usually very scanty. Several methods of indirect diagnosis of malaria by the application of immunological techniques have been developed. In a review of the IFA test, Sulzer & Wilson (1972) confirmed the value of this test in 10 cases of transfusion malaria, and indicated that an antibody titre of 1:256 or higher is suggestive of a current malaria infection if there has been no specific treatment during
the previous six months. Reference was also made to an immunological investigation carried out in France by Ambroise-Thomas, Garin & Kien Truong (1971) covering more than 1000 donors who had lived in malarious areas overseas. Using P. cynomolgi [bastianellii] as an antigen for IFA tests, these authors found that in 58.2% of potential blood donors who, on their return to France, were not exposed to the infection for less than five years, the test was negative and these persons could be used as blood donors. On the other hand, in 28.2% of the persons previously exposed to malaria and living in France for over five years, the IFA was still positive. Therefore, the use of their blood would be unsafe because of the possibility of transfusion malaria. Thus, this study demonstrated that the roughly suggested 5-year limit as a "safe period" for prevention of transfusion malaria may be overoptimistic. The value of the IFA test for detection of asymptomatic carriers of malaria was endorsed by Bruce-Chwatt et al. (1972) in their investigation of blood donors in the UK. It should be remembered, however, that a positive test signifies only previous infection and cannot be considered a criterion of the actual presence of malaria parasites.

- Treatment of donors or recipients: Several authors stressed the practical difficulties and the unreliability of pre-medication of suspected donors. On the other hand, treatment of recipients of suspected blood has been found more reliable and easier in practice. Several authors agree that a dose of 600 mg of chloroquine (base) given to a recipient of infected blood 24 hours before transfusion protects from induced malaria. It may be prudent not to rely on a single dose of chloroquine but to continue to give the recipient suppressive chloroquine at 300 mg base once a week for at least a month. As it is unlikely that true relapses would occur after a blood transfusion of P. vivax and P. malariae, radical treatment with primaquine is not needed. Treatment of the recipient seems to be the best solution applicable to situations where there are unusual risks of transfusion malaria, but the possibility of chloroquine-resistant P. falciparum strains should be kept in mind.

Bruce-Chwatt (1974) presented a more concise review of transfusion malaria nearly along the same lines shown above.

From a recent experience in France, Ranque, Faugère & Scoffier (1980) presented the problem of malaria infection due to blood transfusion in relation to imported malaria. Transfusion malaria is becoming an important problem in France, being connected with African immigration, professional and touristic travel to malaria endemic areas. Besides which, the increasing demand for blood transfusion coupled with the utilization of large quantities of blood in major surgical interventions has increased the risk of transmission of malaria infection over the past 20 years. Between 1960 and 1980, there were 82 cases of transfusion malaria with P. falciparum being predominant through the close relationship of France with tropical Africa. To solve this problem, some approaches were discussed. To exclude all subjects who spent some time in malaria endemic areas would result in elimination of a large number of blood donors. To consider a period of five years that must elapse after the last clinical manifestation of malaria is not acceptable because of occult infections. Limiting this exclusion to two years would permit the elimination of only P. falciparum. To examine the blood of healthy carriers is extremely difficult and uncertain. The best solution is to resort to immunological tests. IFA test in particular is the most suitable, but its results have to be interpreted in the light of the following information:

- duration of stay in endemic areas;
- the period that elapsed between the cessation of the chemoprophylaxis and the date of the serological test.

Such information was used in interpreting the results of IFA tests made on 2571 sera provided by blood transfusion centres in Marseille and Nice. The geographical origin of infection of the donors were: tropical Africa where the risk of infection is high, and North Africa where malaria endemicity is low, from which a large number of donors originate. The donors presenting antibodies are those who generally resided for a long time in malaria endemic areas or those who made frequent visits. Two thirds of the donors whose serological tests were positive did not declare any previous clinical symptoms.

1. The summary of this paper has been made through the cooperation of Dr R. Le Berre, WHO Entomologist, TDR, WHO, Geneva, by translating parts of the text.
When a level of 1/20 was adopted as an indicator of positivity of healthy carriers by the IFA test, the number of Plasmodium carriers was overestimated. On the contrary, the negativity of such a test at the end of a period of four months after the return from an endemic zone, or two months after the cessation of chemoprophylaxis as in France (a period which is sufficient to constitute the antibodies when malaria infection exists in the blood) would permit the utilization of the donor with absolute security. Thus, a large proportion of donors can be recuperated as it happened in the present series when 86.9% of the donors could be retained. On the basis of this, the following schemes were proposed by the authors:

- Donors frequently visit malaria endemic areas: to be excluded.
- Other donors should be excluded for four months after their return to France, subsequently they can be retained if the IFA test is negative.

However, there is no absolute security with all preventive measures including the latter scheme, because of the possibility of error in information provided by the donor.

Recently, Saleun et al. (1987) pointed to the increasing incidence of transfusion malaria in France. Recalling the data collected by Saleun et al. (1981), the number of reported cases of transfusion malaria increased from 24 in 1960-1969 to 79 in 1970-1979. It must be admitted that the number of cases reported is undoubtedly inferior to the actual number of cases. The same reasons for the increase shown above were also given by the authors. Moreover, the development of methods of transfusion using concentrated erythrocytes increases the chances of infection with malaria parasites. Citing also the data of Saleun et al. (1981), P. falciparum has been responsible for increasing proportions of transfusion malaria constituting 15.4% of all cases detected in 1960-1964, 45.5% in 1965-1969, 79% in 1970-1974 reaching 84% in 1974-1979. P. vivax did not exceed 4% in 1975-1979, and P. malariae decreased from 45.5% in 1965-1969 to 13.9% in 1970-1974 and 8% in 1975-1979. P. ovale has never been mentioned in any investigation. Perhaps this parasite may be masked by other virulent plasmodial parasites such as P. falciparum particularly where both occur in association in tropical Africa. P. falciparum is known by its grave consequences for the patient, and for this reason, the authors systematically tested the blood of the donors for the malaria antibodies starting from 1981. The method of IFA assay as applied by Deroff et al. (1982) was described. The antigen used is commercially produced by Bio-Mérieux Institute under the name "Falci-parum Spot I.F.", and is prepared from P. falciparum in vitro culture. The dilution of 1/20 was adopted as the inferior limit of positivity. During the period 1981-1985, 158 788 blood units were sampled. After interrogation, 1747 subjects were considered donors at risk representing 1.1% of the total sample. Of these 107 were positive in IFA tests, representing 6.12% of the donors at risk, but only 0.6% of the total blood units sampled. Statistically, there was no significant difference between the frequency of seropositive subjects among those who spent less than four months after their return to France and those who spent between four months and two years. On the other hand, this period of stay in France before testing does not give any idea on the duration of the pre-serology phase, since information on the exact period of residence in the malaria endemic area is lacking. However, it seems that testing donors after a period of four months after the return to France is sufficient for avoiding transmission of malaria through blood transfusion. The geographical origin of 1286 donors was traced. Of these, 8.4% originated from tropical Africa, 7.53% from North Africa, Djibouti and the Middle East, 5.94% from South America, 2.44% from the Indian subcontinent and Far East. The high proportion of seropositive donors from tropical Africa is related to the frequent exchange between France and this region which contains high risk malaria endemic areas. Of the seropositive donors from North Africa, seven came from Morocco and two from southern Algeria, but the exact destination should be verified as they may have passed through other countries. The low proportion of seropositive donors from South Asia can be attributed to the limited emigration and touristic journeys from countries of that region to France. In conclusion, the authors pointed out that the screening procedures of the donors largely depend on the medical history. Although the results are satisfactory, they could be improved by using specific monoclonal antibodies.

In Switzerland, malaria infection not directly related to blood transfusion has recently been recorded. As communicated by Zuber & Holzer (1986), two patients with renal insufficiency who had never resided in a malaria endemic area were operated for kidney transplant in December 1984. The donor was an African aged 27 years who died from cerebral haemorrhage, but otherwise was in a healthy condition. His blood film was
negative. Nine and 16 days after the intervention, the two patients respectively developed intermittent fever and P. vivax was identified in their blood films. The two patients responded well to 3-day chloroquine treatment.

In Romania, Panaitescu & Fillotti (1980) indicated that after the interruption of malaria transmission in 1961, the number of P. malariae cases recorded during 1963-1978 was 156, of which 132 were due to blood transfusion and 24 were relapses. The epidemiological investigations of these cases showed that most transfusional cases were distributed over the former malaria endemic territories of Romania, and that their detection was due to the efficient diagnostic system in the country.

Recently, Prof. Hässig of Bern, Switzerland (1987) organized an international forum to obtain views on the following question: "Which are the appropriate modifications of existing regulations designed to prevent the transmission of malaria by blood transfusion, in view of the increasing frequency of travel to endemic areas?" Prof. Hässig as editor presented the views of five leading authorities, which can be read in detail in the original publication, or briefly in two abstracts by Prof. L.J. Bruce-Chwatt in the Tropical Disease Bulletin respectively Nos. 997 and 998, VOL. 85(4), 1988. At the end of these abstracts, Prof. Bruce-Chwatt remarked: "This exchange of views provided several useful points for a wider international meeting on the subject of transfusion malaria. It showed the limited consensus of opinion on the details of screening procedures although a complete agreement on the importance of the subject. It is hoped that the forthcoming International Congress on Blood Transfusion due to meet in July 1988 in London will devote some time to this problem."

b. Accidental malaria

There are several reports of accidental infections transmitted through contaminated needles among hospital staff or drug addicts, and in a few cases through contamination of wounds when handling infected blood. Included here also are two cases of accidentally acquired infection through handling infected mosquito colonies, although such a mode of transmission does not fall under the category of accidentally-induced malaria.

In France, Pasticier et al. (1974) described a case of an assistant nurse aged 27 years at Sensis hospital whose infection was microscopically diagnosed as P. falciparum in August 1973. She also suffered from typhoid at the same time. The possible sources of her malaria infection were considered as follows:

- Possible source: through an infected mosquito in Spain where she spent one month during the previous year, or in Landes in France where she spent four days before showing fever.
- Definite source: as a result of accidental needle prick (10 days before her illness) when she was drawing blood with a syringe from a woman hospitalized suffering from malaria whose infection was identified as P. vivax but the blood slide was not preserved. This patient left the hospital after 48 hours and from a brief enquiry, it appeared that she lived in Africa for three years and resided in New Caledonia for a long time. The authors favoured this latter mode of infection since the period of 10 days that elapsed between the contact with the infected blood and the appearance of malaria symptoms would not be sufficient if transmission was caused by the bite of an infected mosquito. [But the author did not explain how the assistant nurse contracted P. falciparum malaria, while the infection of the hospitalized patient was P. vivax. Could it be that the patient had P. falciparum infection as well but was not recognized?]

Petithory & Lebeau (1977) described a case of a student aged 25 years working in the medical biology department of the Centre Hospitalier of Gonesse, France who was hospitalized in November 1974 and his illness was attributed to microscopically confirmed P. falciparum infection. His history showed several prolonged periods of soujourn in Algeria, Madagascar and Somalia, but this was excluded as it occurred 10 years previously and he had administered the chemoprophylaxis correctly. His infection on the Côte d'Azur where he went for a short holiday three months before his illness was also excluded since no autochthonous malaria cases have been reported from that region. Likewise infection in the Paris region was ruled out as it was too cold at that time of the year. No blood transfusion was involved. The only probable explanation was that he acquired the infection in the laboratory while handling a blood sample highly infected with P. falciparum through skin excoriations, although such a mode of infection is extremely rare.
Bastin et al. (1979) described a case of a 20-year-old Vietnamese young man who came directly to France from Saigon on 5 April 1976. Following an intravenous injection of heroin, he suffered from fever for which he was treated with ampicillin for septicaemia with no response. He was admitted to Claude Bernard hospital, Paris, where a blood examination revealed the presence of P. falciparum infection. He was treated initially with chloroquine, but with no response. As chloroquine resistance was suspected, he was given quinine perfusion (1 g/24 h). The fever subsided and his blood became negative except for the presence of gametocytes. Therefore, he was given 3 tablets of joint sulfadoxine-pyrimethamine, after which the blood became totally negative, but IFA test with P. falciparum antigen was positive at a titre of 1/600. Based on information obtained from the patient, the source of infection was suspected to be one of three young Vietnamese immigrants during the previous 3–4 months. It was possible to examine the blood of one of them by IFA test for P. falciparum and found positive at a titre of 1/800. The authors recalled that accidental malaria transmission has been known for a long time, citing Brunnet (1949) who reviewed the literature hitherto available on this mode of transmission. The authors, therefore, reminded that malaria should be suspected when a drug addict using intravenous injection suffers from fever, hence microscopic examination of his blood must be sought in the first place. On the other hand, the epidemiological consequences of the present observation should await the appearance of new cases.

In Switzerland, Zuber & Holzer (1985) reported a case of accidental malaria in a Swiss nurse aged 27 years who had never resided in a tropical country. On 25 June 1985, she accidentally pricked her finger with the needle of a syringe while taking a blood sample from a patient who was hospitalized for undetermined fever. This patient returned to Switzerland after residing in Kenya without taking any chemoprophylactic drug. Two weeks later, the nurse went for a holiday in Israel where malaria does not exist. Two days after her arrival there she developed febrile episodes accompanied by diarrhoea for which she was hospitalized and treated with antibiotics. Subsequently she was flown to Switzerland where she was hospitalized. Examination of a blood film revealed the presence of a massive P. falciparum infection. She recovered rapidly when treated with quinine followed by Fansidar.

Two cases not accidentally induced, but accidentally transmitted through bites of laboratory reared infected mosquitos were reported in France by Drulhe et al. (1980). They were two laboratory assistants: a 28-year-old female and a 30-year-old male in charge of maintaining laboratory colonies of An. freeborni infected with a strain of P. cynomolgi bastianelli kept in a Rhesus monkey (Macaca mulatta). They presented themselves with fever and malaise to the Laboratoire Central de Parasitologie et Consultation des Maladies Tropicales et Parasitaires, Paris in May 1977 and May 1979 respectively. The first patient was given antibiotic and chloroquine treatment by her private doctor before any laboratory examination. This treatment was stopped after three days; subsequently, a blood smear examined a week later was negative but IFA test was positive at 1/1300 and 1/1800 with P. falciparum antigen. The patient responded well to full chloroquine treatment. A thick blood smear from the second patient was positive but the parasite was very rare (one infected r.b.c. per 20 000); the parasite was identified as P. cynomolgi bastianelli after prolonged examination. Two healthy Rhesus monkeys were inoculated intravenously with heparinized blood collected from the second patient on admission. The blood of the two monkeys was parasitized on the 17th and 24th day of inoculation, and P. cynomolgi bastianelli was clearly identified. Serological investigation by IFA test and counter immuno-electrophoresis using different antigens rendered useful information. The two assistants recalled that during their normal work with the laboratory infected colonies, they were frequently bitten by mosquitos.

Bruce-Chwatt (1982) in his review of imported malaria, tabulated the data recorded in the UK during 1970–1980. Of 11 032 cases there was only one case described as accidental malaria. He explained that this was a case of P. vivax which occurred in 1980 in a nurse, who pricked her finger with a contaminated needle, when giving an injection to a patient with confirmed infection.

In West Germany (Federal Republic of Germany), Börsch et al. (1982) described the clinical symptoms of a 39-year-old nurse who took a venous blood sample from a malaria patient in August 1982. The patient was a 39-year-old male Pakistani whose infection was microscopically confirmed P. vivax. He recovered after treatment with chloroquine and
primavine. In September 1982, a blood smear from the nurse revealed the presence of
P. vivax, which was corroborated by a high antibody titre (1:320) in IFA test. The nurse
did not give any history of long-distance travel. She had not had any blood transfusion
in the previous 17 years, nor had she been living near an international airport. She was
not conscious of a needleprick, though she remembered having several small scratches on
her fingertips (caused by peeling potatoes) while handling the blood sample without
wearing gloves. Since other modes of infection have been excluded, the authors considered
that parenteral transmission of P. vivax was undoubtedly the cause of this case. This
would suggest that even minor injuries could be a realistic, though rare, threat to the
medical staff.

In Italy, Orlando et al. (1982) described an outbreak of P. falciparum malaria among
drug addicts which occurred in Milan during February-July 1981. The first case was a
32-year-old Italian male who was admitted to Milan hospital suffering from fever of
unknown origin. His symptoms were fever, chills, anaemia and hypotension, simulating
sepsis, but P. falciparum was identified in his blood 41 days after his admission. He was
treated with chloroquine at an initial dose of 600 mg followed by 300 mg six hours later,
then by 300 mg daily. On the 5th day of treatment the patient was still febrile, and ring
forms could be found in a thin film of his blood. He was, therefore, treated with quinine
sulphate at a dosage of 600 mg every eight hours. However, parasitaemia persisted until
the 9th day, but later he was discharged in good health and had no relapses subsequently.
This could be a case of chloroquine resistance. Eleven other heroin users affected by
P. falciparum infections were later observed in the hospital; all came from the same area
of the city. The time lapse between the onset of their symptoms and diagnosis was shorter
than in the first patient due to the awareness of the clinicians. Clinical symptoms of
these patients at the time of admission were generally fevers and chills, and two of the
patients were comatose. All cases were due to P. falciparum infection, and were given
quinine treatment as chloroquine resistance was suspected. One patient died and a
post-mortem examination revealed congestion of the cerebral and visceral capillaries with
parasitized red blood cells and aspergillosis of the lungs. One patient was readmitted
after one month for recrudescence. The first source of this outbreak remained unknown.
None of the patients travelled to malaria endemic areas. Probably an asymptomatic carrier
coming from a malarious area initiated this outbreak by sharing his intravenous equipment
with other drug addicts. The incubation period of these infections could not be
established because of the difficulty in determining the time of the infective injection.
Up to this episode, malaria infection among heroin users has not been reported in Italy
and this is why physicians did not consider this possibility in the differential diagnosis
of fevers among heroin addicts. Public health measures to prevent the spread of malaria
infection involved informing heroin users through peripheral centres for addict
assistance. No more cases were seen after July 1981.1

In Spain, Gonzalez Garcia et al. (1986) reported on an outbreak of P. vivax malaria
among heroin users which occurred in Madrid in the spring of 1984. This is the first
outbreak of induced malaria among heroin users in Spain, and the first one caused by P.
vivax in Europe. Five white male drug addicts, 17 to 18 years old, who had never visited
malaria endemic areas, were admitted to hospital because of malaria and fever. The
history of drug addiction began six months before. The diagnosis of malaria was
microscopically confirmed in thick and thin blood films. The five drug addicts came from
the same area of Madrid and shared contaminated injection equipment with a common friend
who had often travelled to Equatorial Guinea and was affected by malaria, and this was the
source of the outbreak. A seventh young man diagnosed as having malaria, refused to be
admitted to the hospital for further study. Four of the patients were diagnosed
microscopically in thick and thin blood films as P. vivax with low parasitaemia ranging
from 1 to 3% red blood cells. The fifth patient was classified as "seropositive contact"
because he had a febrile syndrome and positive IFA (1:160), but no parasites were detected
in his blood films. Chloroquine treatment was given at a dosage of 1500 mg over three
days. Parasitological blood examination became negative one to two days after commencing
treatment. No recrudescence of malaria was observed during a mean follow-up period of six
months. No primaquine treatment was necessary, since in induced malaria there is no
exocrythrocytic cycle as the parasites live and multiply in the red blood cells. Until
the present outbreak, malaria has not been reported in Spain among intravenous drug
abusers and this is the reason why physicians had not been aware of the possibility of

1. An official publication communicated to WHO by Italian authorities showed that the
total malaria cases in drug addicts was 23 in 1981 - see Table 4(b).
malaria in the differential diagnosis of fever in drug addicts who have never travelled to malaria endemic areas.

The number of malaria cases among drug addicts has recently decreased, but the reasons are not known. This may have been due to the efforts of the centres of addicts assistance as in Italy. In USA where an epidemic of malaria (P. falciparum) broke out in the 1930's and persisted for about 10 years. As indicated by Dover (1971) no further cases were seen following the detection of quinine as a common diluent or adulterant of confiscated heroin. This factor does not seem to have been investigated in Europe.

1.2.1 (iii) Malaria associated with airports

Since 1977 several reports have been published in France and elsewhere in Europe describing malaria cases among people working in or living near international airports. For simplicity these were termed "airport malaria". All reports point to the possibility of transmission being caused by infected anopheline vectors escaping from airplanes coming from tropical countries. Some authors when reviewing airport malaria, summarized the available information in tabular form, e.g., Cassaigne, Brulare & Leger (1980), Gentilini & Danis (1981), Holvoet, Michielsen & Vandepitte (1983), and Smith & Carter (1984). More detailed and up-to-date information on airport malaria is summarized here in Table 3. Few cases thought to have been contracted through bites of what has been termed "commuter mosquito" in flights originating from malaria endemic areas, are also included. In this table, information is arranged chronologically according to date of publications.

Some entomological investigations have been carried out in conjunction with airport malaria. In France, Pesson et al. (1980) presented a summary of the results of entomological surveys carried out for recording the local potential anopheline vector which may transmit malaria in and around international airports in the Paris area, and Leger et al. (1981) reported these results in more detail. During 1976-1979, 13 cases of malaria associated with airports were recorded: 5 among the temporary or permanent staff of Roissy-Charles de Gaulle, 4 living at about 4 km from this airport, and 4 at a longer distance from airports. Of the 13 cases, 11 were recorded in summer and autumn seasons, one in February, and one in December. The entomological surveys were started in August 1978, by inspecting the water collections that could serve as larval breeding places for mosquitoes. In addition to ground inspection, a helicopter was used once during the dry period and once in the wet period of the summer. The searches covered the Orly and Roissy airports and the surrounding communities. At Orly, nine potential breeding places were inspected regularly and all were negative for Anopheles larvae. At Roissy, among 45 potential water collections located by ground and helicopter inspection, 25 were surveyed regularly during the summer of 1979. Besides breeding places of Cx. pipiens s.l. and Culiseta annulata, four places harboured larvae of An. claviger and An. maculipennis s.l. These breeding places were basins for retention of drainage waters. During June-September 1979, inspection of two breeding places close to the airport indicated that they can support at least three generations of Anopheles species. Surveys of five localities around the airport were all negative for Anopheles. Search for adults by hand capture in transit and passenger halls revealed only a limited number of domestic insects. In luggage tunnels, many insects coming from outside were collected, but the only mosquito encountered was Culiseta annulata.

Leger et al. (loc.cit.) and Leger, Timbal & Pesson (1980) reported the results of an investigation on survival of Anopheles in air flights carried out to elucidate the possibility of transporting exotic malaria vectors from endemic zones. The investigation comprised transporting mosquitoes in cabins and luggage stores which are pressurized on long distance flights. On a flight of Boeing 747 operating between Rio de Janeiro and Paris, caged mosquitoes were placed in the pressurized cabin, inside baggage and in luggage stores in dry and humid atmosphere. Under such usual conditions of transportation of passengers and luggage, mosquitoes survived the journey until safe arrival. In addition, an experiment was made by confining caged mosquitoes (An. stephensi and An. maculipennis s.l.) in pressurized containers at varying temperatures (from -80°C to 25°C). Mosquito cages were protected from the dry ice which was used for producing low temperatures. The containers were placed on a flight simulating Paris-Dakar using two types of planes: Boeing 747 flying at a maximum altitude of 12 000 m, and Focker at a maximum altitude of 4000 m. The two Anopheles species well supported the action of the pressure, while the temperature was the only factor influencing their survival. The
survival rate was 100% at 25°C, 10% at 0°C, and 0% at -10°C, whether mosquitoes were
placed under controlled or uncontrolled pressures. From this it was inferred that the
survival of some mosquitoes outside the cabin of the aircraft is quite possible but such a
condition was considered rare. (See new observations below on survival of insects in wheel
bays of an aircraft.) Searches for mosquitoes in containers transported by airplanes coming
different countries of tropical Africa and the Far East were all negative.

In light of all the above results, the authors discussed the possible modes of
transmission of airport malaria. In favour of the hypothesis of transmission by local
anophelines are the following findings:

- Nearly all the malaria cases were associated with Roissy–Charles de Gaulle Airport,
  except one case recorded in 1974 near Orly Airport. The present entomological
  investigation gave contrary results between the two airports, in that *Anopheles* mosquitoes
  were found breeding only in the Roissy area.

- Most of the airport cases were observed during the summer of exceptionally hot years.

Against this hypothesis is the fact that 10 of the airport cases were *P. falciparum*, a
species which has disappeared from Europe where the local anophelines have been found
incapable of supporting the development of strains of this parasite of African origin,
although they are more adapted to exotic *P. vivax*. However, the authors felt that the
susceptibility of the local anophelines to exotic *P. falciparum* still await firm
conclusions, in view of the experiments made in the USSR indicating the susceptibility of
certain species of the *An. maculipennis* complex to some African strains of *P. falciparum*,
citing Daškova (1977) and Dzhavadov et al. (1978). The authors also reminded that in
malaria outbreak that occurred in the valley of Blève in 1940, there were two cases of
*P. falciparum*. For some reason, no experimental infection could be carried out in
France involving airport malaria. However, negative results would be only of relative
value since the exact geographical origin of the strains that caused airport malaria
remains unknown.

Being unable to draw firm conclusions favouring one of the two hypothetical modes of
transmission of the airport cases: by local anophelines or imported infective vectors, the
authors recommended certain protective measures to be limited, for the time being, to the
area of Roissy–Charles de Gaulle Airport as it is proved to be the most exposed to such
infections.

These measures are:

- replacing dieldrin with malathion as residual spraying because of resistance of the
  *An. maculipennis* complex to dieldrin. Malathion is to be applied at a dosage of 2g/m²
twice annually (May and July). The spraying should cover passenger and luggage halls as
well as luggage transferring tunnels (see information on the effect of this spraying
below);

- larviciding of breeding places around the airport with temephos at 1 ppm in two
rounds (at the beginning of each of May and July), and to continue application of
*Bacillus thuringiensis*-serotype H-14;

- reminding air companies to adhere to international regulations of WHO for
disinsecting aircraft;

- health education for the staff of airports to inform them about the risk of
contracting malaria;

- alerting medical practitioners to the possibility of accidental and airport associated
malaria.

1. In a later review by Daškova & Rasnicyn (1982), experimental infection studies
involving tropical strains of *P. falciparum* in *An. sacharovi* and *An. subalpinus* were
reviewed—see under 1.2.1 (i) above and also VOL. I, under 2.8.2 (ii).
In the UK, Curtis & White (1984) reviewed the reports of malaria associated with airports in Europe and the two cases recorded in Ruster and Horsham in Sussex, England during 1983, as well as reports of searches made in aircraft including those arriving in Gatwick Airport for detecting mosquitoes. They further discussed the possibility of transmission by local potential anopheline vectors in Sussex from an imported P. falciparum case. To find a suitable P. falciparum gametocyte carrier in Sussex was considered unlikely, but this possibility exists at Gatwick Airport. However, the chances of a local anopheline to travel 10-15 km to the homes of the two patients would be no greater than those of an infected tropical vector carried by an aircraft from an endemic area. It was more plausible to assume that the infected mosquito was transported passively from the airport by a vehicle (as explained in Table 3). A few days after the diagnosis of the two cases in August 1983, Curtis & White visited the homes of the two patients in Sussex and could collect larvae of An. claviger and An. plumbeus. Based on literature review, it was pointed out that the question of whether or not these two species are susceptible to tropical P. falciparum does not seem to have been definitely settled, and has been confused in publications by several misquotations of various publications. It was suggested that with the availability of P. falciparum gametocytes cultured in vitro, the question of the susceptibility of the two anopheline species should be clarified. Of other British anophelines, An. atroparvus used to be the vector of malaria in England. It was found susceptible to European strains of P. falciparum but refractory to African or Asian P. falciparum citing Shute (1940) and more recent work of Zulueta, Ramsdale & Coluzzi (1975) and Ramsdale & Coluzzi (1975) using strains of this parasite occurring in Nigeria and Kenya. Reference was also made to experiments of Dašková (1977), Dzhavadov et al. (1978) and Dašková & Rasnicyn (1982). While An. atroparvus was refractory to African P. falciparum some positive results were obtained with An. subalpinus and An. sacharovi (as shown above). Curtis & White thought that as the last two members of the An. maculipennis complex occur in southern and eastern parts of Europe, their susceptibility to African P. falciparum would be irrelevant for a discussion of potential vectors in northwestern Europe.

In their conclusions, Curtis & White underlined the following:

- Two cases of P. falciparum transmission in Sussex that were recorded during July-August 1983 represent the first cases of malaria transmission in Britain since 1953. The only record of P. falciparum transmission in Britain was in 1920.

- Two additional cases of P. falciparum were diagnosed in two resident British women who travelled independently on the same Ethiopian Airline flight from London Heathrow Airport to Rome on the evening of 11 June 1983. It seems almost certain that both women must have been infected through an interrupted bloodmeal by an African vector on board the aircraft which originated in Ethiopia.

- The British mosquito species: An. claviger and An. plumbeus were found near the homes of both patients in Sussex, but it seems very unlikely that these mosquitoes could have been infected from P. falciparum gametocyte carriers.

- Perhaps all British anopheline species are refractory to tropical P. falciparum strains as distinct from the presently extinct European strains of this parasite.

- As proposed earlier, the two Sussex cases most probably were bitten by a single infected mosquito imported on an aircraft and transported by a car to Sussex. Its survival would have been aided by the high ambient temperature during the summer of 1983.

- Of 67 aircraft searched upon arrival at Gatwick Airport, 12 harboured culicines of African origin. The only anopheline mosquito was An. claviger apparently of British origin. Some of the aircraft with live mosquitoes had been sprayed with insecticide aerosols.

- Laboratory tests made in a sealed room showed no evidence of resistance to aerosols in the progeny of culicine mosquitoes collected alive in the aircraft.

- Caged mosquitoes (males) deliberately placed on commercial flights showed 100% mortality when the aircraft was sprayed with 57% or more of the recommended aerosol dose, but incomplete mortality resulted when less than half of the recommended dose was applied.
To prevent the transport of infective malaria vectors and possible spread of non-indigenous species to new areas, it is necessary that aircraft from malaria endemic regions are treated with an adequate dosage of insecticide.

Under current international health regulations all interior parts of the aircraft need to be sprayed with the full dose recommended by WHO.

The substitution of aerosols by residual spraying of aircraft by low toxicity insecticides would merit further study. [Actually this has now been included in the new recommendations of WHO for dissection of aircraft - see below under 1.2.2].

Curtis & White also referred to the recommendations of Léger et al. (1981) who stressed the need for applying residual spraying in baggage tunnels and halls in Charles de Gaulle Airport. Since this measure was adopted in 1981, no cases of airport malaria have been recorded in Paris (citing personal communication from N. Léger to W. Peters).

Smith & Carter (1984) wrote a chapter on the international transportation of mosquitoes and its implication in public health. The chapter includes: a review of reports of mosquito-borne diseases transmitted by the introduction and establishment of exotic species of mosquitoes; records of malaria cases associated with European international airports arising from imported infective vectors, from published information up to 1982; factors affecting and contributing to the establishment of mosquito vectors and the introduction of mosquito-borne diseases into new areas; requirements for improving control and surveillance in international transportation of mosquitoes of public health importance; and preventive and control measures. In an appendix, records of mosquitoes detected in international ships or aircraft are listed. For details of these aspects, the original chapter should be consulted. It is sufficient here to summarize the appropriate preventive and control measures as classified by the authors into two categories:

(a) Surveillance within receptive areas: Surveillance in a receptive country involves maintenance of effective detection mechanism and control measures. The WHO Expert Committees have repeatedly emphasized the need for maintenance of effective antimosquito measures within and around international airports and ports. These measures should include:

- Appropriate sanitary engineering principles should be observed in the design and maintenance of international airports to minimize vector breeding and prevent vector entry into airport buildings.

- Maintaining regular entomological surveys, and application of larvicides to breeding places. It may be necessary to treat buildings within and around airports and ports with residual and ultralow volume (ULV) insecticide formulations. Vectors should be susceptible to insecticides used.

Surveillance procedures should also include detection of exotic vectors in international aircraft and ships. This aspect needs more precise study than at present, with the aim of determining the sources of infestation of aircraft and ships because the risk of infestation is much greater on some routes than on others. When the vulnerable routes are identified, it may be possible to redirect the activity of detection and control of exotic vectors to only those international aircraft travelling regularly on these routes. The method of disinfesting passenger cabins immediately after disembarkation as practised in the US, awaits wide trial. Other methods for aircraft disinsection that are acceptable to crew and passengers await development.

(b) International cooperation to control the mosquito vectors at source: Governments having international airports in areas infested with mosquito vectors should be encouraged to:

- make in-depth vector studies in and around their international airports and ports, and assess the implications of the findings from an international standpoint;

- describe the current vector control operations, and indicate the degree of control achieved;
<table>
<thead>
<tr>
<th>Country</th>
<th>Reference</th>
<th>Patient</th>
<th>Date of detection</th>
<th>Parasite</th>
<th>Explanation offered</th>
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</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Holvoet, Michielsen &amp; Vandepitte (1982, 1983)</td>
<td>Male, 18 yrs</td>
<td>Aug. 1982</td>
<td>P.f.</td>
<td>Two brothers lived in the same house at Perk, a rural village less than 2 km from the cargo section of Brussels International Airport. They do not work at airport. Never travelled outside Belgium, no history of blood transfusion or of drug abuse. Probably they were bitten by the same infected mosquito imported from a tropical area, presumably Central Africa.</td>
</tr>
<tr>
<td></td>
<td>WHO(1986) Wkly Epide. Rec. based on a report from the Ministry of Health and the Family, June 1986</td>
<td>5 Customs Officers</td>
<td>June 1986</td>
<td>P.f.</td>
<td>The five customs officers were working in Brussels International Airport in a special terminal reserved in particular for the transportation of goods. <em>P. falciparum</em> was the parasite species responsible for the five cases. The exceptionally warm weather and high humidity probably favoured the survival of the imported vector. One officer died and the post-mortem examination indicated lesions of the cortex and the brain-stem.</td>
</tr>
<tr>
<td>France</td>
<td>Giacomini et al. (1977)</td>
<td>Male, 20 yrs</td>
<td>Aug. 1976</td>
<td>P.f.</td>
<td>Patient working as a porter during his vacation at Roissy Airport; never left France, never received blood transfusion, and is not a drug addict. Probably he was bitten by an imported vector during his work as he was in charge of unloading freight luggage.</td>
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<td></td>
<td></td>
<td>Male, 76 yrs</td>
<td>Aug. 1977</td>
<td>P.f.</td>
<td>Patient with no history of travel abroad, no blood transfusion in the months before his illness; lives at 1.5 km (as the crow flies) from the freight hangar of Roissy Airport.</td>
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<td></td>
<td>Colignon et al. (1978)</td>
<td>Male, 26 yrs</td>
<td>Sept. 1977</td>
<td>P.f.</td>
<td>Patient works at Roissy Airport; never travelled abroad; infection through an infected mosquito imported by aircraft from malaria endemic area postulated.</td>
</tr>
<tr>
<td></td>
<td>Bentata-Pessayre et al. (1978)</td>
<td>Male, 41 yrs</td>
<td>Aug. 1976</td>
<td>P.f.</td>
<td>Patient of Algerian origin but never visited North Africa during 5 years previously; working at Roissy Airport; no history of blood transfusion; infection similar to those cases recorded in summer among people living near or working at airports.</td>
</tr>
<tr>
<td></td>
<td>Larcan et al. (1978)</td>
<td>Male, 33 yrs</td>
<td>Sept. 1977</td>
<td>P.v.</td>
<td>Patient in charge of searching baggage of passengers in customs of Roissy Airport. Infection during a visit to Corsica was excluded as this happened four years previously. Infection through an imported vector postulated, though considered an exceptional mode</td>
</tr>
</tbody>
</table>
TABLE 3. MALARIA ASSOCIATED WITH AIRPORTS \(^1\) (continued)

<table>
<thead>
<tr>
<th>Country</th>
<th>Reference</th>
<th>Patient</th>
<th>Date of detection</th>
<th>Parasite (^2)</th>
<th>Explanation offered</th>
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</thead>
<tbody>
<tr>
<td>France</td>
<td>Gentilini et al. (1978)</td>
<td>Male, 27 yrs</td>
<td>Oct. 1974</td>
<td>P.f.</td>
<td>Patient released from prison on 5 Oct., spent a day in close proximity of Orly Airport, and on 11 Oct. was admitted to hospital for car accident. Subsequently his malaria infection was microscopically diagnosed on 27 Oct. He never travelled out of France, and had no history of blood transfusion; infection through an imported vector in the vicinity of the airport postulated.</td>
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<td></td>
<td>Saliou et al. (1978)</td>
<td>Male, 45 yrs - Republican guard</td>
<td>Feb. 1978</td>
<td>P.f.</td>
<td>Patient never left France except for 2 years in Algeria and Morocco during 1958-1960; blood transfusion excluded. He went to Roissy and Orly airports regularly as a member of the music band of the Republican guards; infection through imported vector postulated, as infection in local anophelines in winter in Paris region was ruled out.</td>
</tr>
<tr>
<td></td>
<td>Dobby &amp; Guignen (1981)</td>
<td>Male &amp; female</td>
<td>Aug. 1969</td>
<td>P.f.</td>
<td>Found infected in Brittany but were investigated retrospectively and found to fit as airport malaria cases - see authors' explanation under 1.2.1 (i) above.</td>
</tr>
<tr>
<td>Italy</td>
<td>Rosci et al. (1987)</td>
<td>Female, 30 yrs</td>
<td>July 1985</td>
<td>P.f.</td>
<td>Patient lived in Marino, a small town on Colli Albani (Castelli Romani), 5 km from Ciampino Airport and 25 km from Fiumicino Airport, Rome. Blood transfusion given on 19 July, but donor had never been to tropics and was IFA negative. Patient is not drug addict. A few days after the onset of her fever on 1 July, she gave birth to a healthy baby. Sensitivity of P. falciparum to chloroquine was demonstrated by in vitro and in vivo tests. Some of the patient's neighbours work at airports and use cars for transport. It was assumed that transmission of malaria in this case was effected by an infective anopheline mosquito of tropical origin, either by flying at night from Ciampino airport, or by car from one of the Rome airports.</td>
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<tr>
<td>Country</td>
<td>Reference</td>
<td>Patient</td>
<td>Date of detection</td>
<td>Parasite</td>
<td>Explanation offered</td>
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<tr>
<td>Netherlands</td>
<td>Delemarre &amp; van der Kaay (1979)</td>
<td>Female, 24 yrs</td>
<td>Aug. 1978</td>
<td>P.f.</td>
<td>Patient whose infection identified as <em>P. falciparum</em> has never left Netherlands. She lived in Hoofdorp, a village about 1.5 km from Schiphol Airport in a house situated next to one of the landing and take-off strips. The local potential vector <em>An. atroparvus</em> had only transmitted <em>P. vivax</em> malaria in the past when this disease was endemic in the Netherlands. Local <em>P. falciparum</em> never recorded before. It was assumed that transmission of this case was effected by an infected mosquito carried by an airplane coming from an endemic area and landed in a nearby airfield.</td>
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<td></td>
<td>Delemarre- van de Waal &amp; de Waal (1981)</td>
<td>Female, 10 yrs</td>
<td>Aug. 1981</td>
<td>P.f.</td>
<td>This is a second case of <em>P. falciparum</em> in the Netherlands. Patient has never left the country, and never had a blood transfusion. Ten days before onset of symptoms, she spent the night on a boat in Nieuwe lake situated at less than 1.5 km from Amsterdam Airport. It was also assumed that an imported vector was responsible for transmission in this case.</td>
</tr>
<tr>
<td>Spain</td>
<td>Boletin Microbiológico Seminal (1985)</td>
<td>A female</td>
<td>Oct. 1985</td>
<td>P.f.</td>
<td>The patient suffered from <em>P. falciparum</em> malaria confirmed microscopically, with IFA test positive at a titre of 1/160. Transmission by <em>An. atroparvus</em> infected from an imported case excluded on the basis of the repeatedly cited experimental evidence of refractoriness of <em>An. atroparvus</em> to exotic <em>P. falciparum</em> strains. As the patient lived at about 6 km from Barajas Airport, transmission through an imported vector was the most probable explanation for this case.</td>
</tr>
<tr>
<td>Switzerland</td>
<td>WHO (1978) Wkly Epidem. Rec. (Based on a report from Univ. of Basle)</td>
<td>2 military recruits</td>
<td>Aug. 1970</td>
<td>P.f.</td>
<td>The two patients were stationed close to Zürich Internat. Airport, they have never visited a malaria endemic area. As their symptoms occurred at the same time, it was assumed that they were bitten on the same night by the same infected anopheline. Patient has never visited an endemic area, but also lived close to Zürich Airport. Two possible explanations of such cases were offered: an infected anopheline imported by aircraft from an endemic area <em>An. maculipennis</em> which exists in Switzerland was found breeding in the vicinity of Zürich airport, but the risk was considered negligible as this Anopheline could possibly become infected.</td>
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<td></td>
<td></td>
<td>Female, 60 yrs</td>
<td>Aug. 1972</td>
<td>P.m.</td>
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<td>Country</td>
<td>Reference</td>
<td>Patient</td>
<td>Date of detection</td>
<td>Parasite</td>
<td>Explanation offered</td>
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<tr>
<td>United Kingdom</td>
<td>Whitfield et al. (1984)</td>
<td>Male, 48 yrs</td>
<td>Aug. 1983</td>
<td>P.f.</td>
<td>Patient is a landlord of public house at Horsham, Sussex, 10 km west of Gatwick Airport; the onset of symptoms was about 5-9 July. He had never left the UK in two years before becoming ill. Prior to that he had visited south of France, but never travelled to a malaria endemic area; no history of blood transfusion. Many airport staff visit his public house.</td>
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<td></td>
<td></td>
<td>Female, ?</td>
<td>Aug. 1983</td>
<td>P.f.</td>
<td>Patient lives in house at Raspur, Sussex, 13 km southwest of Gatwick Airport, and 5.5 km from the public house. Her husband works at the airport. She had never travelled to an endemic area, and had no history of blood transfusion. Six weeks before her illness she visited Mallorca, which is malaria-free for the last 22 years. Her first symptoms occurred about 25-29 July. Three possibilities were discussed. Transmission by infected indigenous anophelines, or imported anophelines after acquiring the infection from a P.falciparum gametocyte carrier in Britain were considered unlikely. The most likely possibility is that transmission was effected by an imported infected vector(s) from endemic tropical areas. Flights from holoendemic areas of West Africa regularly arrive at Gatwick Airport, and for various reasons not every airplane from there was disinfected with an adequate quantity of insecticide. Mosquitos arriving on aircraft would be unlikely to fly unaided to the homes of the two cases. A more plausible means would be in the vehicles of the airport staff who are customers of the public house in the first case or in the car of the husband in the second case. It was further assumed that a single imported infected African Anopheles was transported to the public house and bit both patients within the same area some time apart. The weather in July was exceptionally hot and humid, favouring the survival of a tropical mosquito.</td>
</tr>
<tr>
<td></td>
<td>Smeaton, Slater &amp; Robson (1984)</td>
<td>Female, 35 yrs</td>
<td>30 June 1983</td>
<td>P.f.</td>
<td>Patient lives in Durham County. On 11 June, she left from London (Heathrow) by an Ethiopian Airways flight, for a holiday in Italy. On 12th day of holiday, while in Sicily she felt unwell with sweating, shivering, headache, and generalized limb pains. Later,</td>
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<tr>
<td>Country</td>
<td>Reference</td>
<td>Patient</td>
<td>Date of detection</td>
<td>Parasite</td>
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<td></td>
<td>Weir et al. (1987)</td>
<td>Female 30 yrs German house wife</td>
<td>4 July 1983</td>
<td>P. f.</td>
<td>She developed diarrhoea in north of Italy and was treated for enteritis, but her condition deteriorated and she flew to London on about the 7th day of her illness, i.e., 19 days from onset of the first symptoms. Microscopical examination of a thick blood smear revealed the presence of heavy infection of <em>P. falciparum</em>. She was treated with chloroquine. As her pyrexia and parasitaemia persisted, she was given quinine followed after 3 days by a single dose of sulphadoxine and pyrimethamine. She responded promptly to this treatment and made a full recovery. As the patient has never visited a malaria endemic area, and malaria has been eradicated from Italy including Sicily, two possibilities were considered. The patient could have been bitten by a &quot;comuter&quot; mosquito on the airplane, which had come to London from Addis Ababa, Ethiopia, or by a mosquito which had fed on an imported malaria case in Italy. The former possibility seems the more likely, in view of the 12 days that elapsed between the date of the flight to Italy and the first symptoms. Chloroquine resistance in <em>P. falciparum</em> of this case was suspected. The authors noted that Ethiopia is not thought to be an area of chloroquine resistance, but it is not known where the airplane had landed before Addis Ababa. [Later, chloroquine resistance was recorded in Ethiopia in 1985 by in vivo and in vitro tests — see <em>Wld Hlth Statist. Quart.</em> (1987)]. Patient lives in London. On 11 June she travelled by same flight shown above independently to Rome. On 24 June her illness started and she returned to London where she was admitted to hospital on 1 July. She was treated with antibiotics for other suspected infections. Her condition remained critical until examination of several blood films revealed the presence of <em>P. falciparum</em> infection. Chloroquine given intravenously effected a rapid cure and her subsequent recovery was uneventful. Airport malaria either at Heathrow or Rome was suspected. The authors ascertained that this and the above case travelled by the same flight to Rome in the evening of 11 June, and found it quite plausible to assume that the two cases were bitten by the same &quot;comuter&quot; mosquito vector which had been on board since the airplane left Ethiopia. A mosquito if disturbed during feeding will turn to another host to complete its bloodmeal.</td>
</tr>
<tr>
<td></td>
<td>Warhurst, Curtis &amp; White (1984)</td>
<td>&quot;</td>
<td>&quot;</td>
<td>P. f.</td>
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</tbody>
</table>
TABLE 3. MALARIA ASSOCIATED WITH AIRPORTS$^1$ (continued)

1. More "airport" malaria cases were included in reports communicated to WHO by health authorities - see Table 4(b): Belgium, 1983; France, 1985; Spain, 1984.

- indicate the constraints that hamper the maintenance of vector control operations in and around airports and ports;

- consult with other countries concerned, and with WHO, as to how these constraints, including those related to technical, personnel and financial problems, may be reduced;

- publish the results.

The role of WHO was defined as follows:

- to encourage training of personnel for international vector control;
- to stimulate research and development to improve techniques for international vector control, and to develop insecticide formulations for aircraft disinsection;
- to advise Member States on methods of assessment of vector infestations and vector control in international situations;
- to encourage Member States to fulfil their obligations under the International Health Regulations regarding the maintenance of ports and airports free from mosquito vectors;
- to advise the International Civil Aviation Organization (ICAO) and International Air Transport Association (IATA) of the need of continuing aircraft disinsection on vulnerable routes.

It is interesting to note that Russell (1987) confined samples of insects: mosquitos (Cx. quinquefasciatus), houseflies (Musca domestica), and flour beetles (Tribolium confusum) in cages and placed these within the wheel bays of a Boeing 747B aircraft. These insects survived travel on the following normal commercial routes: Sydney-Melbourne; Melbourne-Singapore; Singapore-Bangkok; Bangkok-Singapore; and Singapore-Melbourne. Survival of all three species was high, averaging 84% for mosquitos and higher for flies (93%) and beetles (99%). Although external temperatures were -42°C to 54°C for aircraft cruising at 10 700 - 11 900 m, minimum temperatures within wheel bays ranged from +8°C to +25°C. Aerosol disinsection of wheel bays immediately before departure would assist in preventing transport of many insect species, depending on insecticide formulation, unless an automatic disinsection device can be incorporated into the wheel bays.

1.2.2 Action by WHO

During the past decade, several meetings were organized by or with the participation of the WHO Regional Office for Europe to deal with problems of prevention of reintroduction of malaria or to coordinate the antimalarial activities. Only the recommendations related to problems of importation of malaria in areas where the disease has been eradicated in the European Region are summarized here.

In September 1978, a WHO Working Group met in Izmir, Turkey (WHO, 1979a) to discuss problems of receptivity to malaria and other parasitic diseases. It was concluded that imported malaria is increasing in most European countries, with infected travellers arriving from Africa, Asia and elsewhere. Importation of malaria into highly receptive areas constitutes a serious hazard. The procedures by which the risk of reintroduction of malaria can be assessed in terms of malarialogenic potential of an area was annexed. Of the specific recommendations related to malaria, reference is made to:

(a) The distribution, abundance and vectorial capacity of potential malaria vectors should be further examined in formerly malarious countries, with particular reference to their susceptibility to exotic Plasmodium strains.

(b) Susceptibility of malaria vectors to insecticides should be regularly monitored in case there is a renewal of malaria transmission.

(c) Field studies should be intensified to assess the risk of introduction and spread of known malaria vectors from neighbouring or distant areas, with special attention to the vicinity of international airports and such major routes as the Trans-Saharan road.

(d) In view of the threat posed by the spread of chloroquine-resistant strains of P. falciparum, every effort should be made to apply the available techniques to determine
the sensitivity level of the parasite to chloroquine and other drugs when cases of
P. falciparum infection are detected.

(e) As a general principle surveillance in countries with medium or high malarriogenic
potential must be intensified in order to detect and eliminate any focal transmission
arising from introduced malaria cases, or from relapses among indigenous infections.

(f) It is essential to strengthen reference institutions in endemic and high-risk
countries in order to carry out monitoring and research activities. Regional and national
laboratories should be established or reinforced. Such laboratories should be involved in
the development and evaluation of control strategies in endemic areas, and be able to
assist in the training of personnel.

(g) WHO should pursue through its channels including its research and training
programme in tropical and parasitic diseases, the research for new antimalarial drugs,
vaccines, and assist in their evaluation through a network of collaborating centres and
field projects. There is a particularly urgent need for a radical curative agent for
P. vivax infection that can safely be used in individuals with G6PD deficiency, which
exists in many individuals in the Region.

(h) WHO should ensure continuing production and dissemination of information required
for health education and training on the control of vector-borne diseases.

In October 1979, a coordination meeting on the prevention of re-introduction of malaria
in countries of the west Mediterranean was convened in Erice, Italy jointly by the WHO
Regional Office for Europe and the Italian Government (WHO, 1979b). The meeting was
attended by participants from Algeria, Morocco and Tunisia, as well as France, Italy,
Portugal and Spain. The meeting reviewed the malaria situation in the participating
countries and the problem of importation of malaria into continental Europe. Further, the
meeting discussed the risks of re-introduction of malaria in relation to the malarriogenic
potential and the need for epidemiological surveillance in relation to the degree of risks
of re-introduction of the disease.

Of the series of recommendations made by the meeting, reference is made to the
following:

(1) In view of the malaria situation in the world, the epidemiological situation
should be periodically evaluated in order to make the necessary adjustments in the
surveillance system as would be necessary to prevent the re-introduction of malaria.

(2) As experience over the last decade has shown that re-introduction of malaria can
be attributed to lack of an appropriate system of vigilance, surveillance activities
proportionate to the risk of introduction or recrudescence of the disease, should be
established or reorganized according to the malarriogenic potential in each area of the
countries concerned. The surveillance system should be based on a regularly updated
epidemiological stratification of various parts of the country.

(3) In view of the real and immediate danger of importation of malaria, notification
of all types of malaria cases (indigenous, introduced, imported, induced, etc.) should be
made compulsory in countries where this has not so far been done.

(4) In view of the practical difficulties of imposing compulsory screening of
international travellers for malaria, more information should be disseminated on the areas
where there is a risk of malaria infection, and clear, precise and simple instructions
should be issued on malaria chemoprophylaxis and other measures of individual protection.
For this, closer collaboration should be established with travel agencies and companies
operating in malarrious areas etc., to provide more active support by making information
available to their clients and staff. There is also a need for appropriate coordination
to be established between health services and immigration agencies, particularly in
countries where there are large scale population movements to and from malaria endemic
areas involving pilgrims, repatriates, refugees, etc.

(5) In view of the real danger of importation of infected anophelines by air from
countries where malaria is endemic, it was recommended that the International Health
Regulations concerning disinsection of ports, airports and aircraft carrying passengers or goods should be strictly applied. In the case of the trans-Saharan highway, it is essential to set up as soon as possible at the point where the highway enters Algeria, a disinsection station for treating vehicles coming from areas of Africa south of the Sahara. There is also a need for an entomological monitoring system to cover all water points and irrigation sites in the vicinity of the highway in order to detect any establishment of a tropical anopheline species as rapidly as possible, and to take the necessary measures.

(6) As the density of vector populations tends to increase when spraying operations are discontinued, recommendations were made for countries concerned as follows: to maintain a team of technical staff and the necessary specialized infrastructure to take rapid and immediate action in case of malaria epidemics; to monitor the level of susceptibility to insecticides used and to determine the alternative insecticides to be applied when necessary; to apply other measures to limit the density of vector populations and prevent any expansion of the area of their distribution (biological control, source reduction, etc.); to establish cooperation between the Ministry of Health and ministries and authorities responsible for water-resources projects (reservoirs, construction or extension of irrigation systems, expansion of rice cultivation, etc.) for monitoring the maintenance of the schemes, as well as the correct use of water resources so as to avoid the formation of pockets of water that might favour the spread of anophelines.

(7) In view of the increasing shortage of specialized staff (malarialogists, entomologists, sanitary engineers, technicians, etc.), WHO should encourage and support the organization of periodic and regular courses in malarialogy and control methods. For this, theoretical and practical training could benefit from the resources available in the participating countries. Field training could be conducted in countries where control operations are underway.

(8) WHO should cooperate with interested countries for promoting basic and applied research in malarialogy and methods of control particularly the following aspects:

(a) evaluation of the effect of biological control of larvae on the density of adult anopheline populations;

(b) selection of the most cost-effective methods of ultra-low-volume insecticide application and assessment of their efficiency;

(c) conducting longitudinal studies on possible variations in the composition, behaviour and vector potential of local anopheline populations;

(d) conducting studies on breeding preferences of different vector species of the western Mediterranean (including the Sahara region). Such studies should lead to a more rational planning of source reduction measures based largely on the cooperation of the communities;

(e) conducting studies aiming at further clarifying the question of the potential of the exotic strains of P. falciparum and transmitting them to human hosts;

(f) carrying out objective evaluation of the benefits accrued from malaria eradication or the reduction of its incidence in each of the participating countries, with the establishment of norms and criteria to assess:

- the impact of malaria control on socioeconomic development.
- the impact of socioeconomic development on endemic malaria.

(9) In view of the steady increase of the resistance of P. falciparum strains to chloroquine, and taking into account the prophylactic and therapeutic problems facing the international and national travellers of the participating countries, it was recommended:

(a) that each country should designate a national reference centre to establish in vitro culture of P. falciparum and make a systematic study of sensitivity tests to the 4-aminoquinolines in strains of this species that may be detected in patients with suspected signs of resistance;
(b) that WHO should organize further training courses on sensitivity tests;

(c) that all confirmed cases of *P. falciparum* resistance to the 4-aminoquinolines should be reported to WHO as rapidly as possible.

(10) Since the elimination or sharp reduction of endemic malaria in the participating countries has led to a reduced interest among the population as a whole and the medical profession in particular, the teaching of parasitology and tropical medicine should either be reintroduced or made compulsory in faculties of medicine and biology and in schools of paramedical and auxiliary personnel.

(11) In view of the risks associated with the use of residual insecticides (environmental pollution and the selection of insecticide resistance), it was recommended that health authorities should acquire the necessary legislative powers to exercise effective and balanced control in the field.

(12) For successful implementation of the above recommendations and for exchange of information among participating countries, especially those of Maghreb, further coordination meetings were recommended. Also, a seminar on information and coordination was suggested comprising North African countries and the adjacent neighbouring countries of tropical Africa, under the sponsorship of WHO Regional Offices, AFRO, EMRO and EURO.

In March 1980, the WHO Regional Office for Europe and United Nations Development Programme, in collaboration with the Government of Bulgaria, organized a meeting in Sofia for the purpose of establishing coordination of antimalaria activities among countries of south east Europe (WHO, 1980a). The meeting was convened within the framework of an intercountry project set up by WHO and UNDP in 1978, in order to meet the challenge of malaria resurgence, particularly in view of the vulnerability and receptivity to the disease in several countries. Participants from countries participating in the projects were invited namely: Bulgaria, Greece, Turkey and Yugoslavia, as well as Syria from the WHO East Mediterranean Region. The meeting reviewed the malaria situation in the participating countries and the existing organization and facilities. The meeting also discussed the amount, type and periodicity of information to be exchanged, and the possibility of exchanging expertise and resources in cases of emergency. The proposed activities of the WHO/UNDP project and its coordination were also discussed. A summary of the recommendations follows:

**General**

(1) to adjust the nature and intensity of vigilance activities to the amount of risk of malaria transmission, and to review the activities periodically in the light of environmental and social changes;

(2) in liaison with other insecticide users, particularly crop protection services, to rationalize the application of insecticides for public health, in order to delay the evolution of insecticide resistance;

(3) to prepare inventory facilities for research and training in each country, on the basis of which mutual exchanges of personnel and teaching materials can be made;

(4) to establish a standard epidemiological information system using an agreed format;

(5) to encourage immunological screening of groups of people coming from malarious countries;

(6) to organize coordination meetings once a year in each country in turn to review the malaria situation, update the plan of work of the project, and discuss the related national activities;

(7) whenever necessary, specific border problems and activities of significance to some countries should be considered at bilateral/trilateral meetings, while recognizing that the main thrust of the project should be towards eradication of malaria in the affected areas and prevention of reintroduction of transmission in vulnerable areas.
For countries where malaria transmission exists

(8) to strengthen cooperation with neighbouring Middle East countries, particularly Iraq and Syria, which face malaria control problems similar to those in Turkey, and with other countries of south east Europe not represented in the meeting regarding:

- exchange of technical information and expertise as required;
- conducting antimalaria activities particularly in border areas;

(9) to give special attention to progressive transfer of responsibility for malaria control to the general public health service as soon as the development of the primary health care network permits.

For countries where malaria no longer exists

(10) every country should have at least one malaria vigilance unit to perform and supervise operations at country level particularly in:

(a) implementing appropriate antimalaria measures;
(b) preparing regulations and instructions concerning importation of malaria including:
- measures aimed at preventing infection of citizens travelling to malaria endemic areas (chemoprophylaxis, health education);
- measures aimed at early detection of malaria in international passengers coming from endemic areas as they arrive at the border of the country (information, leaflets, referral for medical examination and taking blood samples when indicated, surveillance, etc.);
(c) conducting regular entomological activities in selected localities on the basis of the procedures outlined by WHO.

Several topics were suggested in the report of the meeting for undertaking basic and applied research covering: malaria parasites and the human host; parasites in the mosquito host; vector biology; insecticides; and vector control and its evaluation.

In October 1980, a conference was held in Cagliari, Italy on the occasion of the celebration of the thirtieth anniversary of malaria eradication in Sardinia, in collaboration with the WHO Regional Office for Europe, the Government of Italy and the Regional Government of Sardinia (WHO, 1980b). The conference was attended by participants from several countries of continental Europe as well as Algeria, Morocco and Turkey. In defining the purpose of the conference, it was pointed out that despite the efforts of the WHO Malaria Action Programme, malaria persisted at an endemic level in many tropical and sub-tropical countries, giving rise at times to epidemic outbreaks. The increasing interchange of populations between malaria-free (or freed) areas and those which are still malarious, is responsible for the continuous increase in the number of malaria cases imported into continental Europe causing serious concern, for the patients themselves, for the medical profession and for health authorities, because of the possible resurgence of malaria in focal outbreaks in the receptive areas particularly those situated in the Mediterranean basin. The conference provided an opportunity to discuss and agree on joint action that would support the WHO Malaria Action Programme.

The conference reviewed the malaria situation in the world with special reference to the global problems and future prospects and discussed the basic and applied research needed for solving technical problems and for clarifying epidemiological situations as well as testing tools and approaches for more effective malaria control. The conference also reviewed the malaria situation in the WHO European Region and discussed the problems of continued focal malaria transmission in Algeria1 and Morocco1, and the explosive epidemic that broke out in Turkey during the past three years. Emphasis was laid on the problem of imported and induced malaria in continental Europe and the associated risk of

1. Algeria and Morocco hitherto in the WHO European Region, now in the WHO African Region and the WHO Eastern Mediterranean Region respectively.
reintroduction of malaria transmission. Training needs and the facilities existing in Europe were discussed. Several recommendations were made for action to be taken at an international level to provide technical and financial assistance to the Malaria Action Programme. Specific recommendations were made for supporting research and training activities in malarious countries of the WHO European Region as summarized in the following:

(1) Support should be given for increasing the research and training to be established as joint activities between institutions in malarious and malaria-free countries.

(2) International training courses should be organized in an institute in Italy, with the possibility of practical field training in a demonstration area in Turkey.

(3) There is a need to organize and develop research in this demonstration and training area to be used by Turkey and neighbouring countries for developing malaria control strategies based on the concept of primary health care, to be applied in areas of long transmission season associated with irrigation and vector multi-resistance to insecticides. WHO, in close liaison with European and other countries concerned, should explore the ways and means to speed up the development of this facility, which could serve countries of south Europe, Middle East and North Africa.

Specific recommendations were also made for countries where malaria is no longer endemic in the European and other Regions, as summarized in the following:

(1) Countries should maintain and, if necessary, increase their expertise in the field of malaria, in order to adjust their vigilance activities to the degree of malaria risk, and that they should strengthen their technical cooperation with countries that still have malaria as a problem.

(2) There is a need to ensure that notification of all cases of malaria, whether indigenous, imported, introduced or induced is carried out by all health institutions.

(3) A national malaria reference centre should be established by each country.

(4) Necessary and pertinent information about malaria risk should be provided to all travel agencies and travellers.

(5) There is a need to increase the awareness of the possibility of malaria outbreaks, so that countries should have the necessary human and technical resources for rapid deployment, and to prepare a plan for concerted action involving the early release of funds, lifting of relevant customs barriers and restrictions on purchase of material and equipment not available locally.

(6) The receptivity of various important Anopheles species to human plasmodia of tropical origin should be investigated fully and speedily.

In October 1986, a meeting of a WHO Working Group on malaria risk for travellers was held at the Hungarian Tropical Health Institute in Budapest, People's Republic of Hungary (WHO, 1987). The working group was formed of participants from Austria, Hungary, Sweden, Switzerland, the United Kingdom, the USSR and Yugoslavia. WHO was represented by Dr J.A. Najera, Director of the Malaria Action Programme. A study was carried out by Professor D. Bradley (United Kingdom) and Professor F. Várnai (Hungary) involving collection and analysis of information from various countries in Europe to find out the risks encountered by different groups of travellers. This provided ample basic material for discussion and formulating the recommendations. Tabulated data of imported cases reported to WHO by national health authorities covering the period 1974-1985 were presented and discussed in the meeting.

The Working Group examined the problem of imported malaria in continental Europe and made several observations of which reference is made to:

(a) Examination of data reported by health authorities to WHO indicates that the number of imported cases has been increasing steadily over the past 12 years, from 6385 cases reported in 1974 to 3634 cases in 1985. (this figure of 1985 was revised later to
6215 - see Table 4(a) below). This rise corresponds to the increase in the number of travellers to areas of endemic malaria, and to the overall increase in malaria transmission in some parts of the world. With few exceptions, the linear increase shows a constant trend. However, analysis of data by country shows great variation from country to country and from year to year. This was attributed to a number of objective factors such as the number of travellers, the motive for travel, endemic area visited and the length of exposure to infection, preventive measures undertaken, etc. However, subjective variables related to recording and reporting of the imported cases must also be considered. Despite the fact that malaria is a notifiable disease in most countries of Europe, it is believed that the number of malaria cases is, in fact, considerably greater than reported. In support of this belief, it was pointed out that most countries of Europe have well established mechanisms for dealing with imported malaria, such as specialized hospitals or institutes of tropical diseases or reference centres for diagnosis. These institutions are also responsible for collecting and analyzing epidemiological information, but in many instances there is no way of studying the actual coverage attained by these diagnostic and treatment facilities. Reported number of deaths indicate a case fatality rate of 0.5 - 1% for malaria infection as a whole, and specific fatality rates for P. falciparum in some countries have been as high as 7%. These fatality rates are incompatible with the quality of medical care generally available in Europe, and should be taken as an indication of inadequate application of knowledge and management of resources for diagnosis and treatment. These are probably some of the reasons why the extent of the problem of imported malaria has not been fully recognized at a national level.

(b) The epidemiological characteristics of imported malaria (e.g., the relative proportions of various parasite species, areas of the world from which the infection originates, and the main social, ethnic or occupational groups predominantly affected), appear to remain constant for a given country. These characteristics reflect the traditional pattern of travel and trade links of the country concerned. However, there is some evidence that, as a result of the growth of travel and mobility of labour among European populations, the risk of acquiring malaria may have spread well beyond the traditionally exposed population groups.

(c) The instructions given to prevent malaria among non-immune travellers visiting malaria endemic areas may have created the impression that the drugs used for chemoprophylaxis prevent the infection in all situations, and that these drugs are sufficiently safe to be recommended without reservations. For this reason malaria chemoprophylaxis has recently become the only measure applied by international travellers. However, studies published in the past few years on the efficacy and safety of prophylactic drugs indicate that these are neither as effective nor as safe as they are believed to be. Furthermore, a wide range of advice is being offered by different services in an attempt to strike an appropriate balance between drug safety, efficacy and availability. This is further complicated by the fact that information on adverse reactions to antimalarial drugs is incomplete, and in certain instances, apparently contradictory. Information about compliance with the preventive advice is available from limited studies in a few countries. The need to balance the risk of exposure to infection against the risk of adverse drug reactions calls for more accurate targeting of advice in relation to specific areas and populations. Efforts to improve compliance with the preventive advice may become more rewarding when focused on high-risk situations.

(d) In some countries, the incidence of imported malaria is apparently higher among immigrant populations than among non-immune European travellers. The most plausible explanation for this is that immigrants lose their immunity to malaria as they reside in Europe, and consequently they easily become infected when they return to malaria endemic areas in their native countries.

(e) Resistance of P. falciparum to chloroquine has been confirmed in more than 40 countries, and in 1985 it extended its distribution in tropical Africa as it was reported for the first time from Cameroon, Congo, Senegal and South Africa. Resistance to Fansidar now exists in 11 countries (including Kenya and Tanzania). Resistance to quinine was reported from three countries in Asia, and resistance to mefloquine was observed in the Philippines, Thailand and Tanzania. Although the increase in the total number of imported malaria cases in Europe has not so far been greatly affected by P. falciparum resistance to antimalarials, the constant presence of such resistance poses difficulties for the appropriate treatment of malaria cases.
There are only a few epidemiological studies on imported malaria in Europe and the way in which it is managed. In addition, these studies are the result of individual initiatives and lack appropriate coordination. Health services do not yet appear to be ready for using the epidemiological information to improve their management of the problem.

Observations made on management of malaria showed that information provided by national health services in Europe indicate that there are considerable variation in the data collected on imported malaria. Hence, it is almost impossible to compare between countries when it comes to details regarding the actual compared with the theoretical risk of infection, or with regard to the incidence per number of travellers. Nevertheless, there is a certain consistency in that most countries record data on parasite species and origin of infection. On the other hand, there are countries in which more than one agency compiles reports, and others in which reports from peripheral laboratories do not match reports based on individual notification of cases. Studies have shown, however, that if some additional efforts were made at national level to coordinate the activities of all health establishments including private physicians, and to cooperate with other countries, the problem of imported malaria could be defined more realistically and managed more effectively.

The results of enquiries received from 11 countries in Europe indicated that despite many gaps, the information provided could serve as a good basis for comparison. However, some important data on clinical and epidemiological events were lacking such as reasons for travel, length of exposure, and the degree of compliance with the recommended chemoprophylaxis and/or personal protection measures, nor have data been collected on the history of malaria fevers among travellers temporarily residing in areas with endemic malaria. There would be a great advantage if European countries adopted a common and uniform approach for recording data on imported malaria. For this, the working group proposed a questionnaire for further consideration and consultation by national authorities responsible for malaria control through WHO.

The Working Group further examined the information provided by certain countries on chemoprophylaxis recommended to travellers visiting areas of chloroquine-susceptible and chloroquine-resistant P. falciparum. The side effects of various antimalarial drugs were also examined on the basis of many papers published in the past two or three years, and specific recommendations were made in this respect (see below). On prevention of man-mosquito contact, from written interviews made in Switzerland with 10 000 travellers, 58% of the Swiss tourists claimed to use such measures. There were no data available from other countries. Booklets have been published on life in tropical countries giving details of protective measures against malaria and other tropical diseases, and some countries (e.g., Bulgaria) such booklets are provided free of charge. However, it is not known to what extent these instructions were followed. National health services when advising travellers about malaria endemic areas, should attach equal importance to the methods of personal protection such as screening of windows and the use of bed-nets or repellents.

The Working Group further pointed to the research for evaluating the risk of malaria. Research on the epidemiology of imported malaria has been confined to compilation of data on reported cases. It is only recently that certain aspects have been studied in Hungary, Switzerland and the UK. Topics of studies that have been completed or in progress were shown as follows:

- retrospective analyses of risk in relation to chemoprophylaxis (Hungary and Switzerland);
- cohort studies of package tour travellers (Switzerland);
- assessment of compliance with advice given (the UK);
- studies of compliance among air travellers (Switzerland and the UK);
- risk analysis for ethnic minority groups (the UK);
- arriving traveller population studies (the UK);
- assessment of risk in overland travellers to Asia (the UK).

The Working Group added that further research is needed to define the high risk groups in order to reduce the extent and consequences of imported malaria. Research must also be carried out to assess the actual versus the theoretical risk of infection for different categories of travellers (businessmen, tourists, short-term personnel, diplomats, etc.) to
determine the most effective and safe prophylactic regimens, to define the best advice to be given for each subgroup, and to find out the best way to convey advice so as to achieve maximum compliance. Models of studies already initiated could be used by countries other than those mentioned above.

On the basis of aspects discussed, the Working Group presented a series of recommendations as quoted below:

1. National health services in Europe are urged to adopt a systematic and responsible attitude to the management of imported malaria. While it is clear that all the countries of Europe have the necessary expertise to diagnose and treat malaria, there is an obvious need to develop mechanisms to ensure better utilization of this expertise. In fact, the management of imported malaria should be an integral part of the management of imported diseases in general. To achieve this, national health services should use existing facilities to maintain interest in and focus attention on diagnosis and treatment, case reporting, prophylactic advice and health education of travellers, together with the organization of appropriate health measures. Medical associations and, in particular, their sections for preventive medicine can make a considerable contribution to carrying out this task by organizing special meetings or seminars.

2. In view of the need for comparable and complete reporting on imported malaria as a basis for rational management of the problem, steps should be taken to adopt a common approach to the epidemiology of malaria. To achieve this, the World Health Organization in conjunction with Member States could jointly convene a meeting to be attended by representatives from each country of Europe and aimed at achieving comparable reporting. Prior to this meeting, a small working group could be organized to develop proposals.

3. In view of differences in the intensity and seasonal patterns of malaria transmission in various parts of the world, as well as the different patterns and duration of exposure of non-immune people to malarial infection, further studies should be made of the actual malaria risk for various groups (businessmen, tourists, temporary residents in endemic areas, immigrants from endemic areas residing in Europe).

4. The choice of chemoprophylactics for regular use should be based on an evaluation of the risk of adverse reactions from the drug(s) used as against the risk of infection. Safety and efficacy should be appropriately balanced. It should be recognized that, in many instances, complete protection will not be achieved by chemoprophylaxis.

5. Previous efforts to prevent infection of travellers by chemoprophylaxis have not been very successful. Given the evolution of the malaria problem in endemic countries and the reduced effectiveness of chemoprophylactic agents, greater emphasis must be placed on promoting personal protection against mosquito bites, including the use of bed-nets, screened accommodation, appropriate clothing and behaviour and repellents, as well as on immediate recourse to appropriate diagnosis and treatment in the event of fever or to a full course of treatment if such facilities do not exist. Travellers should be provided with appropriate drugs for treatment and should be made aware of the need to alert their doctors to the fact that they have been in a malarious country if they fall ill after their return.

6. Since the continued incidence of malaria is due in part to imported infected mosquitoes, preflight disinsection of aircraft is important. Member States should insist on this being done on a regular basis.

7. In order to prevent induced malaria secondary to imported parasite carriers appropriate screening of blood donors must be carried out when the donor has travelled abroad.

8. While appreciating the need for flexibility in providing advice on particular drugs or drug combinations, the Working Group cannot recommend mefloquine (Lariam) as a long-term prophylactic on the basis of information currently available. Regarding Fansidar, the Working Group reiterates the view that this drug gives good protection in many cases of chloroquine-resistant P. falciparum malaria. However, its administration is absolutely contraindicated for people who have previously manifested sulfonamide intolerance. Data on Fansidar safety among travellers at large are somewhat contradictory. An incidence of
Stevens-Johnson syndrome of the order of 1 per 10,000 tests, with fatal adverse cutaneous reactions in 1 per 20,000 tests, as observed in the United States of America and elsewhere, contrasts with an apparent high degree of safety in Swiss travellers. According to some investigators, the concurrent administration of chloroquine might have contributed to the frequency of adverse reactions, and the use of Fansidar in conjunction with chloroquine appears to be ill advised. The fact should not be ignored, however, that in numerous instances Fansidar alone has provoked the same types of adverse reaction. For this reason the risks involved in the use of Fansidar alone require further study. Meanwhile, the administration of this drug as a prophylactic should conform to the spirit of recommendation 5 above.

9. Recognizing that research on the epidemiology of imported malaria needs to be broadened, the Working Group recommends that stronger support should be given to such research by countries' national health services and by WHO. Large-scale studies of relative risk, prophylactic efficacy and compliance with advice given need to be increased in number and in the variety of approaches adopted, in order to obtain valid data under different conditions, and especially among neglected categories of populations and travellers to whom it is not easy to gain access. Activities described in section 4.2 of this report should be taken as an integral part of this recommendation."

Recently, WHO has updated its recommendations on the disinsection of aircraft. These cover general description of aerosol dispensers, WHO procedures for testing of aerosol discharge and biological performance, the formulation of the standard reference, aerosol and alternative aerosol formulations; disinsecting procedures: before take-off, "blocks away", disinsecting on the ground upon arrival, and residual treatment of aircraft. For details of these recommendations the WHO (1985 Wkly Epidem. Rec.) should be consulted.

The latest records of imported malaria in continental Europe were compiled from data communicated to WHO by health authorities during 1980-1986 as shown in Table 4(a). The WHO Working Group that met in Budapest in 1986 has already commented on the data of imported cases in Europe up to 1985 (see above). It is clear that there has been a marked increase in the number of cases starting from 1985, reaching 6883 in 1986, i.e., more than 2000 cases higher than in 1984. This has been due to a better reporting system in France and probably so in the Federal Republic of Germany (FRG). The highest number of imported cases in 1986 was reported from the United Kingdom (UK) (2306 cases), followed by FRG (1099 cases) and France (1021). The highest death rate was observed in Spain (2.2%) and in Portugal (2.1%), and the lowest death rate in the UK (0.17%) and USSR (0.18%). Details of other malaria infections that are related to imported cases or imported anopheline vectors has been compiled in Table 4(b). The total number of these infections that have been reported during seven years is 179. About half of these (90) were induced cases most probably due to blood transfusion. These were followed by cases of drug addicts (18.4%), relapses (10.1%), airport malaria (7.8%), congenital malaria (7.8%), while only very small numbers of introduced, cryptic and undetermined cases were recorded, each constituting 1.1% of the total cases. Of 165 cases for which parasite identification was provided, 68% were P. malariae, 17.4% P. vivax, 13% P. falciparum and 1.4% P. ovale. Of 78 cases of induced malaria, 57.7% were P. malariae. This is as expected from the long lasting infection of P. malariae constituting a large proportion of transfusional malaria [see Bruce-Chwatt, 1972 under 1.2.1(ii-a) above]. Congenital malaria invariably appeared in the UK each year, making a total of 11 cases in seven years, of which eight were P. vivax and the remaining cases were P. falciparum. This is nearly similar to the findings of Phillips-Howard et al. (1988) who indicated that P. vivax infections in babies were of Asian origin, while P. falciparum infections were of African origin [see 1.2.1(i) above]. Malaria infections among drug addicts were exclusively reported from Italy and Spain with two major episodes in 1981 and 1984 respectively [see under 1.2.1(ii-b) above]. As shown in an official publication of the Italian Ministry of Health that was communicated to WHO, there were more cases of malaria recorded in Italy in 1981 than those reported by Orlando et al. (1982). Thereafter, there were only a few cases in 1982 and 1983, probably due to health education of heroin users at peripheral centres for addict assistance. During 1980-1986, malaria cases associated with airports were reported only

1. This refers to the types of research activities which have already been initiated by Hungary, Switzerland and the UK as outlined above.
2. Compiled by Mr J. Hempel of the Epidemiological Methodology and Evaluation Unit (EME), MAP, WHO, Geneva.
from six countries, viz: Belgium, France, Italy, the Netherlands, Spain and the UK (see also Table 3). In Belgium, after the two cases recorded in 1982, airport malaria cases continued to be detected with one case reported in 1983 and five cases in 1986. In France, no cases of airport malaria have been reported recently except a single record from Marseille Airport in 1985. It has been explained that since the application of residual spraying in Charles de Gaulle Airport no further airport cases have been detected in the Paris area [see the last paragraph under 1.2.1(iii) above]. The report of the two British citizens who acquired the infection in 1983 from a commuter vector on board a flight coming from Ethiopia, remains as a single record of this exceptional mode of transmission.

Nowadays, the new trend is to protect tourists' health from infections and parasitic diseases as a whole, including malaria. For this purpose, two meetings were held during the first quarter of 1988. The first was an inter-regional meeting held jointly at Rimini, Italy during 8–11 February 1988 by the Società Italiana di Medicina del Turismo (SIMT), WHO, and the World Tourism Organization (WTO). As shown in the WHO (1988a Wkly Epidem. Rec.), the aim of the meeting was to discuss the prevention and control of infections among tourists in the Mediterranean area. Although the more serious infectious diseases (typhoid fever, malaria, schistosomiasis, louse-borne typhus, anthrax) have been eliminated or brought under control, a low endemicity of these diseases still exists in certain parts of the Mediterranean area. The most frequent infections to which tourists are exposed include: diarrhoeas, other gastrointestinal infections and intoxications, acute respiratory infections, sexually transmitted diseases, zoonoses and some parasitic diseases. There have been many instances of hesitation to disseminate the results of disease surveillance for fear of discouraging tourists. The interchange of disease surveillance information between the Mediterranean countries and those from which the tourists come has often been slow or absent. Therefore, there is a need to re-examine the problem of disease surveillance from the standpoint of contemporary tourism and increasing international travel. The meeting stressed that the protection and promotion of the health of tourists requires the combined efforts of several disciplines and professions such as medicine, environmental health, and other health sciences, civil engineering, transport, hotel catering and tourist industries as well as governmental and non-governmental agencies. The meeting further proposed that "tourist health" be recognized as a specialized branch of public health and that the three organizing agencies (SIMOT, WHO and WTO) should consider holding an expert consultation in order to define this discipline and to plan education and training in various participating fields/sectors, advise on organization of services and coordination of multisectoral contributions at different levels. The report of this meeting is being prepared.

The second meeting was in the form of a conference held in Zürich, Switzerland during 5 April 1988 on International Travel Medicine, under the sponsorship of the Swiss Federal Office of Public Health, the British Public Health Service, the US Centers for Disease Control, WTO, WHO, and the London School of Hygiene and Tropical Medicine. As shown in the WHO (1988b Wkly Epidem. Rec.), the aim of the conference was to improve the protection of the traveller by more effective and more uniform recommendations by all concerned, with particular emphasis on epidemiological and preventive respects. Participants from 40 countries and territories including those of the European Region as well as representatives of all six WHO Regions attended this Conference. During plenary sessions, presentations were made and discussions took place on general epidemiology including travel statistics, the impact of international travel on developing countries and health risks associated with such travel: malaria, vaccines and vaccine-preventable diseases, diarrhoea, sexually transmitted diseases and AIDS, specific health problems, health information and communication and certain individual health risks to which the traveller may be subjected. In addition to the subjects discussed at the plenary sessions and further enlarged upon at other sessions, attention was also given to the health risks, health protection and medical care abroad, to a review of the parasitic and other diseases found in returning travellers, and to health advice to travellers and in-flight environmental problems. Round-table discussions were held on a number of subjects including malaria chemotherapy and self-therapy, immunization for travellers, AIDS and the prevention of diarrhoea among travellers. At each of these discussion sessions, recommendations were formulated which will appear in the formal published proceedings of the Conference, entitled "International Travel Medicine" (in preparation)1.

1. To be published by Springer-Verlag, D-1000 Berlin.
Table 4(a). MALARIA CASES REPORTED TO WHO BY HEALTH AUTHORITIES OF CONTINENTAL EUROPE DURING 1980–1986.

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Tot = total cases  
Imp = imported cases  
Other = infections other than imported cases  
D = deaths
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airp = airport malaria
accid = accidental in lab or hospital
cong = congenital
crypt = cryptic
drug ad = drug addict
fl = flight
indc = induced most probably due to
intr = introduced
rel = relapse
* = considered imported cases
? = no information or doubtful
Pf = P. falciparum
Pv = P. vivax
Pm = P. malariae
Po = P. ovale
2. The Mediterranean Region

As mentioned earlier, it has been found convenient not to follow the boundaries of the WHO Regions, because Algeria is now with WHO/AFRO (previously with WHO/EURO), Morocco is now with WHO/EMRO (previously with WHO/EURO) and Israel is now with WHO/EURO (previously with WHO/EMRO). Therefore, the designated Mediterranean Region has been arbitrarily divided into two sub-regions as shown in Fig 1: The Mediterranean Basin covering the Mediterranean countries of Europe and countries of Africa north of the Sahara (Algeria, Morocco, Tunisia, Libya and Egypt) as well as Jordan, Israel, Lebanon and Syria, and the zone of Asia west of India extending from the eastern part of the Mediterranean to the east up to and including Pakistan. This zone largely covers the WHO Eastern Mediterranean Region with the exception of Israel. The recent malaria situation in these geographical areas has been compiled from information shown in the "World Health Statistical Quart" (WHO 1985, 1986 & 1987) for the years 1983, 1984 and 1985 respectively as follows:

[For more details - see Subsection (11) EPIDEMIOLOGY AND CONTROL OF MALARIA in each of SECTION III (A) (in press), and SECTION III (B) (in preparation) to be issued later.]

2.1 The Mediterranean Basin (Fig. 1)

The status of malaria eradication and current problems in the Mediterranean countries of Europe have been dealt with under 1.1 and 1.2 above. Only Turkey and the remaining countries of the Mediterranean Basin are dealt with here.

In Turkey, endemic malaria has persisted in certain areas. After having almost disappeared in 1968, the number of cases started to build up gradually until an epidemic broke out in 1976 and 1977 when 37,000 and 115,000 cases were recorded respectively. The most affected areas were: Adana; Içel (Chukurova); and Hatay (Amikova). Emergency measures brought the situation under control to some extent. The number of cases after decreasing to 29,000 in 1979, rose again to 34,000, 55,000, and 62,000 in 1980, 1981 and 1982 respectively. In 1983, the annual incidence reached 67,000. In both 1982 and 1983, over 50% of the cases were reported from Chukurova plain, and malaria foci continued to persist in certain areas (Antalya, Edirne, Izmir, Konya, Nigde, Yozgat), while foci expanded in some others (Aydin, Manisa). In 1984, the situation improved, as the number of cases decreased to 55,000. The improvement was thought to be due to changing the insecticide used for residual house spraying as malathion was replaced by pirimiphos-methyl. The reduction in the number of cases occurred not so much in Chukurova plain but mainly in eastern Anatolia where the number of cases decreased from 20,900 in 1983 to 12,500 in 1984.

The total population of countries of Africa north of the Sahara reached 103 million in 1985. About 79 million live in originally malarious areas. In 1983, malaria transmission was much reduced and continued to be confined to small foci. The number of cases reported decreased from 561 in 1982, to 453 in 1983, but this trend was reversed as 666 were recorded in 1984, and 921 in 1985.

In Morocco, local P. vivax transmission increased in northern provinces; the total number of cases reported in 1984 was 318 compared with 62 and 75 in 1982 and 1983 respectively. In 1985, the number of cases sharply increased to 713. Malaria cases were detected in 21 provinces as in 1984, but the number of sectors and localities with positive cases increased from 63 to 79 and from 85 to 150 respectively. The data of 1984 showed that passive case detection, i.e., health posts and hospitals, discovered 53% of all cases, while 43% were found by epidemiological survey around detected cases, suggesting that surveillance was at times deficient. In 1985, indigenous cases were mainly reported from five provinces: Chefchaouen (46%), Beni Mellal (19%), Tetouan (12%), Nador (7%) and Al Hoceima (7%). Remedial measures were applied.

In Algeria, reports of 1982 showed that the 26 northern provinces (Wilayat) were free of indigenous malaria for the first time since the start of the malaria eradication programme in 1969. All these provinces were expected to enter the maintenance phase from 1984 onwards. The small focus in Adrar province (health sector of Timimoun) persisted in 1983 with 12 new cases detected: 3 P. vivax and 9 P. malariae. In 1984, the northern provinces continued to be free of indigenous malaria. In the focus of Adrar province, only three indigenous cases were recorded. Additionally, there were two locally
contracted P. vivax cases in In-Salah, but the epidemiological investigation did not reveal any other cases. In the Sahara provinces, there were 27 cases detected, and all were imported ones originating mostly from Mali. In 1985, only four isolated cases were detected: one indigenous P. vivax in Skikda province, one relapse case of P. vivax each in J华北 (Djanet sector) and Adrar provinces, and one relapse case of P. malariae in Baida province (Douera sector). In addition, there were 40 cases detected but all, as in 1984, were imported from neighbouring countries south of the Sahara.

In Tunisia and Libya all cases detected in 1983 and 1984 were imported. In 1985, both countries reported only imported cases, but Tunisia also recorded three cases of induced malaria.

Cyprus, Jordan, Israel and Lebanon remained free of indigenous malaria. The surveillance schemes in most of these countries (excluding Lebanon where activities are limited) successfully prevented the re-establishment of malaria transmission despite the very large number of imported cases recorded.

In Egypt, there were 198 cases reported in 1983 compared with 423 cases in 1982. An increase of incidence was reported from Kafr-El-Sheikh governorate in the central northern part of the Nile Delta, and in Fayoum governorate transmission continued to persist. In 1984 and 1985, a very low incidence of malaria continued to be reported from the whole country, with P. falciparum transmission remaining confined to Fayoum governorate.

In Syria the number of malaria cases steadily decreased from 2,200 in 1982 to 1,300 in 1983, 840 in 1984, and 435 in 1985 (all were P. vivax with the exception of three imported infections). The record of 1985 was the lowest incidence recorded since 1975. The improvement in the epidemiological situation has been attributed to the good spraying coverage and the use of permethrin in areas where inhabitants refused malathion spraying. In July 1984, a focus developed in the Ghoute agricultural area near Damascus. A mass blood survey yielded further cases in August and September; the total number of cases in this focus was 157. The cases of 1985 were distributed as follows: 132 in the foci of Malkiya (north-eastern border) on the Tigris river; 75 in Idleb; 41 in Lattakia; 129 near Damascus; 50 in Deraa. Remedial measures were applied.

2.2 Asia west of India (Fig. 1)

The total population in this area was estimated in 1985 to be 222 million, of which 186 live in originally malarious areas, while 15 million people live in areas which have been freed from malaria, and 35 million live in areas with limited risk. About four million people are not protected by specific antimalaria measures.

Bahrain, Kuwait and Qatar continue to be free of indigenous malaria.

Of other countries in this area, Iraq, Iran, Oman, Pakistan, Saudi Arabia and the United Arab Emirates (UAE) have nationwide antimalaria activities. The antimalaria activities in Afghanistan, Yemen and Democratic Yemen do not cover all the population living in originally malarious areas. It should be re-emphasized that southwest Saudi Arabia, Yemen and Democratic Yemen have been dealt with in PART II [see also PREFACE of VOL. I of the present series] because their anopheline fauna partly belongs to the Afrotropical region. Since these three countries form an integral part of the Arabian Peninsula regarded as a meeting place of the Palearctic, Oriental and Afrotropical fauna, it is useful to cover them by an updated overview of the malaria situation from the available information communicated to WHO in 1984-1985. In the overview of the malaria situation given below, countries are arranged according to their geographical location starting from the west and moving eastwardly.

In Iraq, the number of malaria cases steadily increased from 2,400 in 1983 to 3,300 in 1984, and to 4,800 in 1985. Malaria transmission continued in 1985 in four provinces in the Northern Region (Ninawa, Dehok, Sulaimanya and Erbil), especially in the old foci. In the other three regions (Central, Central Euphrates, Southern) as well as in Al-Tamim province in the Northern Region, interruption of transmission was generally maintained. Nearly all 327 cases detected in these areas were imported.

In Saudi Arabia, the number of malaria cases decreased from 18,000 in 1983 to 11,000 in 1984, but increased to 16,000 in 1985. The Eastern and Northern provinces and the Asir plateau in the south, are considered free from malaria transmission. Also the Western Province is free from malaria transmission except for small residual foci in the Hijaz mountain range. However, malaria is still endemic in the foothill and lowland areas of the Tihamah Region (southwest coastal plain along the Red Sea), and about 75% of the cases detected in 1985 originated from this area. Weekly larviciding with temephos applied on a large scale could not prevent the occurrence of a malaria outbreak in the Giza area during the rainy season. More than 10,000 cases were recorded during January-April 1985, and remedial measures had to be applied to control the situation.

In Yemen, baseline data collected from the Tihamah Region in 1984-1985 indicated that malaria is hyperendemic and unstable with focal distribution. Relatively high parasite rates and vector densities were observed during the cooler period of the year (November-February). So far, some 90,000 inhabitants are protected by residual house spraying and about 5,000 by larviciding operations. Peripheral malaria detection posts have been established in most of the health centres in the Tihamah Region, and two in the foothill region and in the region of intermediate altitude. These posts provide diagnostic services and treatment of cases and serve to monitor the malaria situation in these regions.

In Democratic Yemen, 1984 was an exceptionally dry year and consequently the number of malaria cases was comparatively low. Due to shortage of financial resources and trained manpower, malaria control operations continued to be applied in limited areas of economic importance and high malaria endemicity. Among the six governorates, Al Mahara has no antimalarial activities, and in Shabwa, the activities are very limited. Malaria risk is minimal in the narrow coastal belt, and is practically absent in Aden city, but prevalent in the interior. In Socotra island where very high malaria endemicity prevails, no antimalarial measures have been undertaken up to 1985. In areas under operations, the activities include residual house spraying, larviciding, source reduction on a limited scale, and dissemination of local larvivorous fish (Aphanius dispar) into natural perennial breeding sites. Case detection is limited to Lahj, Abiyun and Hadramut governorates, but reporting by hospitals and health centres is deficient and many cases are diagnosed on clinical grounds only.

In the UAE, the antimalaria programme continued to receive high priority. The steady decline in the number of malaria cases has continued. In 1984, there were 3,500 cases compared with 23,000 in 1978. Many of the cases were imported as associated with the unrestricted influx of labourers from South Asian countries. However, with the declining job opportunities due to the saturation of the construction sector, fewer people from malarious countries have been entering the Emirates, and consequently the number of imported cases has started to decline. Malaria surveillance is carried out through the network of primary health care (PHC) centres. In 1985, 2,600 cases were recorded, more than 75% of which were imported. Three quarters of the population are living in areas where malaria risk has been practically eliminated. Local transmission occurs only in the northeastern part of the country. More than 95% of the population are protected through vector control by larviciding with temephos.

In Oman, malaria is considered highly unstable in the foothill regions, unstable in the desert areas, and stable in the coastal areas. The number of malaria cases decreased from 35,000 in 1983 to 23,000 in 1984, and likewise the slide positivity rate fell from 20% to 9%. The much reduced rainfall certainly contributed to this reduction, but there was also an added effect of an improvement in the implementation of antimalaria activities with a larger proportion of the population protected. Since 1981 all areas of the Capital Region have been protected by antilavlar measures and many of the cases detected seemed to have contracted the infection outside urban areas. Residual house spraying carried out in several regions, generally, appears to have had little impact on the malaria situation. On the other hand, larviciding seems to have been effective in reducing malaria prevalence in Barkanah, Sur-es-Salaan, and Sharkyla regions. Surveys based on adequate sample size carried out in 1983 and 1984 in Dhofar Region did not reveal any malaria cases. A few cases detected among outpatients of health facilities appear to have been infected outside this region. In 1985, case detection activities (excluding surveys) discovered 14,000 cases. The decrease in the number of cases from the 1984 level was observed in all areas including the coastal region where enhanced control operations are thought to be the main contributing factor. Other factors have been the widespread drought and improvements in housing and general socioeconomic standard of the population.
In Iran, the number of malaria cases decreased from 43,000 detected in 1983 to 31,000 recorded in 1984, of which 26,000 originated from the attack phase areas compared with 42,000 in 1983. In 1985, the number of cases further declined to 26,000 of which 21,000 were from the attack phase areas. This marked reduction was attributed to climatic conditions and the timely application of spraying operations. In the areas where transmission is considered interrupted (consolidation phase areas with a population of 22 million) the number of cases increased slightly from 4,100 in 1983 to 4,400 in 1984, including 2,900 imported from Afghanistan. The detection of several foci in these areas demonstrates the risk arising from the high number of imported cases especially since these cases occur mainly in areas of difficult accessibility coupled with uncontrolled population movement. In 1985, the number of cases in the consolidation phase areas further increased to 5,600, including some 4,300 imported from Afghanistan. The increase in the number of imported cases led to the occurrence of many new foci in these areas.

In Afghanistan, the number of malaria cases rose further to 119,000 (provisional) in 1983 compared with 34,000 in 1979. Despite difficulties, antimalaria activities continued although on a much reduced scale. A great malaria epidemic broke out in 1983 in Jalalabad, Talogan, Laghman and Kunar units. Limited mass drug prophylaxis was carried out in 1983 in Khost, Jalalabad, Faryab, Faizabad, Khanabad and Pulkhumri units (total population 94,000). Only 33 peripheral laboratories function in 1983 out of 150 planned. In 1984, the number of malaria cases continued to rise reaching 156,000 (provisional). Whereas in 1979, 2.6% of the blood slides collected were found positive, in 1984 this rate was 28%. The number of P. falciparum infections, although very low, rose from 272 in 1983 to 391 in 1984. Most of these seem to have originated from border areas with Pakistan and Iran. The large epidemic that broke out in 1983 continued in Jalalabad, Laghman and Talaguan. In 1985, the malaria situation continued to deteriorate as the provisional number of cases reached 228,000, and the proportion of positive blood slides increased to 33%. High malaria incidence was reported from the following malaria service units: Kunduz, Imamshahib, Taloguan, Faizabad, Laghman, Kunar, Jalalabad, and Ghazibad. Despite prevailing conditions, all antimalaria activities continued in 1985, although on a very much reduced scale.

In Pakistan, although the number of malaria cases was lower in 1983 than in 1982, epidemiological indices showed no improvement over the situation in 1983. The number of blood slides collected from fever cases dropped from 3.3 million to 2.6 million, most of these coming from active case detection. The contribution of the general health services to case detection was minimal, despite the integration of malaria control within these services in Punjab and Sind provinces, where 80% of the population at risk live. The relative prevalence of P. falciparum infections increased from 13% in 1981 to 32% in 1983. The prevalence of this parasite was 33% in Punjab and Sind provinces, 16% in North-West Frontier province and 49% in Baluchistan province (after being 20% in 1982). Monitoring of the response of P. falciparum to chloroquine revealed signs of low-grade resistance in at least three districts of Punjab province: Sheikhupura, Balhawalnayar and Jhang. In 1984, the number of malaria cases reported rose to 74,000 from 52,000 in 1982, which further illustrates the general rising trend of incidence in recent years. In fact, the proportion of positive blood slides rose from 0.45% in 1979 to 0.59%, 1.3%, 1.7% and 2% in subsequent years reaching 2.3% in 1984. Integration of malaria activities to various degrees within other health services was extended to each province. However, cooperation and coordination of the emerging PHC system still remains to be developed. In 1985, the number of malaria cases recorded from January–November was 61,000, indicating that the rising trend has been halted. An improvement in the participation of general health services in malaria surveillance has been noted particularly in the North-West Frontier and Baluchistan provinces. However, the relative prevalence of P. falciparum infections increased further, reaching 53% in Sind and 52% in Baluchistan. Strains of P. falciparum resistant to chloroquine have already been detected in six districts in Punjab. Signs of increasing tolerance to chloroquine have also appeared in the North-West Frontier Province.
CONCLUSIONS (SECTION I)

Great concern has been expressed by many authors and in regional conferences about the substantial increase of imported malaria in continental Europe where malaria has been eradicated or disappeared. This increase has been closely associated with the increase in air travel and movement of migrant workers. The widespread P. falciparum drug resistance in Asia and its increasing distribution in tropical Africa adds greater dimension to the problem. There is a consensus of opinion that measures against importation of malaria should primarily be directed to intensifying health education for travellers to malaria endemic areas for not only complying with chemoprophylaxis but also to undertake personal protection measures against mosquito bites. The collaboration of travel companies and tourist agencies operating between Europe and endemic areas should be fully exploited.

There are indications that the incidence of transfusion malaria is grossly underestimated. As microscopical diagnosis of infection in the blood of donors has proved difficult, use of serological methods (e.g., IFA test) and the criteria for accepting a donor have been recommended. Of other problems associated with imported malaria are the accidentally-induced infections. Two outbreaks of malaria among drug addicts occurred in Italy and Spain in 1981 and 1984 respectively, but later only a few cases were reported, the reason for such a decrease is not understood. This may have been due to the efforts of the centres for addicts assistance as in Italy. However, in USA where an epidemic of P. falciparum malaria broke out among drug addicts in the 1930's and persisted for nearly 10 years, no further cases were seen following the detection of quinine as a common diluent or adulterant of confiscated heroin. (Dover 1971). This does not seem to have been investigated in Europe. Other accidentally-induced malaria has been invariably recorded among hospital staff due to laxity in taking the necessary precautions when drawing blood samples from patients.

Following reports from France and Switzerland during the 1970's pointing to implication of international airports in malaria transmission by imported infective anopheline vectors, attention has been directed to this mode of transmission which previously had not been recognized. Thus, reports of "airport malaria" subsequently followed in France, the Netherlands, Belgium, the UK and Spain. Of a total of 25 airport cases recorded during the period 1970-1986, 23 were P. falciparum, one P. vivax and one P. malariae. The exact geographical origin of P. falciparum cannot be determined with certainty, but an African origin has often been assumed when the airport concerned is known to receive planes from tropical Africa. Contraction of the infection from an infected vector on board an airplane originating from a tropical country as in the case of the two British citizens (see Table 3) should direct the attention to this mode of transmission that may occur fairly frequently but pass unrecognized. To counteract the importation of infected vectors, disinsection of aircraft according to WHO instructions has been re-emphasized, and as an additional measure residual spraying luggage tunnels and halls has been recommended in France.

Some cases of P. falciparum malaria which did not fit in any of the above mentioned categories have remained inexplicable or undetermined (Gentilini & Danis, 1981). Local transmission by a potential vector of the An. maculipennis complex has been discounted on the basis of the available experimental evidence pointing to the refractoriness of An. atroparvus and An. labranchiae to exotic strains of P. falciparum. Some views have suggested that the susceptibility of members of the An. maculipennis and other important species to P. falciparum strains from different regions should be re-investigated (Bettini et al., 1978 and WHO, 1980b). This is supported by the fact that experiments in the USSR demonstrated the susceptibility of An. subalpinus to African strains of P. falciparum, while An. sacharovi gave contradictory results (Daškova & Rasnicyn, 1982). It would also be useful if the susceptibility of An. claviger s.l. to exotic strains of P. falciparum is re-investigated (Curtis & White, 1984).

Improving surveillance and re-emphasizing the importance of notification of malaria cases in continental Europe have been stressed. As malaria has been forgotten for a long time in Europe, alerting the medical profession to the need for microscopical blood examination in febrile cases has been repeatedly emphasized. Attention has also been drawn to the need for more elaborate parasitology teaching in undergraduate medical studies, and for organizing courses in malariology for medical officers and biologists.
In order to assist countries of Europe in reporting comparable information on imported malaria and related infections, WHO is trying to develop a standardized and homogenous form of reporting in consultation with health authorities concerned (WHO, 1987).

An overview of the malaria situation and malaria control has been presented covering countries of the North African Mediterranean basin and those of the Eastern Mediterranean zone up to and including Pakistan. Steady improvement of the malaria situation has been observed in Turkey since the epidemic of 1976-1977. In the North African countries malaria transmission has been interrupted or has persisted in small foci. Variable degrees of progress have been recorded in other countries with nationwide antimalaria activities. The worst situation has been observed in Afghanistan as can be expected under the prevailing adverse conditions. Malaria is still endemic in southwest Saudi Arabia despite large-scale malaria control operations, and in Yemen and Southern Yemen where limited resources and trained manpower allowed only small-scale antimalaria activities. Surveillance and/or vector control activities are applied in countries originally free or freed of malaria transmission namely Bahrain, Cyprus, Israel, Jordan, Kuwait and Qatar where imported cases continue to be recorded.
SECTION II: VECTOR DISTRIBUTION

1. Species distribution

The distribution ranges of important anopheline species occurring in the geographical area under review are presented on a series of maps. Figs. 3(a & b) show the distribution of members of the An. maculipennis complex. Fig. 11 illustrates the distribution of the two members of the An. claviger group. Figs. 4-10 present the distribution of seven other species.

2. Vector distribution

It is well known that the ability of a species to transmit malaria may vary throughout its distribution range. Therefore, it is necessary to outline briefly here the areas where a species has been known to be a vector with special emphasis on its vector status at the present time, but more details will be given later in SECTIONS III(A) & (B).

Knowledge on vector status compiled here is partly taken from Zahar (1974) supplemented with some general information from Service (1986) and more specific information from other relevant references.

2.1 Major vectors

2.1.1 The An. maculipennis complex, Figs. 3(a & b): An. maculipennis s.s. and An. messeae are now regarded as potential vectors in Europe. An. maculipennis s.s. extends its distribution to northern Iran where it acts as a vector (Notabar, Tabibzadeh & Manouchehri, 1974). An. atroparvus and An. labranchiae are also regarded as potential vectors in Europe. However, the outbreak of P. vivax malaria that occurred in Corsica, France in 1970-1971 should serve as a reminder for the possibility of re introduction of malaria by An. labranchiae from P. vivax imported cases [see SECTION I under France in l.2.1(i) above]. With regard to P. falciparum, experimental evidence has so far shown that An. atroparvus and An. labranchiae are refractory to imported exotic strains of this parasite (see CONCLUSIONS of SECTION I, above). An. labranchiae is still regarded as the main vector in North Africa (Algeria, Morocco and Tunisia). It was recorded from Tripolitania in Libya which seems to be its easternmost limit of distribution in North Africa (Macdonald, 1982).

An. sacharovi, Fig. 3(b) is a potential vector in southeastern Europe, but an important active vector in Turkey, Syria, Iraq (northern region), and Iran (northwestern, central and southwestern areas). In Israel, An. sacharovi formerly one of the main vectors, disappeared from 1960 to 1969, but subsequently reappeared and increased in numbers in recent years. To prevent the reintroduction of malaria from imported cases, and in view of the reappearance of An. sacharovi, and the persistence of the former vectors: An. sergentii, An. superpictus and An. claviger, continued surveillance has been recommended (Pener & Kitron, 1985a). An. sacharovi and An. superpictus have been regarded as the major vectors in Lebanon before the elimination of malaria transmission, (Gramiccia 1953), but no recent information on the present situation could be traced.

1. Reproduced (with modification) by permission of Dr V.N. Stegniy, and Dr W.W.M. Steiner (ed.) from Fig. 1 in the article of Stegniy (1982). In: Recent Development in the Genetics of Insect Disease Vectors.
2. Reproduced (with enlargement and some additions) by permission of Prof. M. Coluzzi, and Service des Publications de l'ORSTOM, from the article of Coluzzi, Saccà & Feliciangeli (1965) in Cah. ORSTOM, sér. Ent. méd. Parasitol.
3. Reproduced from a VBC document (WHO, 1989a); “Geographical distribution of arthropod-borne diseases and their principal vectors.” Chapter 1. Malaria, prepared by Dr C.B. White. (The map of An. sergentii has been reproduced here with modification).
2.1.2 *An. superpictus*, Fig. 4: In the wide area of its distribution, *An. superpictus* has been regarded as a vector in Turkey, Iraq, Syria north of Saudi Arabia, Iran, and in certain parts of Afghanistan and Pakistan. *An. superpictus* and *An. sergentii* are found in association in Israel and Jordan where they are considered potential vectors and kept under vigilance and control because of the threat of reintroduction of malaria transmission as a result of an influx of imported cases in both countries. *An. superpictus* is a potential vector in Cyprus as it has persisted after malaria has been eradicated from the island. In Lebanon, *superpictus* together with *sacharovi* had been regarded as major vectors before malaria transmission was eliminated as mentioned above.

2.1.3 *An. sergentii*, Fig. 5: In the area of its distribution, *An. sergentii* acts as an important vector of malaria in the oases and the western desert and Faiyum province in Egypt, west and southwest Saudi Arabia, Yemen and Southern Yemen. Formerly, it had been regarded as an important vector in Israel, Jordan and Libya but now it stands as a potential vector. It was the responsible vector in three southern governorates in Tunisia (Gafsa, Gabès and Médenine). It disappeared as a result of aerial spraying of insecticides but reappeared later (Wernsdorfer, unpublished report to WHO, 1973). It exists in small foci in the southern oases of Algeria and Morocco. It extends its existence to Canary Islands in the Atlantic Ocean, but it has never been recorded in the northern Mediterranean area, with the exception of a single record from Bulgaria, the locality of which remains unknown (Senevet & Andarell, 1956) – [see more details in SECTION III(A) under (1). 2 in document VBC/90.2 – MAL/90.2]. More recently, it was newly recorded by D’Alessandro & Saccà (1967) who discovered the presence of a population of this species during an entomological survey carried out in conjunction with an epidemiological investigation of two cases of malaria regarded as indigenous in the island of Pantelleria, Sicily, Italy. The morphology of the larval specimens examined slightly differed from the typical *An. sergentii*.

2.1.4 *An. pharoensis*, Fig. 6: Although widely distributed, *An. pharoensis* acts as an important vector of malaria only in Egypt. Genetic and cytogenetic studies showed that the form of *An. pharoensis* existing in Egypt can be distinguished from other forms that occur in tropical Africa by the presence of an inversion on the X-chromosome, and it is more closely associated with man (see VOL. I, under 1.5, pp 61-62).

2.1.5 *An. fluviatilis*, Fig. 7: This species has a wide distribution range. In the present geographical area, it has been considered as a vector in Iran and Pakistan. In Iran, it occupies the southern slopes and foothills of the Zagros mountains and is associated with *An. superpictus* and *An. stephensi*. Both *An. fluviatilis* and *An. superpictus* were responsible for maintaining malaria transmission in those areas in Iran despite house spraying, due to their exophilic behaviour. In Pakistan, *An. fluviatilis* is found in the foothill regions of the mountainous tracts in the north. Although it is known to be a vector in the neighbouring countries of Iran and India, its role in malaria transmission in Pakistan needs further study. Malaria was reported to be hypoenemic in the area occupied by *An. fluviatilis* in Pakistan.

2.1.6 *An. pulcherrimus*, Fig. 8: It is also widely distributed, but was only considered a vector of importance only in Iraq and Afghanistan. In Iraq, it was incriminated on epidemiological grounds as it was the only species present during a malaria outbreak in Kerbala province in 1969. In Afghanistan, it was incriminated through the finding of sporozoite-positive specimens in Kunduz area in the north in 1969 (Badawy, unpublished report to WHO, 1970), and it has been regarded as the main vector responsible for malaria transmission after the complete disappearance of the former principal vector, *An. superpictus* for more than 15 years following the initial DDT house spraying.

2.1.7 *An. stephensi*, Fig. 9: It is an important vector over much of its distribution range, especially in and around urban areas. Several studies suggested that the two forms: *An. stephensi* and its variety *An. stephensi mysorensis* should be considered as population variants (see VOL. I, under 1.4, pp. 48-52). A single record of *An. stephensi* came from outside the normal range of its distribution (Gad, 1967), as it was reported from Shoukeir locality area Ras Gharib south of the Gulf of Suez, Egypt. As cited by Zahar (1974), Dr P.F. Mattingly of the British Museum (Natural History) London, found that the material resembled *Anopheles dancalicus* Corradetti, but considered it an aberrant form of *An. stephensi*. There was no evidence of malaria transmission in this area which was put under intensive oil larviciding. Gad & Kamel (1967) tried to find an
explanation for the existence of *stephensi* on the Egyptian coast of the Red Sea out of its distribution range in the Oriental Zoogeographical Region. Two assumptions were discussed: The first was the possibility of transportation by ships, and the second was its existence as an indigenous species in the Red Sea area. The first assumption was discounted, since the only port in the area is Ras Ghareb (at 35 km from Shoukeir), but it does not receive any ships from abroad. The authors favoured the second assumption because: (a) Dr Mattingly found that Shoukeir specimens did not match with any of the collection of the British Museum in all respects. These marked differences in the Egyptian material might indicate that the mosquito has existed for a long time in the area. (b) Larval susceptibility tests made on *stephensi* from Shoukeir showed that the species was susceptible to DDT, dieldrin and malathion, while *stephensi* in most of its range was resistant to organochlorine insecticides. (c) Larvae in Shoukeir were breeding in water with high salinity: 18.9 chlorides/1000 or 65% sea-water, whereas *stephensi* in its range is known to breed in freshwater.

Recently, a mosquito survey was conducted during 1981-1983 by Gad et al. (1987) in the Red Sea governorate in Egypt (the Egyptian western coast of the Red Sea). Larvae of the species described by Gad (1967) as *stephensi* were collected from the type locality and from a similar area 14 km further north. Morphological studies showed that this species is similar to Anopheles salbati Maffi & Coluzzi. Biological, ecological and morphological findings indicated that this mosquito species is not *stephensi*, and may be a new species. The authors indicated that studies designating this new species will be published later, and will provisionally be referred to as Anopheles ainshamsi.

[It may be argued that the original *stephensi* was eradicated under the effect of intensive larviciding operations hitherto instituted in the type locality. Subsequently, no material could be obtained from this focus for crossing experiments with known strains of *stephensi* to confirm the identity of this mosquito as suggested by Zahar (1974). It follows that the new taxon now discovered in the type locality may have existed as an associating species, but for unknown reasons escaped the identification and persisted in the area defying the action of larviciding; a point which is very difficult to prove or deny. When the full description of the new taxon is published, the situation may be clarified.]

2.1.8 *An. culicifacies* complex, Fig. 10: *An. culicifacies* s.l. is much more widely distributed and overlaps with *An. stephensi* over most of its range. Four members of the *An. culicifacies* complex: A, B, C and D have recently been identified cytogenetically (see VOL. I under 1.3). In the present geographical area only species A and B have, so far, been identified in Pakistan and species A in UAE and Oman. Unlike *An. stephensi*, *An. culicifacies* s.l. extends its existence to southwest Arabia namely in Yemen and Southern Yemen, but not in southwest Saudi Arabia. In Yemen and Southern Yemen, the subspecies *An. culicifacies adenensis* also exists (see PART I, document VBC/85.3 - MAP/85.3, pp. 213-220). *An. culicifacies* s.l. is an important vector over much of its range.

2.1.9 The *An. gambiae* complex: The distribution of members of the *An. gambiae* complex has been shown in PART I (document VBC/84.6 - MAP/84.3, pp. 69-75). It is sufficient to mention here that of members of this complex only *An. arabiensis* occurs in southwest Saudi Arabia, Yemen and Southern Yemen where it acts as a major vector of malaria particularly in the coastal plains.

2.2 Secondary and suspected vectors

2.2.1 *An. claviger* group, Fig. 11: In Europe, *An. claviger* s.l. had been regarded as a non-vector or at most a vector of minor importance. In Turkey, it has also been considered a vector of minor importance and has little influence on receptivity to malaria in areas where transmission has been interrupted (Postiglione, Tabanli & Ramsdale, 1972). In contrast, *An. claviger* s.l. has been regarded as an important vector in certain areas of the Middle East. Gramiccia (1956) pointed to the role of *An. claviger* s.l. as a vector over a wider area namely: Cyprus, Palestine, Lebanon, Mesopotamia, Baku (Azerbaijan) and

1. This was published before Zulueta et al. (1968) pointed out that in Fao Haslaha locality, south of Iraq, the breeding places of *An. stephensi* often have a very high salinity (equal to or higher than sea-water; see more details in VOL. I, under 1.4.2, p. 49).
southern Italy. Coluzzi, Saccâ & Felicianeafi (1964) identified An. claviger s.s. from larval samples collected in Palestine, and indicated that it is most probably responsible for malaria transmission in certain areas of the Middle East due to the presence of favourable environmental conditions which do not exist elsewhere. An. claviger s.l. was associated with an outbreak of P. vivax malaria in Aleppo, Syria in October 1970, where no other anopheline species existed and 2 sporozoite-positive specimens were detected out of 20 females dissected (Muir & Keilany, 1975).

2.2.2 An. hyrcanus s.l.: The geographical distribution and the taxonomic status has been reviewed in VOL I, under 1.2. In Turkey, An. sacharovi and An. hyrcanus s.l. occur in the Chukurova plain which occupies much of the provinces of Adana and Içel on the Mediterranean coast. While An. sacharovi is the major vector of malaria, the possible involvement of An. hyrcanus s.l. in malaria outbreaks in this area could not be excluded (Postiglione, Tabani & Ramsdale, 1973). In the Kunduz area, northern Afghanistan, An. hyrcanus s.l. was found with salivary gland infection in 1969 (Badawy, unpublished report to WHO, 1970), and it is believed that it plays a role in malaria transmission early in the season (May-June), after which period An. pulcherrimus takes over to the end of the season (July-October).

2.2.3 An. d’thali: It is a very abundant species, widespread in semi-arid regions from the Atlantic coast of North Africa to Baluchistan and northwestern Pakistan. South of the Sahara, it is the dominant species in many areas bordering the Red Sea and the Gulf of A'den, and it extends from the Sudan coast through Ethiopia, southern Arabia down to just north of Mogadishu (Gillies & De Meillon, 1968). Unconfirmed observations were reported from Somalia where one sporozoite-positive specimen was detected out of 14 females dissected (Rishikesh, 1961) - [see PART I, document VBC/85.3 - MAP/85.3, p. 89]. It was only in Iran that sporozoite-positive specimens of An. d’thali were repeatedly detected during 1965-1967 in areas where malaria transmission was persisting. An. d’thali was, therefore, considered a secondary vector in southern Iran (Manouchehri, Ghilasdei & Shahgudian, 1972).

2.2.4 An. multicolor: A north African species which extends its distribution eastwards to Pakistan. In Africa, it extends up the Nile as far as the Sudan and also occurs on the Red Sea coast around Port Sudan (Gillies & De Meillon, 1968). Although Kirkpatrick (1925) considered An. multicolor a vector on epidemiological grounds, this species has never been shown to act as a natural vector of malaria in Egypt (Halawani & Shawarby, 1957). This seems to hold true despite the fact that it has been successfully infected experimentally in Egypt. (see VOL I, under 2.8.1). In Libya, it was suspected to be a vector on epidemiological grounds (Goodwin & Paltrinieri, 1959 and others) since it was found alone or associated with An. sergentii in southern oases where malaria transmission persisted during the 1960’s. In Iran, a single female of An. multicolor was detected during 1955 with only a gut infection, and the species has been regarded as a suspected vector (Esghy, 1977).

CONCLUSIONS (SECTION II)

The present geographical area which covers Europe and the Mediterranean Region is rich in anopheline vector fauna. Of the subgenus Anopheles, members of the An. maculipennis complex are widespread in Europe and act as potential malaria vectors, but An. sacharovi acts as an important vector in Turkey and the Middle East, while An. maculipennis is a localized vector in Iran. Other species of the subgenus Anopheles, An. claviger and An. hyrcanus are localized secondary vectors in the Middle East. The subgenus Cellia is represented by An. culicifacies, An. d’thali, An. gambiae complex, An. fluviatilis, An. multicolor, An. pharoensis, An. pulcherrimus, An. sergentii, An. stephensi, and An. superpictus. An. culicifacies and An. stephensi are widely distributed in the eastern part of the present geographical area and act as important malaria vectors over most of their distribution ranges. An. sergentii is an important vector in the oases of North Africa and Egypt. An. arabiensis is the major vector of malaria in Southwestern Arabian Peninsula. The incrimination of An. t’thali as a secondary vector was confirmed only in Iran, while An. multicolor still remains a suspected vector on epidemiological grounds.

More details are given on the vectorial status and local spatial distribution of major, secondary and suspected vectors in SECTION III(A); Document VBC/90.2 - MAL/90.2 and SECTION III(B); Document VBC/90.3 - MAL/90.3, to be issued later.
Fig. 3 (a) Distribution of members of the *Anopheles maculipennis* complex

Fig. 3 (b) Detailed distribution of four members of the *Anopheles maculipennis* complex
Fig. 4. Distribution of Anopheles messeae and Anopheles superpictus.
Fig. 7. Distribution of *An. fluviatilis*

Fig. 8. Distribution of *An. pulcherrimus*
Fig. 9. Distribution of An. stephensi

Fig. 10. Distribution of An. culicifacies
SECTION I: AN OVERVIEW OF THE MALARIA SITUATION AND MALARIA CONTROL PROBLEMS

The references are arranged alphabetically under each main subject heading following the same sequence as in the text. References of 1.2.1 (i) are arranged by country in alphabetical order - those dealing with more than one country are placed first under GENERAL. References cited by authors are marked in the margin with c, and those not seen in the original are marked with an asterisk.

1. The European Region

1.1 Status of malaria eradication and control

Belios, G.D. (1976) - see under GREECE below.


c Bruce-Chwatt, L.J. et al. (1975) - see under GREECE below.

Violaki, M., Avramidis, D. & Trichopoulou (1976) - see under GREECE below.


1.2 Imported malaria in continental Europe

1.2.1 Authors' views

(i) The extent of the problem of imported malaria

GENERAL


BRITAIN (UK)

Bruce-Chwatt, L.J. (1982) - see under 1.2.1 GENERAL above.


BULGARIA


FRANCE


Gentilini, M. et al. (1978) - see under 1.2.1 (iii) below.


Saliou, P. (1978) - see also under 1.2.1(iii).


GREECE


HUNGARY


ITALY


NETHERLANDS


PORTUGAL


SPAIN


USSR

Chagin, K.P. et al. (1975) The problem of malaria importation to the USSR from abroad. Medskaya Parazit. 44: [In Russian with English summary]


Duhanina, N.N. et al. (1979) Present problems of prevention of malaria in USSR. Medskaya Parazit. 48:3-10. [In Russian with English summary].


1.2.1 (ii) Induced malaria


Bruce-Chwatt, L.J. (1982) - see under 1.2.1 GENERAL above


* c Deroff, P. et al. (1982) Dépistage des donneurs de sang susceptibles de transmettre P. falciparum. Rev. Fr. Transfus. Immunohematol. 25:3-


Hässig, A. (1987) (Editor) Which are the appropriate modifications of existing regulations designed to prevent the transmission of malaria by blood transfusion, in view of the increasing frequency of travel to endemic areas? *Vox sanguinis*, 52:138-148.


1.2.1 (iii) Malaria associated with airports


Cassaigne, R., Bruaire, M. & Léger, N. (1980) – see under 1.2.1 (i) – FRANCE.


c Dzhavadov, R.B. et al. (1978) Susceptibility of Anopheles maculipennis saccharovi and A.M. subalpinus to infection with the agents of imported tropical malaria from Africa. Med. Parazit. 47:84-87. [In Russian with English summary].


1.2.2 **Action by WHO**


2. **The Mediterranean Region**


SECTION II: VECTOR DISTRIBUTION


ANNEX 1

CORRIGENDUM TO VOL. I

Page 11

Page 16
Authors and copyright should read Authors and copyright.

Page 18
List of names under VBC: Dr G. Quelenec should read Dr G. Quélenec.

Page 151
3rd paragraph, 2nd line: Tadjih should read Tadjik.

Page 203
Last line: Parassitologica should read Parassitologia.

Page 214
2nd line: The reference of Zulueta, J. de et al. (1951 should be placed at the end of the reference list of 2.6.3 An. stephensi in p. 216.