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# Current status of medical and veterinary entomology in France: endangered discipline or promising science?

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## Abstract

Following alarming statements (French Senate, Académie des Sciences) on the present situation concerning entomology and systematics in France, the Conseil Général Vétérinaire designated one of us (D.C.) to carry out a survey on the status of medical and veterinary entomology (MVE) with respect to research orientations and university curricula. Around 100 participants, including scientists, teachers and several directors of research and educational bodies, were interviewed and filled in questionnaires for this survey. On the basis of the results, it was concluded that the deterioration of MVE in France is associated with: (1) the hasty reorganisation of training and research in the life sciences, leading to the disappearance of several disciplines. Hence, the postgraduate DEA degree in entomology was eliminated, and even the name 'entomology' no longer appears in teaching programmes or on research contracts; (2) France's withdrawal from action research programmes in

*Abbreviations:* CGV, Conseil général vétérinaire; CEAV, Certificat d'études approfondies vétérinaires; CIRAD, Centre de coopération internationale en recherche agronomique pour le développement; CNRS, Centre national de la recherche scientifique; DEA, Diplôme d'études approfondies; DESS, Diplôme d'études supérieures spécialisées; EDEN, Association européenne des opérateurs publics de démoustication et de gestion en zones humides démoustiquées; EID, Ententes interdépartementales pour la démoustication; ENV, Ecoles nationales vétérinaires; EMV, Entomologie médicale et vétérinaire; GIS, Geographical information system; GTZ, Deutsche Gesellschaft für Technische Zusammenarbeit; INRA, Institut national de la recherche agronomique; IP, Institut Pasteur; IPO M, Instituts Pasteur d'Outre-Mer; IRD, Institut de recherche pour le développement (ex-ORSTOM, Office de la recherche scientifique et technique Outre-mer); MNHN, Muséum national d'Histoire naturelle; REID, Réseau Environnement des interactions durables; RTTCP, Regional Tsetse and Trypanosomosis Control Programme; SEF, Société Entomologique de France; UEF, Union de l'Entomologie Française.

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developing countries. Although these programmes were efficient in controlling outbreaks of major endemic diseases, integrated pest and vector management programmes have been replaced by basic health care (*'Health for everyone in 2000'*) and vaccination programmes; (3) the general shift from field to laboratory research, focused mainly on molecular mechanisms. The survey results confirmed generally acknowledged trends concerning many points and highlighted several specific problems, such as the disappearance of systematics experts. Several potential solutions are proposed.

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**Keywords:** Medical and veterinary entomology; France; Human health; Animal health; Communicable diseases; Arthropod vectors; State of the discipline; Specialised survey

## Résumé

A la suite d'informations alarmantes (Sénat français, Académie des Sciences) sur la situation présente dans laquelle se trouvent l'Entomologie et la Systématique en France, le Conseil Général Vétérinaire a désigné l'un d'entre nous (D.C.) pour entreprendre une évaluation de l'état de l'entomologie médicale et vétérinaire (EMV) au point de vue des orientations de recherche et de la formation universitaire. Pour ce faire, une centaine de spécialistes, comprenant des chercheurs, des enseignants et plusieurs responsables d'équipes de recherche et de formation, ont été interrogés et ont rempli un questionnaire. Sur la base des résultats de cette enquête, on peut estimer que la dégradation de l'EMV en France est en relation avec: (1) la réorganisation précipitée de l'enseignement et de la recherche dans le domaine des sciences de la vie, conduisant à la disparition de plusieurs disciplines. Ainsi, le Diplôme d'études approfondies (DEA) en Entomologie a disparu, et le mot même d' «entomologie» n'apparaît plus dans les programmes d'enseignement ou les contrats de recherche; (2) le retrait de la France des activités de recherche dans les pays en développement. Bien que ces programmes aient été efficaces dans le contrôle de maladies endémiques majeures, les actions concernant la lutte intégrée contre les agents infectieux et les vecteurs ont été remplacées par la promotion des soins de santé primaire («*La santé pour tous en l'an 2000*») et des programmes de vaccination; (3) la dérive générale des activités de terrain vers la recherche en laboratoire, principalement orientée vers l'étude des mécanismes moléculaires. Les conclusions de cette étude confirment les tendances généralement admises à propos de nombreuses questions et mettent en relief plusieurs problèmes spécifiques, comme la disparition des experts en matière de systématique. Plusieurs solutions d'avenir sont proposées pour remédier à cette situation.

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**Mots-clé:** Entomologie médicale et vétérinaire; France; Santé publique humaine; Santé publique vétérinaire; Maladies transmissibles; Arthropodes vecteurs; Etat de la discipline; Enquête spécialisée

## 1. Introduction

Applied entomology encompasses a broad range of research areas (agricultural, forestry, domestic and medicolegal, etc.). Medical and veterinary entomology (MVE) is a key field that involves: (1) communicable diseases, including parasitic (malaria, trypanosomosis, leishmaniosis, filariasis, etc.), bacterial (plague, typhus, Lyme disease, etc.) and viral (yellow fever, dengue, hemorrhagic fever, West Nile, etc.) forms; (2) allergic phenomena; (3) pests; (4) envenomation protection. Entomology also deals with some domestic damage caused by insect pests.

Arthropods—which are responsible for transmitting a broad range of diseases—have infinitely varied behavioural patterns: blood feeding (by vectors and pests), inoculation of venomous toxins (envenomation by stinging by black flies, hymenopterans, ticks, scorpions or spiders), and passive transport of pathogens (anthrax, trachoma, salmonellosis). Moreover, epidemiological systems (metazoonosis) and intravectorial cycles (anterograde or posterograde digestive infestations in vectors of trypanosomosis, transovarian transmission of viruses and rickettsia) are highly complex.

In this context, MVE specialists require ‘*broad-ranging scientific knowledge and extensive field experience.*’ Besides basic entomological training, they must have a full overall understanding of agents that are transmitted (parasites, bacteria, viruses), epidemiological cycles (pathogen systems) and concerned environments, in both natural ecosystems and ones changed by man (e.g. agrosystems). Medical and veterinary entomologists are specialised to deal with this extraordinary pathogenic and eco-epidemiological complexity [11,14].

At the request of the French Conseil général vétérinaire, one of us (D. Cuisance) was assigned to coordinate a national survey on the ‘*Medical and veterinary entomology (MVE) situation in France.*’ This survey was set up in response to the alarming statements put forward by several renowned scientists at meetings held at the Palais du Luxembourg (‘*Entomology training and knowledge transfer*’) [20] and the Académie des Sciences (‘*Systematics. Classifying the diversity of living organisms*’) [1]. For the head of the project, this meant updating—for the benefit of decision-makers and users—assessment data concerning training, research and development throughout this discipline, i.e. entomology applied to human and veterinary medicine.

Within this framework, it was essential to focus the analysis on retrospective events, beginning with programmes developed in the 1950s and concluding with proposals for the future. This meant taking into account: (1) patterns concerning laboratory and field research oriented concepts, methods and techniques during this period; (2) student training, career access and recruitment of young professionals; (3) the upsurge of new epidemics (emerging and re-emerging diseases) and their economic and sociopolitical impacts. The results of this survey, which was conducted between 2001 and 2003, were publicly presented by the survey coordinator at a conference held in Montpellier (France) in March 2003 (‘*Medical entomology: a social and scientific challenge*’). Here we briefly review these results.

## 2. Materials and methods

The survey involved questionnaires, direct interviews and literature reviews (publications and reports).

The questionnaire included 34 items (open- and close-ended questions), that were aimed at classifying the medical and veterinary entomologist population (initial training, specialisation, membership, status, age pyramid), quantitative development patterns, geographical distributions, etc. It was addressed to: (1) ‘grassroots’ medical and veterinary entomologists working in metropolitan France and the French overseas departments and territories; (2) research contract coordinators; (3) directors of research units (IRD, CIRAD, Institut Pasteur, universities, national veterinary schools, French Muséum national d’Histoire naturelle, CNRS, INSERM, French national police force, private establish-

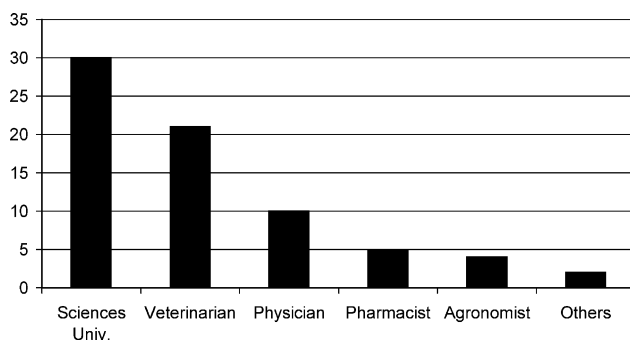


Fig. 1. MVE survey/questionnaire. Initial educational background of the 72 respondents. Forty-eight percent had a university education in medicine and pharmacy, while 41% had a university education in science.

ments and companies); (4) training coordinators (postgraduate DESS, DEA, MSc., PhD degrees); (5) entomology decision-makers and consultants (qualification criteria for degrees and publications, recruitment committee qualifications, impact factors); and (6) pest control structures (EID, EDEN) (Figs. 1 and 2).

The questionnaire was also circulated through learned societies, professional associations and networks: Société française de parasitologie, Association des enseignants de parasitologie-mycologie médicale, Société entomologique de France, Entente interdépartementale pour la démostication, EDEN, Anofel network, Arthropodes hématophages network, Evolmont (Evolution/Montpellier) network, and the Reid network (sustainable interactions).

The interviews (at meetings, by telephone, fax and e-mail) mainly involved decision-makers and directors, but also entomologists *intuitu personae* who had not filled in the questionnaire for various reasons (external missions, etc.). Special attention was paid to 'retired scientists', especially those who had previously worked for the main organizations involved (IRD, Institut Pasteur, CIRAD, INRA), and whose opinions were often highly valuable (historical documents, administrative reforms, research contracts, specialised training, career based in the tropics, reference collections, etc. (Fig. 3)).

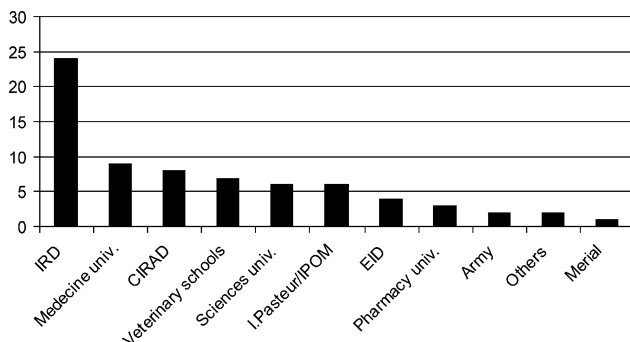


Fig. 2. MVE survey. Institutional affiliation of the 72 respondents. Fifty-six percent were scientists and research engineers affiliated with public research centers (IRD, CIRAD, CNRS, INRA) and institutions (IP, IPOM). Thirty four percent were teacher scientists (universities, schools). Ten percent were working for public or private operational structures (EID, Merial).

The literature review was carried out in an in-depth manner by specialised services at IRD (M. Stjepanovic) and CIRAD (A. Marti). It focused on two major topics: ‘Mosquitoes and malaria’ and ‘Tsetse flies and trypanosomosis.’ The first topic was based on a corpus of 10 000 references (1972–2001), using the most pertinent key-words (biology, ecology, systematics, genetics, epidemiology, model, control, GIS, etc.), with reference to subgroups of French and English terms. The second topic was based on a corpus of 9000 references (1972–2003) obtained through queries of international databases and via cross-references using the same key-words as listed above.

### 3. Results

#### 3.1. Institutional origins, training, expertise and professional work areas of medical-veterinary entomologists

- (1) Those involved in MVE at various levels obtained their initial education in science universities (42%), national veterinary schools (29%), medical and pharmacy universities (21%) and national agricultural schools (6%); (other 2%).
- (2) They were trained in MVE: 40% of the population in official educational structures of Institut Pasteur-ORSTOM (1945–1973), ORSTOM-Université Paris XII, Paris VI (postgraduate DEA degree, 1974–1987) and Institut Pasteur (1980–2003); and 60% in a specialised research team (‘on the job’).
- (3) Then 56% of this population began working as scientists and engineer-scientists (ORSTOM-IRD, CIRAD, Institut Pasteur), 34% as teacher-scientists (universities, specialised schools, Institut Pasteur), 10% as engineers and technicians in health, mosquito control and forensic science research organizations. They are working on tropical (65%) or temperate diseases endemic to metropolitan France (31%), with a small number (4%) working in both of these areas. The centres they are attached to are pooled at two main sites, i.e. Montpellier (28 people/82) and Paris (16 people/82), and the remainder are located at 10 other French sites (1–6 scientists per unit). Most of these agents (79%) are involved in applied research, while a minority (16%) consider that they are theorists (fundamental research).

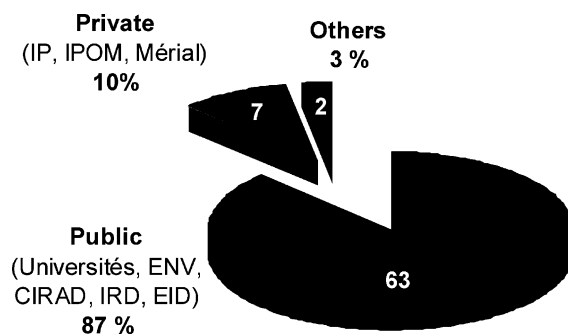


Fig. 3. Affiliation of MVE respondents by type of establishment.

- (4) There were 118 responses on expertise areas: (1) 36% concerned functional topics, including eco-physiology, ethology, genetics, parasite–vector and vector–reservoir interactions, and rearing; (2) 26% concerned epidemiology, including the ecology of vectorial systems, modelling, risk analysis, disease surveillance and pest monitoring; (3) 22% concerned pest management, including operational strategies, pesticides, resistance, and unintentional effects; (4) 15% concerned systematics, including biometry, taxonomy, identification, phylogenesis, cryptic species, and collections; (5) 1% concerned various topics, such as forensic science, envenomation and allergies. (6) Note that 63% of these entomologists work in the field whereas 21% work only in the laboratory, and the remaining 16% work in both environments, usually first in the field and then in the laboratory.

### 3.2. Systematics: a fundamental discipline that is now marginalised

- (1) Systematics, the science of classification, is a broad ranging field, from the collection and description of organisms (capture, diagnosis, nomenclature, collections) to phylogenetic relationships (evolutionary systematics, *alias* biosystematics), while also encompassing practical determination (dichotomous keys and multifactorial computer programmes). Taxonomy, which is sometimes synonymous with systematics, is actually a methodological discipline (selection of characters and morphological and molecular states, Linnean, Adansonian and Hennigian classification). Systematics are crucial in many medical and veterinary fields: analysis of epidemiological cycles (vectors, reservoirs, parasites, vicarious organisms), bioindicators research (risk areas, forensic science), impact of pesticides on non-target fauna and flora (unintentional effects).
- (2) Of the 109 responses obtained in the present survey, the proportions of entomologists per systematic group are as follows: mosquitoes 36%; tsetse flies 14%; ticks 12%; sandflies 9%; fleas 7%; Ceratopogonid insects 7%; tabanid stomoxys and 7%; blackflies 4%; lice 2%; and assassin bugs 2%. However, it should be kept in mind that some groups included only a few systematics experts who were readily able to identify all species from the same family or genus [12]. For instance, in France, only one person was able to identify Old World Ceratopogonid insects, i.e. only one genus (*Culicoides*) (Fig. 4).
- (3) It was found that only 15% of those questioned had systematics skills concerning arthropods of medical importance, and most of these entomologists were in an older age class. This situation is further worsened by the fact that training cycles are very long and there has been a serious reduction in qualified replacement entomologists.
- (4) To halt this drastic reduction, most French systematics experts would like to be attached to a common structure, in the form of an expertise network that would be open to the European Community, which in turn would fund it *pro parte*. Overall (98%), medical entomologists were in agreement with this proposal. This network could include relevant theorists who would serve as specialised consultants, e.g. from the French Muséum national d'Histoire naturelle. However, medical-veterinary systematics experts should never overlook his/her own activities, i.e. development-oriented research.

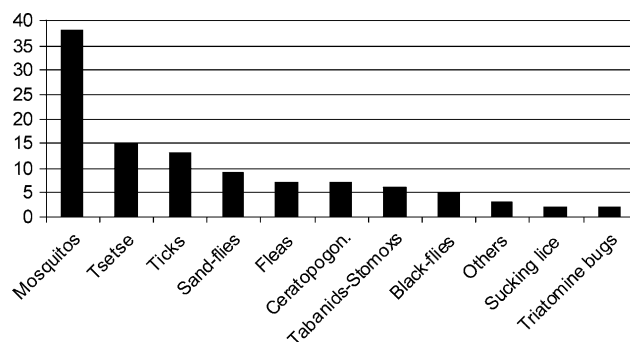


Fig. 4. MVE survey/questionnaire. Number of people involved per arthropod group.

- (5) The problem concerning collections, which are essential tools for the identification and classification of vectors and reservoirs, was noted by several people. In particular, university staff mentioned the destruction of collections containing types or *princeps* series as part of restructuring operations or even simply as a result of a change of director in the reception service. A census of these collections was officially recommended but is taking too long to organise.

### 3.3. Medical and veterinary entomologists: an endangered population

- (1) Most of the responses revealed a major concern about the future of MVE in France because 74% of entomologists are over 40 years old and 50% are over 50 (Fig. 5), so the over-50 cohort will disappear at a rate of 2.4 entomologists a year over the next 15 years.
- (2) This drastic reduction will have a negative impact on MVE, especially since research programmes, as of 1980, have been focused on human pathology and vaccination issues to the detriment of analysis of parasite cycles and vector control. If no changes are made, this trend will continue until most ecologists and systematics experts disappear.
- (3) Finally, this finding [14,20] confirms the conclusions of the Académie des Sciences conference: *'Efforts should focus on training and also on the existing research teams, since those involved in this discipline are essential, but seriously endangered'* (Ac Sc., 2000) [1]. This alarm call echoes others made earlier by J. Brengues (1983): *'To preserve a sufficient critical mass, so that we can respond to our partners' proposals, this regression should be halted,'* and by J.L. Frézil (1995): *"If our ultimate aim is to control major vector-transmitted parasitoses, within a cooperation framework, it is clear that the French research potential is debilitated."*

### 3.4. Meanwhile there is a substantial medical entomology demand

- (1) In the light of this alarming fact, the need for medical-veterinary entomologists is markedly increasing (61%), for both development-oriented research (action research) organizations and pest and vector control units. The specialisations in highest demand are eco-epidemiology of parasite cycles and IPM (45%), systematics (39%) and molecular genetics (16%). However, the demand varies substantially according to the

type of action involved, so the control of large endemic diseases is the main focus in the tropics (60%), whereas surveillance and monitoring are in highest demand in metropolitan France (24%). Systematics experts are in demand (39%) in many areas.

- (2) It was noted that traditional entomologists (field scientists) adopted molecular tools to a much greater extent (82%) than molecular entomologists adopted field research tools (18%).
- (3) The need for ongoing training in MVE was strongly expressed by most respondents (79%), mainly in the fields of systematics (61%) and ecology (38%).

### 3.5. An urgent reform: medical entomology scientist assessment methods

Fifty percent of the respondents stressed the need for active support for applied research They would specifically like:

- (1) The key objective of medical entomologists to be taken into account, i.e. public health research, especially in developing countries. Under these conditions, efficiently maintaining a log book is often a major challenge: local sociopolitical problems, field constraints due to problems of developing operational sampling, to a shortage of logistics resources, to the obligation (statistical) of covering several annual cycles (high-risk seasons) and to scientific isolation. Collaboration (*in natura*) between specialists from different fields (ecologists, geographers, mammalogists, ethnologists, etc.) is thus essential [6,21].
- (2) *The rehabilitation of research publications.* Fifty-six percent of the respondents stressed that '*the current literature assessment method for scientists is poor.*' In this field, a new balance is required in order to avoid systematically favouring publications with a high impact factor ( $> 2$ ), such as those concerning molecular genetics, modelling and geographical information systems [2,3,8]. The following reform proposals were put forward: (1) the creation of MVE-specific indicators (or coefficients); (2) assessment of research work by an independent centre or an intra-institutional peer group (e.g. a university consultative committee); (3) giving applied and fundamental research the same weight of importance; (4) taking into consideration the number and originality of publications relative to the entire population of scientists in the same domain; (5) taking all publications into account, i.e. international, national and regional; (6) An analysis of bibliometric patterns concerning EMV production over the last 30 years (A. Matri et M; Stjepanovic, 2003, pers. com.) concerning 'anopheles' and 'tse-tse flies' indicates a regression in 'biology', 'ecology' and 'control' topics, whereas 'systematics-taxonomy' topics have remained stable at a low level. On the other hand, there has been a spectacular increase in 'genetic-molecular tools' topics, as well as (but to a lesser extent) 'GIS, remote-sensing, modelling topics'; a distribution by type of journals (impact factor) (IF) concerning 'anopheles' shows that publications relative to 'genetic-molecular tools' and 'GIS, remote-sensing, modelling' topics are mainly (70%) in journals with an IF of above 2 whereas those relative to 'systematics-taxonomy', 'ecology' and 'control' topics are in journals with an IF of less than 2. These changes seemed to emerge around the 1980s.



## 4. Discussion

In response to the recent alarm calls emitted by higher authorities (French Senate, 2000; Académie des Sciences, 2000), a survey of French medical entomologists was conducted between 2000 and 2002, at the request of the Conseil général vétérinaire (coordinator: D. Cuisance). A 'priced trend picture' of the entomology situation in France over the last five decades was drawn up on the basis of the survey results. The main findings are reviewed here.

### 4.1. A need for competent and experienced entomologists

- (1) It is estimated that there are currently only around 100 medical entomologists in France and 76 of these filled in the complete questionnaire and provided further information on structures, recruitment and training in this field. In this population, 48% were educated in medical schools and universities (physicians, veterinarians, pharmacists) and 31% in science universities. Eighty-seven percent of the population are working for a French public body (IRD, CIRAD, universities, national veterinary schools, CNRS, EID) while 10% are in the private sector (Institut Pasteur, pharmaceutical laboratories). Seventy percent are tropical entomologists in charge of development-oriented research.
- (2) Prior to being officially employed in this field, most of the entomologists received a graduate level university degree supplemented with specialised MVE training. This supplementary training was obtained: (1) within the framework of regular academic courses (40%), initially given by ORSTOM, in association with Institut Pasteur (1945), and then the universities, and finally given by Institut Pasteur alone (since 1988); (2) by direct immersion in one of the few existing specialised teams (60%).
- (3) In addition to this theoretical education, these medical and veterinary entomologists were trained via their long practical experience in the field [14,20], thus facilitating their understanding of complex epidemiological systems, including arthropod-vectors, and vertebrate-reservoirs (for metazoanotic diseases). Moreover, 88% of project coordinators consider only scientists who have obtained field training (*ecology pro parte*).

### 4.2. An ageing and endangered population

- (1) Currently 50% of French medical and veterinary entomologists are over 50 years old, but it is not certain that they will be replaced after retirement. Moreover, it is predicted that 2.5 entomologists will retire yearly over the next 15 years. At IRD (ex-ORSTOM), 41 retirements are expected over the next 20 years (2/year), whereas only 15 entomologists were recruited over the last 20 years (0.7/year). This ageing trend is highly detrimental to scientific production, supervision of research teams, national and European expertise, as well as France's reputation in international bodies devoted to human and animal health (Fig. 5).
- (2) Amongst French medical entomologists, there is only a very small group of systematics experts, despite the fact that they are essential for classifying and

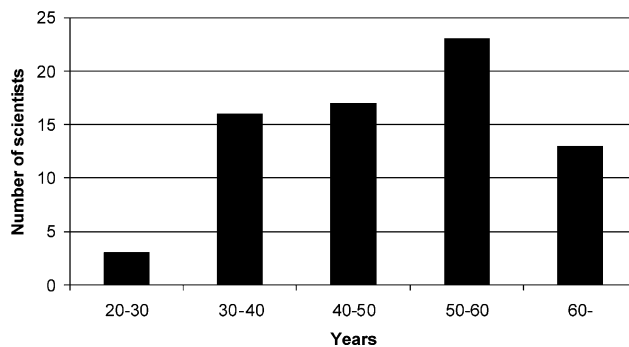


Fig. 5. Age pyramid of the 72 MVE survey/questionnaire respondents. Seventy-four percent were over 40 years old and 50% were over 50.

identifying vectors (taxonomists). They are highly skilled specialists, but there is often only a single expert per arthropod family or genus. Hence, there is a real future risk of not being able to identify certain insects and mites of epidemiological importance, and directors of French research institutions could thus be obliged to recruit foreign scientists in the near future. This will probably be the case for Ceratopogonidae (genus *Culicoides*), which are responsible for transmitting bluetongue, an epizootic viral infection of sheep that has a major economic impact in Mediterranean Basin countries.

- (3) Questionnaire respondents stated that the following are key MVE areas (1) *Laboratory topics* (57 responses): molecular genetics (28%), systematics (26%), vector–parasite interactions (12%), (2) *Field topics* (41 responses): vector control (20%), ecology (19%), epidemiology (9%), surveillance and monitoring (9%).

#### 4.3. Reasons for the decline in the following three fields

- (1) *In the research field.* (1) The serious deficit in the recruitment of field scientists (naturalists, ecologists), despite the high scientific demand [14,20], with a current bias in favour of laboratory research associated with the fascination for molecular tools, an area in which the career potential in public and private sectors is more promising. (2) ‘The enormous imbalance between resources allocated to reductive approaches (molecular and cellular biology) and those allocated to studies on organism function, especially with respect to interactions with their environments,’ Le Maho, 2003).
- (2) *In the educational field.* The restructuring of major educational and research organizations, with the resulting untimely reformation of life science training units—a ‘revolution’ that will reduce biology to functional and evolutionary mechanisms to the detriment of systemic, structural and dynamic mechanisms. Note, however, that quite early the key focus of MVE was pathogen complexes with a vector component’ i.e. parasitic systems in the broadest sense. This institutional restructuring has had a serious impact on MVE, including the suppression of the postgraduate DEA degree in entomology, disappearance of the word ‘entomology’ from educational categories and key-words, and the status of entomology as a discipline is now even being questioned!

- (3) *In the cooperation policy field.* The withdrawal of France's commitment in developing countries [20]. This withdrawal has had serious operational consequences: the reduction of IPM to the benefit of basic health care. Scientists are losing interest in research programmes on vectors that are responsible for major endemic diseases: tsetse flies and trypanosomosis, mosquitoes and malaria, blackflies and onchocercosis, sandflies and leishmaniasis. Traditional methods have been successfully readopted after a few major failures. Unfortunately, the tropical entomologist community dwindled during the reform. Moreover, vector control had slipped towards the many new fashionable molecular approaches (transgenic insects, manipulation of the reproductive potential and vectorial mechanisms). Admittedly, a fundamental change in approach while retaining practical applications (standard science, techno-science) would require long-term planning.

#### 4.4. Rehabilitation strategies: (1) informing politicians

The first step for MVE rehabilitation would be to obtain official recognition at the highest policy-making levels: public health, national education, and economic development. Indeed, political authorities must be both instigators and supporters. Many different arguments could be put forward to convince them:

- (1) Since the discovery that blood-sucking arthropods are involved in the transmission of certain infectious diseases (malaria, filariasis, trypanosomosis, leishmaniasis, virus diseases), France has remained a forerunner in further discoveries and innovations. Quite early on, French entomologists understood that vectors play a primary role in the epidemiological process (key factor: vectorial pre-eminence). Then vectors became a main focus of interventions, with the development of 'vector control' and then 'integrated control' (*alias* IPM) concepts. It became clear that entomologists required in-depth knowledge of the arthropods involved—including their systematics, genetics, physiology, ethology, chorology, receptivity and population dynamics—to ensure the success of all control and prevention operations [12,18,19].
- (2) In recent years, several vector-borne diseases (ehrlichiosis, West Nile virus, bluetongue of sheep) have emerged and spread [9,10,13,15,16,17,21,22]. Climate change [18,19] (often associated with exploitation of habitats and transcontinental transportation) seems to be one of the main factors that have promoted this phenomenon, linked with the fact that arthropods are highly susceptible to pluviothermal variations. Medical entomologists are often called in to act as mediators between the epidemiologist, from the health service, and the climatologist. Indeed, the entomologist is a '*key player who can understand epidemiological processes of vector-borne diseases and participate in designing control strategies and conditions*' (J. Mouchet, 2000). '*The entomologist is at the crossroads between pathogenic, agroecological and socioeconomic systems*' (D. Cuisance, 2000) [7].
- (3) The control of vectorial diseases is a high priority for many intergovernmental and international bodies (WHO, FAO, OIE, IAEA).
- (4) The success of IPM against pest mosquitoes, which are considered to be an obstacle to the economic development of French coastal areas. In the 1960s, the French

government adopted a deliberately scientific strategy, with emphasis on ecological knowledge on involved species. Operational structures (EID) were created in this spirit (now termed ‘sustainable development’) by local authorities, and the validity of this approach was quickly confirmed. Pest mosquitoes were thus reduced (and maintained) to below the tolerance threshold, while preserving the floristic and faunistic quality (*alias* biodiversity) of environments that are potential breeding grounds for target mosquitoes. On the basis of this success, the strategy was adopted in several foreign countries (Germany, Canada, Spain, Greece, Italy, Morocco, Tunisia, etc.).

- (5) Finally, it is essential to forewarn members of parliament by widely circulating the conclusions of the UEF/SEF conference, which was held at the Palais du Luxembourg in February 2000 on the topic ‘*Training and transfer of knowledge in entomology.*’

#### 4.5. Rehabilitation strategies: (2) reactivating MVE training programmes

- (1) In response to the observed degradation, it is urgent to develop and consolidate MVE training programmes (Figs. 6,7,8).
- (2) Eighty-three percent of the survey respondents are currently involved in a medical and/or veterinary entomology training programme (graduate level, continuing education, technical training, public conferences), but many are at the end of their career and wish to pass on their knowledge. The respondents mentioned that 97% of the concerned student community would be interested in benefiting from this knowledge, and they propose to create a centre for this special training, e.g. Institut Pasteur.
- (3) There is currently only one full MVE course offered, i.e. by Institut Pasteur in Paris (9 weeks, including on-the-job training). Unfortunately it seems this course will be abandoned in 2005. Other unnamed courses are offered in various graduate programmes (DEA and DESS degrees in parasitology, virology, bacteriology and ecology) in universities of medicine, pharmacy and science, and also in the national veterinary schools.

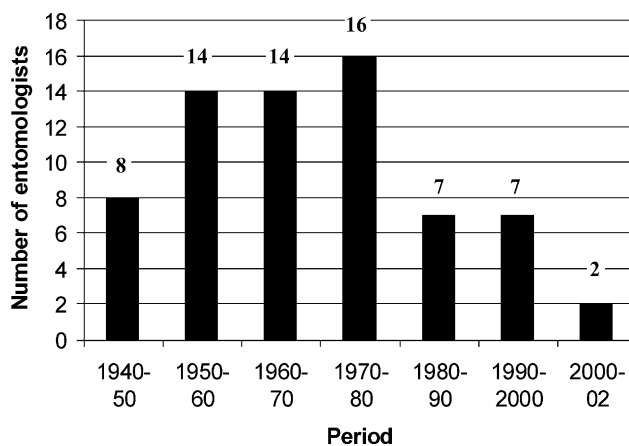


Fig. 6. MVE recruitment patterns at ORSTOM/IRD from 1940 to 2002. After a satisfactory recruitment period (1940–1980), there has been a sharp steady decline since 1980.

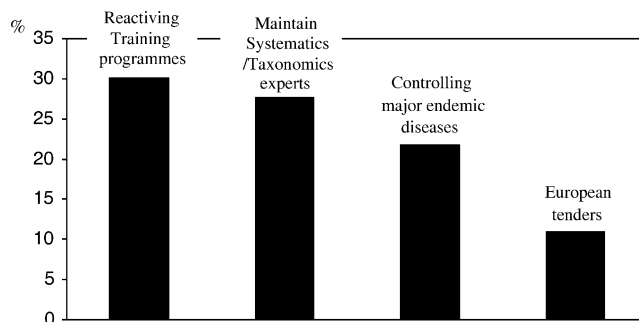


Fig. 7. MVE survey. Areas that would require strengthening and funding support according to 47 respondents (126 responses).

#### 4.6. Rehabilitation strategies: (3) development-oriented research

Conduct dynamic scientific research based on:

- (1) Controlling major tropical endemic diseases (in Africa, Latin America, Asia, etc.) via the presence of top level French scientists in the field, in collaboration with others partners.
- (2) Field detection of emerging diseases (in temperate and tropical countries) the epidemiological cycles of which are still relatively unclear, or even completely unknown.
- (3) Active surveillance (*alias* preventive surveillance) of long-standing communicable diseases that have disappeared or are rapidly declining (role in promoting climatic change and the exploitation of the environment, i.e. anthropization, status of mutagenesis phenomena and different vector and parasite selection processes) [18].

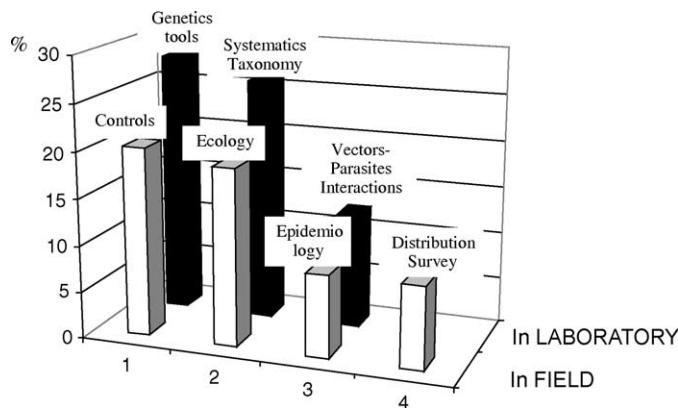


Fig. 8. MVE agents' expressed needs with respect to laboratory activities (black bars) and field activities (white bars). Genetics (i.e. molecular tools) and control strategies and methods (field), along with systematics and ecology, were the areas most frequently mentioned.

- (4) Interactive field-laboratory approaches: development of molecular tools adapted for field identification of sibling species complexes and pathogens in intra-vectorial conditions; realistic epidemiological models [8]; identification of risk areas (predictive epidemiology) [3,4,5,7,8]; full-scale experiments on new control methods, biopesticides, formulations, GIS, and automated cartography.
- (5) Searching for international partners (North–South networks) and external funding. In July 2003, the European Commission adopted a proposal for the creation of the European Centre for Disease Prevention and Control (ECDPC). This agency will be run as a European scientific expertise network involving national centres in each member state. In addition to communicable diseases, which are the main focus, the Centre will also have an information exchange and knowledge pooling role, while supporting European specialised training programmes.

## 5. Conclusion

France—through its history and situation in the world—has long been affected by human and animal diseases transmitted by blood-sucking arthropods (insects, ticks and mites). It has thus acquired substantial scientific and technical experience and is now the top ranking country with respect to expertise and control operations. Moreover, it has been continuously devoted to transferring knowledge to tropical research scientists of Southern countries. Amongst the many initiatives, this includes the creation of specialised training centres in Côte d'Ivoire (Centre d'entomologie médicale et vétérinaires de Bouaké, IRD, WHO), Burkina Faso (Centre Murraz de Bobo-Dioulasso); coordination of or participation in various educational courses, including the training course for animal trypanosomosis research scientists/IEMVT/FAO/GTZ, the international course on African trypanosomosis (WHO), the international master degree programme in medical and veterinary entomology in Thailand (University of Montpellier/IRD/Kasetsart University/University of Tours), and the postgraduate diploma and master of science in tsetse and trypanosomosis control (CIRAD-RTTCP) in Zimbabwe.

After long being overlooked, MVE is now coming to the forefront as a result of the upsurge, in both tropical and temperate areas, of emerging diseases (bluetongue, Lyme disease, viral encephalitis) and the marked return of so-called rare diseases (West Nile, dengue, Rift Valley fever) and almost extinct diseases (Maxcy's disease). MVE is crucial for dealing with several major endemic diseases (2 million deaths/year for malaria alone).

The future of medical and veterinary entomology (MVE) is not, however, ensured because, as this discipline is not recognised politically, funds are lacking, i.e. the source of human and material resources. In the future, will French MVE be able to respond effectively to new epidemics, which are expected to arise in the near future while dealing with traditional epidemic diseases that are still major public health problems? The most urgent need is to renew MVE teaching staff and develop research teams specialised in this field. This huge challenge must now be addressed by politicians, decision-makers and even basic teacher-scientists!

## 6. Slide show

For further information (in French) on the survey of Dominique Cuisance—*Entomologie médicale et vétérinaire en France. Regard sur une situation*. 2003 (French Ministère de l'agriculture, de l'alimentation, de la pêche et des affaires rurales). <http://www.agriculture.gouv.fr/spip/ressources.themes.santeanimaleetvegetale.santeetprotectionanimales.maladiesanimales>

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