

Medicinal plants used to treat malaria in Madagascar

P. Rasoanaivo^a, A. Petitjean^b, S. Ratsimamanga-Urverg^a and
A. Rakoto-Ratsimamanga^a

^aInstitut Malgache de Recherches Appliquées, B.P. 3833-101-Antananarivo (Madagascar) and ^bUniversité de la Réunion, Faculté des Sciences, 15 Avenue René Cassin, 97487-Saint-Denis (France)

(Received October 28, 1991; revision received February 4, 1992; accepted May 20, 1992)

Two-hundred thirty-nine Madagascan medicinal plants have been either retrieved from computerized ethnobotany information or identified in our own ethnomedicine work as having antimalarial properties. Such a high rate percent of plants compared to those used empirically to treat other diseases reflects the importance and the complication of this major tropical disease in Madagascar.

Key words: antimalarial plants; ethnomedicine; Madagascar

Introduction

According to ancient literature, malaria ('tazo' in the malagasy language) was known by the local population in Madagascar since the 1800s (Blanchard, 1901). Living in permanent symbiosis with nature, they constantly seek medicinal plants to combat their major tropical diseases. Most of the ethnobotanical knowledge acquired by the native population has been passed on to them by word of mouth from one generation to another. In some regions, some of the empirical data cut across ethnic boundaries and the potential of these plants as medicinal herbs is sometimes widely shared among many ethnic groups. Quite often, some remain tribal, clan or even family secrets and are used only by specific medicine-men. Nowadays in rural areas, the majority of the population initially consult the traditional healer before calling on primary health care and hospital facilities. In urban areas, in extreme cases where diseases have proved either resistant or incurable by modern scientific medicines, people have turned to traditional herbalists for a cure. It is a matter for regret that most of the traditional practitioners in Madagascar are illiterates and cannot preserve their rich heritage in writing by themselves. From time to time some of the ethnobotanical knowledge has been released. Western researchers first took the initiative to collect and gather such

ethnomedical information. Actually, the first written data dealing with the subject were published by researchers in Mauritius and La Reunion Islands (Bouton, 1857; Leclercq, 1864; Daruty, 1886). Then more specific information on Madagascan antimalarial plants was published (Parker, 1896; Lasnet, 1900; Ramisiray, 1901; Perret, 1903; Heckel, 1903, 1910; Ravalinera, 1909; Dandouau, 1910, 1913; François, 1925; Rabe, 1928; Rozier, 1942; Decary, 1946; Pernet, 1957, 1959). Later, other documents containing valuable information on the use of Madagascan medicinal plants including those on antimalarial herbal remedies were published (Bost, 1961; Rakoto-Ratsimamanga, 1969; Rason, 1970; Debray, 1970, 1971; Jacquemin, 1971; Schmitt, 1971; Dufournet, 1972; Ranaivoarivao, 1974; Rabesandratana, 1978; Descheemaeker, 1979; Randriamahefa, 1979; Boiteau, 1968, 1979; Solo-Andriamihaja, 1986; Beaujard, 1988; Quansah, 1988). In addition, we have ourselves collected, during the last decade, useful information on the uses of plants in the treatment of malaria (Rasoanaivo, 1989). In effect, malaria has re-emerged since 1981 as the most devastating tropical disease in Madagascar. Its intensity was so great that the Malagasy population believed in a new disease they called 'bemangovitra' (disease which gives intense shivering). Shortage or relatively high cost of chloroquine at that time (if the drug was available) as well as suspected resistance of *Plasmodium falciparum* to the synthetic drug led the population back to the uses of herbal remedies; accordingly, we have now better knowledge and more accurate ethnophar-

Correspondence to: P. Rasoanaivo, Institut Malgache de Recherches Appliquées, B.P. 3833-101-Antananarivo, Madagascar.

macognosical information on such plants. This paper is a first attempt both to update a list of plants used empirically to combat malaria in Madagascar and to summarize published data regarding the nature of bioactive constituents, if known, by bringing together scattered information and previously unpublished data.

Materials and Methods

All ethnobotanical information published in the literature mentioned above was classified, coded and transferred to computer disk (Razafindrakoto, 1989; Petitjean, 1990). Plants used for the treatment of malaria were then retrieved from the computer data. With respect to our own ethnobotanical program, the field work was conducted during the years 1981–1990 in Madagascar and encompassed the Eastern rainforests and the Southern semi-arid region. Ethnomedical information was obtained in two main ways: by (1) going into the forests with traditional practitioners and forest keepers, (2) interviewing people in the nearby villages. Materials were collected and preserved whenever possible. Their botanical identification was first confirmed by experienced forest keepers and further confirmed by comparison with voucher specimens deposited at the Department of Botany of 'Parc Botanique et Zoologique de Tsimbazaza' and 'Direction de Recherches Forestières et Piscicoles'. These departments have wide and regularly updated collections of reference specimens of Madagascan plants.

Results and Discussion

Two-hundred twenty-nine species (Table 1) of which about 30% are endemic to Madagascar have been reported as having antimalarial properties in Madagascan folklore medicine. They are distributed in 75 families and 176 genera. The methods of preparation and uses as well as plant part employed are presented in tabular form.

First, it is worthwhile to point out that although the Madagascan flora is characterized by a high rate of endemism (more than 85% of native species are endemic to Madagascar), about 30% only of the antimalarial plants are specific to the island. Secondly, if we draw a comparison between the number of plants used traditionally to treat malaria with the number of those used to empirically combat other diseases in Madagascar (available from computerized ethnomedical information), we can conclude clearly that antimalarial

plants possess by far the highest rate percent. It thus reflects the importance and complicated nature of the tropical disease in Madagascar. In effect, plants used empirically to treat the symptoms of malaria such as fever, febrile state, headache, splenomegaly have been classified as the so-called antimalaria plants. In other words, as malaria is still the most prevalent parasitic disease in Madagascar, most of the inhabitants having one of the symptoms mentioned above, which are in fact common to other diseases are said to be suffering from malaria. Because of the unreliability of diagnostic data, it is thus difficult to catalogue precisely plants that are successfully employed to combat the parasitic disease. Moreover, in highly infested areas, most of the inhabitants actually do not catch overt malaria but rather a latent form as a result of a certain immunity defense. Following secondary infection with diseases such as diarrhea and typhoid fever, the latent form of malaria becomes effective (medical doctor, team in IMRA, personal communication). Finally, co-occurrence of malaria with another unrelated disease is frequent and it is sometimes difficult to make a correct diagnosis of the real health problem. This has been one of the major causes of death from malaria in Madagascar. Such a situation can explain the wide variety of medicinal plants used to combat malaria in Madagascan traditional herbal remedies.

Research into plant-derived antimalaria drugs in Madagascar was pioneered by Boiteau (1937a) who first studied endemic species of the *Cinchoneae* tribe for better quinine substitutes (Boiteau, 1937b). He then investigated the genus *Burasaia* (Boiteau, 1942) extracts of which were reported to be effective clinically in the treatment of malaria (Davidson, 1945). We have resumed this research work since 1986 following the dramatic resurgence in malaria which caused high mortality in Madagascar. Lessons to be drawn from our ethnobotanical work are as follows: (1) probably by analogy with chloroquine, bitter ('mafaitra' in the malagasy language) plants have received particular attention as antimalarials in folk remedies namely *Cassinopsis madagascariensis* (bemafaitra), *Samadera* (= *Quassia*) *madagascariensis* (hazomafaitra), *Evodia fatraina* (fatray), *Urophyllum lyallii* (afatray), (2) in connection with the so-called new disease 'bemangovitra', a consequence of imaginary beliefs, some plants that were thought to be of particular efficiency received uncommon vernacular names, (3) the Malagasy population especially those living

TABLE 1

MEDICAL PLANTS USED TO TREAT MALARIA AND RELATED DISEASES IN MADAGASCAR

For non-identified species, common vernacular names are given. Abbreviations used: (1) plant part: leaves (LF), stem (ST), roots (RT), root bark (RB), stem bark (SB), flowers (FL), fruits (FR), seeds (SD), aerial part (AP); (2) preparation: decoction (dec), infusion (inf), inhalation (inh); unless otherwise stated, decoction and infusion are taken by oral absorption; (3) traditional uses: febrifuge (fbr), antisplenomegaly (spl), antimalarial (mlr), adjuvant to quinine or chloroquine (adj).

| Botanical name and family | Plant part | Preparation | Traditional uses |
|---|------------|-------------|------------------|
| I — FUNGI | | | |
| AGARICACEAE | | | |
| <i>Psalliotia</i> sp. (holotany) | AP | dec | mlr |
| II — PTERIDOPHYTA | | | |
| ADIANTACEAE | | | |
| <i>Adiantum incisum</i> Forsk | AP | dec | fbr |
| DAVALLIACEAE | | | |
| <i>Nephrolepis tuberosa</i> (Bory) Pr. | AP | dec | fbr |
| III — ANGIOSPERMAE | | | |
| <i>Class DICOTYLEDONAE</i> | | | |
| ACANTHACEAE | | | |
| <i>Isoglossa gracillima</i> Bak. | AP | dec | fbr |
| <i>Justicia gendarussa</i> Burm. | AP | dec | fbr |
| ANACARDIACEAE | | | |
| <i>Mangifera indica</i> L. | LF | dec | fbr |
| <i>Pseudoprotorhus longifolius</i> H. Perr. | LF | dec | mlr |
| <i>Rhus</i> (= <i>Baronia</i>) <i>taratana</i> (Bak.) H. Perr. | LF | dec | mlr |
| <i>Sclerocarya caffra</i> Sond. | LF | inh, dec | mlr |
| ANNONACEAE | | | |
| <i>Popowia heterantha</i> Diels | AP | dec | fbr |
| APOCYNACEAE | | | |
| <i>Carissa edulis</i> Vahl. var <i>revoluta</i> | RT | dec | fbr |
| <i>Plectaneia elastica</i> Jum. et Perr. | AP | dec | spl |
| ARISTOLOCHIACEAE | | | |
| <i>Aristolochia acuminata</i> Lamk. | RT, ST, LF | dec | mlr |
| ASCLEPIADACEAE | | | |
| <i>Leptadenia madagascariensis</i> Decne | AP | dec | fbr |
| <i>Pentopetia androsaemifolia</i> Decne | AP | dec | fbr |
| <i>Folotsia sarcostemmoides</i> Constantin et Bois | AP | dec | fbr |
| AVICENNIACEAE | | | |
| <i>Avicennia marina</i> (Forsk) Vierh. | AP | dec | mlr |
| <i>Avicennia basilicum</i> L. | AP | dec | mlr |
| BALSAMINACEAE | | | |
| <i>Impatiens emirnensis</i> Bak. | AP | dec | fbr |
| BIGNONIACEAE | | | |
| <i>Fernandoa</i> sp. (somontsohy) | AP | dec | mlr |
| <i>Kigelianthe madagascariensis</i> Sprague var. <i>hidebrandtii</i> | LF | inh, inf | mlr |
| <i>Ophiocolea floribunda</i> H. Perr. | LF | dec | fbr |
| <i>Phyllarthron bernierianum</i> Seem. | LF | dec | fbr |

TABLE 1 (continued)

| Botanical name and family | Plant part | Preparation | Traditional uses |
|---|------------|-------------|------------------|
| <i>Stereospermum euphoroides</i> DC. | AP | dec | fbr |
| <i>Stereospermum variable</i> H. Perr. | AP | dec | fbr |
| BOMACACEAE | | | |
| <i>Adansonia digitata</i> L. | LF | dec | fbr |
| <i>Adansonia madagascariensis</i> H. Bn. | LF | dec | fbr |
| <i>Adansonia za</i> H. Bn. | LF | dec | fbr |
| CAPPARIDACEAE | | | |
| <i>Boscia longifolia</i> H. Moustapha | AP | dec | fbr |
| CELASTRACEAE | | | |
| <i>Celastrus madagascariensis</i> Loes. | AP | dec | fbr |
| <i>Gymnosporia</i> (= <i>Maytenus</i>) <i>trigyna</i> (Lamb.) Bak. | LF | inh, dec | fbr |
| CHENOPODIACEAE | | | |
| <i>Chenopodium ambrosioides</i> L. | AP | inh, dec | fbr, spl |
| COMBRETACEAE | | | |
| <i>Combretum coccinenum</i> Lamk. | ST, LF | dec | fbr |
| <i>Combretum villosum</i> Boj. | ST, LF | dec | fbr |
| <i>Combretu raimbaulti</i> Heckel | LF | dec | fbr, mlr |
| <i>Poivrea obscura</i> H. Perr. | AT, RT | dec | fbr |
| COMPOSITAE (= ASTERACEAE) | | | |
| <i>Ageratum conyzoides</i> L. | AP | dec | fbr |
| <i>Anthemis nobilis</i> L. | AP | dec | fbr |
| <i>Brachylaena ramiflora</i> (DC.) H. Humb. | AP | dec | mlr |
| <i>Conyza aegytiaca</i> Ait. var. <i>lineariloba</i> | AP | dec | mlr, adj |
| <i>Dichrocephala lyrata</i> DC. | AP | dec | fbr |
| <i>Dicoma incana</i> Bak. | | | fbr |
| <i>Elephantopus scaber</i> L. | AP | dec | fbr |
| <i>Helichrysum faradifani</i> Sc. Elliot | AP | dec | fbr |
| <i>Inula perrieri</i> H. Humb. | LF | dec | mlr, spl |
| <i>Lactuca welwitschii</i> Sc. Elliot | AP | dec | fbr |
| <i>Launaea pauciflora</i> H. Humb. | AP | dec | fbr |
| <i>Laggera</i> (= <i>Blumea</i>) <i>alata</i> Sch. Bip. ex. Oliv. | AP | dec | fbr |
| <i>Oliganthes pseudocentauroopsis</i> H. Humb. | LF | ind, dec | fbr |
| <i>Parthenium hysterophorus</i> L. | AP | dec | mlr |
| <i>Psiadia coarctata</i> H. Humb. | AP | dec | fbr |
| <i>Pterocaulon decurrens</i> Moore | AP | dec | fbr |
| <i>Senecio antandroy</i> Sc. Elliot | LF, ST | inh, dec | fbr |
| <i>Senecio ompricaefolius</i> (ex DC.) H. Humb. | AP | dec | mlr |
| <i>Stenocline inuloides</i> DC. | LF | dec | mlr, fbr |
| <i>Tagetes erecta</i> L. | LF | dec | fbr, mlr |
| <i>Tagetes patula</i> L. | LF | dec | mlr |
| <i>Vernonia appendiculata</i> Less | LF | inh, dec | fbr |
| <i>Vernonia kentecephala</i> Bak. | LF | inh, dec | fbr |
| <i>Vernonia pectoralis</i> Bak. | AP | dec | mlr |
| <i>Vernonia trichodesma</i> Bak. | LF | dec | mlr |
| <i>Vernonia chapelieri</i> Drak. | AP | dec | mlr |
| <i>Vernonia</i> sp. (Dr. Hely) | AP | dec | mlr |
| <i>Vernonia ampandrandavensis</i> Bak. | AP | dec | mlr |
| <i>Vernonia aemulans</i> Vatke | AP | dec | fbr |
| <i>Vernonia betonicaefolia</i> Bak. | AP | dec | fbr |
| <i>Vernonia prolytricholepsis</i> Bak. | AP | dec | fbr |
| <i>Vernonia rhodolepsis</i> Bak. | AP | dec | fbr |
| <i>Vernonia speciforma</i> Klatt | AP | dec | fbr |

TABLE 1 (continued)

| Botanical name and family | Plant part | Preparation | Traditional uses |
|--|------------|-------------|------------------|
| CONNARACEAE | | | |
| <i>Cnestis polyphylla</i> Lamk. | LF | dec | fbr |
| CRASSULACEAE | | | |
| <i>Kalanchoe</i> (= <i>Bryophyllum</i>) <i>crenata</i> Ham. | AP | dec | fbr |
| <i>Kalanchoe laxiflora</i> Bak. | AP | dec | fbr |
| CUCURBITACEAE | | | |
| <i>Lagenaria siceraria</i> Standley | AP | dec | fbr |
| <i>Momordica charantia</i> L. | AP | dec | mlr |
| CUNONIACEAE | | | |
| <i>Weinmannia lantziana</i> Baill. | LF, ST | inf | fbr |
| EBENACEAE | | | |
| <i>Diospyros humbertiana</i> H. Perr. | RT, ST | dec | fbr |
| ERYTHROXYLACEAE | | | |
| <i>Erythroxylon</i> sp. (fisatelo) | AP | dec | fbr |
| EUPHORBIACEAE | | | |
| <i>Acalypha radula</i> Bak. | AP | inh, dec | fbr |
| <i>Croton</i> sp. (tambio) | ST, LF | inh, dec | fbr |
| <i>Croton goudoti</i> H. Bn. | LF | inh, dec | mlr |
| <i>Flueggea</i> (= <i>Securinega</i>) <i>microcarpa</i> Blume | AP | dec | mlr |
| <i>Jatropha curcas</i> L. | LF, RT | dec | mlr |
| <i>Manihot utilisima</i> Pohl. | LF | dec | mlr |
| <i>Phyllanthus decipiens</i> var. <i>antsihanakensis</i> | LF | dec | fbr |
| <i>Phyllanthus mocquerysianus</i> DC. | RT | dec | spl, adj |
| <i>Phyllanthus</i> sp. (lalangiala) | AP | dec | mlr |
| FLACOURTIACEAE | | | |
| <i>Aphloia theaeformis</i> Benn. | LF | dec | fbr |
| <i>Homalium</i> sp. (hazoambo) | LF | dec | mlr |
| <i>Physena madagascariensis</i> Norrh ex. Thouars | AP | dec | fbr |
| GENTIANACEAE | | | |
| <i>Exacum tsimihety</i> H. Humb | AP | dec | spl |
| GUTTIFERAE (= CLUSIACEAE) | | | |
| <i>Harungana madagascariensis</i> Lam. ex. Poir. | LF | dec | fbr, spl |
| <i>Hypericum lalandii</i> Choisy | AP | inh | fbr |
| <i>Psorospermum androsaemifolium</i> Bak. | LF | inh, dec | fbr |
| HERNANDIACEAE | | | |
| <i>Hernandia voyroni</i> Jum. | SB | dec | adj, spl |
| ICACINACEAE | | | |
| <i>Cassinopsis madagascariensis</i> (Baill.) H. Bn. | LF, SB | dec | mlr |
| LABIATAE (= LAMIACEAE) | | | |
| <i>Burnatastrum</i> (= <i>Plectranthus</i>) <i>lanceolatum</i> J. Briq. | AP | dec | fbr |
| <i>Hyptis pectinata</i> Poit. | LF | dec | mlr |
| <i>Leonotis nepetaefolia</i> R. Br. | AP | dec | fbr |
| <i>Ocimum canum</i> Sims. | ST, SD | dec | mlr |
| <i>Ocimum suave</i> Willdenow | ST, LF | dec | fbr |
| LAURACEAE | | | |
| <i>Cassytha filiformis</i> L. | AP | dec | fbr |
| <i>Cinnamomum camphora</i> (L.) Sieb. | LF | inh, inf | mlr |
| <i>Cinnamomum zeylanicum</i> Breyn. | LF | inh, inf | fbr |
| <i>Ravensara aromatica</i> Gmel. | LF | inh, inf | fbr |

TABLE 1 (continued)

| Botanical name and family | Plant part | Preparation | Traditional uses |
|---|------------|-------------|------------------|
| LEGUMINOSAE (= FABACEAE) | | | |
| <i>Abrus precatorius</i> L. | LF | dec | mlr |
| <i>Acacia</i> sp. (roimena) | LF | dec | fbr |
| <i>Albizia fastigiata</i> Oliv. | SB | dec | fbr |
| <i>Albizia lebbek</i> Benth. | AP | dec | mlr |
| <i>Baphia capparidifolia</i> Bak. | LF | inh | fbr |
| <i>Caesalpinia bonducella</i> Fleming | SD, RT | dec | mlr |
| <i>Cassia laevigata</i> Willd. | LF | dec | spl |
| <i>Cassia occidentalis</i> L. | AP | dec | mlr |
| <i>Crotalaria spinosa</i> Hochst. | LF | dec | mlr |
| <i>Desmodium hirtum</i> Grill et Perr. | AP | dec | spl |
| <i>Erythrina indica</i> Lamk. | AP | dec | mlr |
| <i>Mundulea pauciflora</i> Bak. | LF | inh | fbr |
| <i>Mundulea suberosa</i> Benth. | LF | inh | fbr |
| <i>Neobaronia phyllanthoides</i> Bak. | AP | dec | fbr |
| <i>Phylloxylon ensifolium</i> Baill. | AP | dec | fbr |
| <i>Sesbania punctata</i> DC. | AP | inh, dec | fbr |
| <i>Smithia chamaecrista</i> Benth. | AP | inh, dec | fbr |
| <i>Teramnus labialis</i> Clinn. | AP | inh | fbr |
| LOGANIACEAE | | | |
| <i>Anthocleista amplexicaulus</i> Bak. | AP | dec | mlr |
| <i>Anthocleista rhizophoroides</i> Bak | RT, LF | dec | mlr |
| <i>Nuxia coriacea</i> Sulereeder | AP, RT | dec | fbr |
| <i>Nuxia sphaerocephala</i> Bak. | AP, RT | dec | fbr |
| <i>Nuxia subcoriacea</i> Jovet | AP, RT | dec | fbr |
| <i>Nuxia terminalioides</i> Bak. | AP, RT | dec | fbr |
| <i>Strychnos mostuoides</i> Leeuwenberg | AP | dec | mlr |
| MALVACEAE | | | |
| <i>Pavonia urens</i> Lass. | AP | inh, dec | fbr |
| <i>Sida rhombifolia</i> L. | LF | dec | spl, fbr |
| MELIACEAE | | | |
| <i>Cedrelopsis grevei</i> H. Bn. | SB | dec | fbr |
| <i>Khaya madagascariensis</i> Jum. et Perr. | AP | dec | fbr |
| <i>Malleastrum mandanense</i> Leroy | AP | dec | fbr |
| <i>Melia azedarach</i> L. | RB | dec | fbr |
| MENDONCIACEAE | | | |
| <i>Mendoncia lagellaris</i> F. Benoît | AP | dec | sph |
| MENISPERMACEAE | | | |
| <i>Burasaia australis</i> Sc. Elliot | RB | dec | mlr, adj |
| <i>Burasaia congesta</i> Decne | RB | dec | mlr, adj |
| <i>Burasaia gracilis</i> Decne | RB | dec | mlr, adj |
| <i>Burasaia madagascariensis</i> Thou. | RB | dec | mlr, adj |
| <i>Burasaia nigrescens</i> R. Cap. | RB | dec | mlr, adj |
| <i>Chasmanthera uviformis</i> Baill. | SB | dec | mlr |
| <i>Cissampelos pareira</i> L. | RT | dec | mlr |
| <i>Cissampelos madagascariensis</i> (Baill.) Diels. | RT | dec | mlr |
| <i>Spirospermum penduliflorum</i> Thou. | RT, SB | dec | mlr, adj |
| <i>Strychnopsis thoursii</i> Baill. | LF, RB | dec | mlr, adj |
| <i>Trichlisia macrocarpa</i> (Baill.) Diels | RB, SB | dec | mlr |
| MONIMIACEAE | | | |
| <i>Tambourissa religiosa</i> DC. | LF | dec | fbr |
| MORACEAE | | | |
| <i>Ficus megapoda</i> Bak. | RT, LT | dec | fbr |

TABLE 1 (continued)

| Botanical name and family | Plant part | Preparation | Traditional uses |
|--|------------|-------------|------------------|
| <i>Ficus pyrifolia</i> Lamk. | LF | dec | fbr |
| <i>Ficus melleri</i> Bak. | AP | dec | fbr |
| MORINGACEAE | | | |
| <i>Moringa pterygosperma</i> Gaertn. | RB | dec | fbr, spl |
| MYRTACEAE | | | |
| <i>Eucalyptus amygdalina</i> Lab. | LF | inh | fbr |
| <i>Eucalyptus saligna</i> Smith. | LF | inh | fbr |
| <i>Eugenia</i> sp. (voamaratoatra) | AP | dec | fbr |
| NYCTAGINACEAE | | | |
| <i>Boerhaavia diffusa</i> L. | AP, RT | dec | fbr |
| OCHNACEAE | | | |
| <i>Campylospermum deltoideum</i> Bak. var. <i>tieghem</i> | ST, LF | dec | fbr |
| OENOTHERACEAE (= ONAGRACEAE) | | | |
| <i>Jussiaea</i> (= <i>Ludwigia</i>) <i>suffruticosa</i> L. | AP | inh, dec | fbr |
| OLEACEAE | | | |
| <i>Noronhia myrtoides</i> H. Perr. | AP, RT | dec | fbr |
| OXALIDACEAE | | | |
| <i>Biophytum sensitivum</i> (L.) DC. | LF, AP | dec | fbr, spl |
| PIPERACEAE | | | |
| <i>Piper borbonense</i> (C.) DC. | ST, LF | dec | fbr |
| <i>Piper pachyphyllum</i> Bak. | FR | dec | fbr |
| <i>Piper pyrifolium</i> Vahl. | FR, AP | dec | fbr |
| <i>Piper emirnense</i> Bak. | AP | dec | fbr |
| PITTIOSPORACEAE | | | |
| <i>Pittosporum ochrosiaefolium</i> Boj. | AP | dec | fbr |
| RANUNCULACEAE | | | |
| <i>Clematis mauritiana</i> Lamk. var. <i>normalis</i> | AP | dec | mlr |
| RHIZOPHORACEAE | | | |
| <i>Weihea sessiliflora</i> Bak. | AP | dec | fbr |
| <i>Weihea</i> sp. (hazomamy) | AP | dec | fbr |
| RUBIACEAE | | | |
| <i>Anthospermum emirnense</i> Bak. | AP | dec | mlr |
| <i>Cinchona ledgeriana</i> Muens | SB | dec | mlr |
| <i>Cinchona officinalis</i> L. | SB | dec | mlr |
| <i>Cinchona succirubra</i> Pavon et Kiutzsch | SB | dec | mlr |
| <i>Cephalanthus spathelliferus</i> Bak. | LF | dec | mlr |
| <i>Danais fragrans</i> Gaertn. | RT | dec | mlr |
| <i>Danais gerrardii</i> Bak. | RT | dec | mlr |
| <i>Danais verticillata</i> Bak. | RT | dec | mlr |
| <i>Danais breviflora</i> Bak. | RT | dec | mlr |
| <i>Danais cernua</i> Bak. | RT | dec | mlr |
| <i>Gaertnera abovata</i> Bak. | AP | dec | fbr |
| <i>Gaertnera phanerophlebia</i> Bak. | AP | dec | fbr |
| <i>Hymenodyction lohavato</i> Baill. | RB, SB | dec | mlr |
| <i>Pauridiantha</i> (= <i>Urophyllum</i>) <i>lyallii</i> (Bak.) Bremek. | RB, LF | dec | adj, spl |
| <i>Payera excelsa</i> H. Bn. | LF | dec | fbr |
| <i>Psychotria bulata</i> | AP | dec | fbr |

TABLE 1 (continued)

| Botanical name and family | Plant part | Preparation | Traditional uses |
|---|------------|-------------|------------------|
| <i>Psychotria obtusifolia</i> Meyer | AP | dec | fbr |
| <i>Randia talangnigna</i> DC. | AP | dec | fbr |
| <i>Saldinia</i> sp. (andriambavifoy) | AP | dec | mlr |
| <i>Schismatoclada concinna</i> Bak. | RB | dec | mlr |
| <i>Schismatoclada farahimpensis</i> Bak. | RB | dec | mlr |
| <i>Schismatoclada viburnoides</i> Bak. | RB | dec | mlr |
| <i>Tarenna</i> sp. (mahafetra) | AP | dec | fbr |
| <i>Tricalysia</i> sp. (tavazo) | AP | dec | fbr |
| RUTACEAE | | | |
| <i>Citrus medica</i> L. | LF | inh | fbr |
| <i>Evodia fatraina</i> H. Perr | RB, SB | dec | mlr |
| <i>Toddalia asiatica</i> Lamk. | AP | dec | mlr |
| <i>Zanthoxylum tsihanimpotsa</i> H. Perr. | SB | dec | mlr |
| SAPINDACEAE | | | |
| <i>Dodonaea viscosa</i> Jacq. | LF | dec | mlr |
| <i>Dodonaea madagascariensis</i> Rdlk. | LF | dec | mlr |
| <i>Plagioscyphus</i> sp. (hazokitsikitsika) | AP | dec | fbr |
| SAPOTACEAE | | | |
| <i>Imbricaria</i> (= <i>Mimusops</i>) <i>Bojeri</i> | AP | dec | fbr |
| SCHIZAEACEAE | | | |
| <i>Lygodium lanceolatum</i> Desv. | AP | dec | fbr |
| <i>Mohria caffrorum</i> (L.) Desv. | AP | dec | mlr |
| SCROPHULARIACEAE | | | |
| <i>Halleria</i> sp. (somotsoy) | AP | dec | fbr |
| <i>Scoparia dulcis</i> L. | AP | dec | fbr |
| SIMAROUBACEAE | | | |
| <i>Samadera</i> (= <i>Quassia</i>) <i>madagascariensis</i> Gaertn. | RB | dec | fbr |
| <i>Samadera indica</i> Gaertn. | RB | dec | fbr |
| SOLANACEAE | | | |
| <i>Solanum indicum</i> L. | AP | dec | fbr |
| <i>Solanum macrocarpum</i> L. | RT, FR | inh, dec | fbr |
| <i>Solanum heteracanthum</i> Bak. | AP | dec | fbr |
| STRELITZIACEAE | | | |
| <i>Ravenala madagascariensis</i> Adams | AP | inf, dec | fbr |
| THYMELAEACEAE | | | |
| <i>Gnidia danguyana</i> J. Leand. | AP | inf, dec | fbr |
| <i>Lasiosiphon</i> (= <i>Gnidia</i>) <i>perrieri</i> J. Leand | AP | inf, dec | fbr |
| TILIACEAE | | | |
| <i>Grewia triflora</i> Walp. | AP | dec | fbr |
| ULMACEAE | | | |
| <i>Celtis madagascariensis</i> Boj. | RB, SB | dec | fbr |
| <i>Trema orientalis</i> Blume | AP | dec | mlr |
| <i>Trema commersonii</i> Boj. | AP | dec | mlr |
| UMBELLIFERAE (=APIACEAE) | | | |
| <i>Pimpinella ebracteata</i> Bak. | AP | dec | fbr |

TABLE 1 (continued)

| Botanical name and family | Plant part | Preparation | Traditional uses |
|---|------------|-------------|------------------|
| VERBENACEAE | | | |
| <i>Clerodendrum heterophyllum</i> R. Br. | AP | dec | fbr |
| <i>Lantana camara</i> L. | LF, RT | inf | fbr |
| <i>Premna serratifolia</i> L. | RT, LF | dec | fbr |
| VIOLACEAE | | | |
| <i>Rinorea greveana</i> H. Bn. | LF | dec | fbr |
| <i>Class MONOCOTYLEDONAE</i> | | | |
| AGAVACEAE | | | |
| <i>Dracaena angustifolia</i> Roxb. | AP | dec | fbr |
| <i>Dracaena elliptica</i> Thumb et Dallin. | AP | dec | fbr |
| <i>Dracaena reflexa</i> Lamk. | AP | dec | fbr |
| COMMELINACEAE | | | |
| <i>Commelina benghalensis</i> L. | AP | dec | mlr |
| CYPERACEAE | | | |
| <i>Kyllingia</i> (=Cyperus) <i>polyphylla</i> var. <i>elatior</i> Kükenth | AP | dec | fbr |
| <i>Kyllingia cylindrica</i> Nees | AP | dec | fbr |
| <i>Remirea maritima</i> Aublet | AP | dec | fbr |
| <i>Scleria greigifolia</i> Riedley | LF | dec | fbr |
| DIOSCOREACEAE | | | |
| <i>Dioscorea</i> (orovy) | ST, LF | inf | fbr |
| GRAMINEAE (=POACEAE) | | | |
| <i>Cynodon dactylon</i> (L.) Pers. | AP | dec | spl |
| <i>Imperata cylindrica</i> (L.) P. Beauv. | AP | dec | fbr |
| <i>Phragmites mauritianus</i> Kunth | AP | dec | mlr |
| LILIACEAE | | | |
| <i>Asparagus simulans</i> Bak. | AP | dec | fbr |
| <i>Asparagus vaginellatus</i> Boj. | AP | dec | fbr |
| ORCHIDACEAE | | | |
| <i>Jumellea fragrans</i> Schlechter | AP | dec | fbr |
| <i>Jumellea francoisii</i> Schlechter | AP | dec | fbr |
| POTAMOGETONACEAE | | | |
| <i>Potamogeton javanicus</i> Hass Karl | AP | dec, inf | mlr |
| ZINGIBERACEAE | | | |
| <i>Curcuma longa</i> L. | LF | inh, dec | fbr, mlr |

in the countryside has been in the habit of treating malaria by self-medication by taking a unique dose of chloroquine (one or two tablets) which is insufficient, to supposedly favour general chloroquine resistance; at the same time, they usually drink a decoction of known medicinal plants as an adjunct to chloroquine. On the basis of these ethnopharmacological data, we have selected 24 plants and submitted extracts to in vitro and in

vivo antimalarial tests as well as chloroquine potentiating effect evaluation and cytotoxicity assessment (Ratsimamanga-Urverg, 1990, 1991). It can be inferred from these studies that (1) endemic plants of the *Cinchoneae* tribe (Rubiaceae) are devoid of any antimalarial activity, (2) some terpenoids showed in vitro activity as a consequence of their cytotoxicity but lacked in vivo effect in the animal model, (3) alkaloids of

Menispermaceae and Rutaceae demonstrated significant effects; some of them potentialized the action of chloroquine (Rasoanaivo, 1991).

Conclusions

It is hoped that this compilation will promote comprehensive studies on Madagascar plants with reputed antimalarial activity which have not been thoroughly investigated and from which the active principles remain to be identified. As chloroquine is still the most effective and widely used drug in malaria therapy because of its rapid onset of action, good tolerability and low cost, we are focusing our study on the search of drugs that may complement chloroquine efficiency on malaria.

References

- Beaujard, P. (1988) Les plantes médicinales du Sud-Est de Madagascar. *Journal of Ethnopharmacology* 23, 165.
- Blanchard, R. (1901) Le paludisme à Madagascar. *Revue de Madagascar*, 3 (4), 233–243.
- Boiteau, P. (1979) *Précis de Matière Médicale Malgache*. Librairie de Madagascar, Antananarivo.
- Boiteau, P. (1979) *Dictionnaire des Noms Malgaches des Végétaux*, augmenté de son supplément (inédit).
- Boiteau, P., Sèpacer, K., Rarimampianina and Rakoto Ratsimamanga, A. (1968) Notes d'ethnobotaniques malgaches. *Journal of Agricultural and Tropical Botany Applications* 15 (1–3), 1–15; *Journal of Agricultural and Tropical Botany Applications* 15 (9–11), 337–349.
- Boiteau, P. (1937) Introduction à l'étude des plantes fébrifuges de la Flore Malgache. (a) *Bulletin Economique de Madagascar*, 155–175; (b) *Bulletin de la Société de Pathologie Exotique*, 30, No 8, 739–741.
- Boiteau, P. (1942) Isolement de la burasaine de *Burasia Madagascarensis*. *Bulletin de l'Académie Malgache*, XXV, 31.
- Bost, R. (1961) Pharmacopée Malgache. *Mémoires de l'Institut Scientifique de Madagascar Série B*, X, fas. 2.
- Bouton, L. (1857) *Medicinal Plants Growing or Cultivated in the Island of Mauritius*, R. de Spéville & Co., Maurice.
- Débray, M., Jacquemin, H. and Razafindrambao, R. (1971) Contribution à l'inventaire des plantes médicinales de Madagascar. *Travaux et Documents de l'ORSTOM de Tananarive* 8.
- Débray, M. (1970) Contribution à l'inventaire des plantes Médicinales du Massif de Tsaratanàna. *Mémoires de l'ORSTOM de Tananarive* 37.
- Dandouau, A. (1910) Catalogue alphabétique des Noms Malgaches. *Economique de Madagascar* X, No. 2 et XI, No. 1.
- Dandouau, B. (1913) Ody et Fanafody. *Bulletin de l'Académie Malgache* XI, 153–226.
- Daruty, C. (1886) *Plantes Médicinales de l'Île Maurice et des Pays Intertropicaux*, R. de Spéville et Co, Maurice, pp. 3–61.
- Davidson, S. (1945). Extracts of *Burasia* in the treatment of malaria. *East Africa Medical Journal* 22, 80.
- Decary, R. (1946) Plantes et animaux utiles de Madagascar. *Annales du Musée Colonial de Marseille* 54. 6^{ème} série vol. 4.
- Descheemacker (1979) *Ravimaitso*, Imprimerie St Paul, Fianarantsoa.
- Dufournet, R. (1972) *Plantes Médicinales de Madagascar*, Institut de Recherche Agricole de Madagascar, Tananarive.
- François, E. (1925) Note concernant les plantes médicinales ou officinales introduites à Madagascar. *Bulletin Economique de Madagascar* XXII, 123.
- Heckel, E. (1903) Les plantes utiles de Madagascar, Paris, Challamel; (1910). *Annales du Musée Colonial de Marseille* 8 (2).
- Jacquemin, H. (1971) *Contribution à l'inventaire des plantes médicinales de Madagascar: Plantes de l'Île Ste Marie*. ORSTOM de Tananarive, document E. 331.
- Lasnet (1900) Notes sur la Pharmacopée des Sakalava du Nord-Ouest de Madagascar. *Annales d'Hygiène et de Médecine Coloniales* 17–44. *Revue de Culture Coloniale* 171–175. (20 Mars), 209–13 (5 Avril), 233–238 (20 Avril).
- Leclercq, J. (1864) *Des plantes médicinales de l'Îles de la Réunion et de leur application à la thérapeutique*. La Malle, Saint-Denis, 73 pp.
- Parker, G.W. (1896) A malagasy Materia Medica. *Pharmaceutical Journal & Transactions* 6 Avril.
- Pernet, R. (1957) Les plantes médicinales de Madagascar. *Mémoires de l'Institut Scientifique de Madagascar Série B*, VIII. 1–143; (1959) *Mémoires de l'Institut Scientifique de Madagascar Série B*, IX, 217–303.
- Pernet, R. and Meyer, G. (1957) *Pharmacopée de Madagascar*. Publications de l'Institut de Recherche Scientifique, Tananarive.
- Perret (1903) Croyances médicinales des Malgaches. *Sciences, Arts & Nature, Paris*, 28 Août.
- PetitJean, A., Rakotovoava, L.H. and Andrianarivo, C. (1990) Introduction au Fichier Flore de Madagascar. *The Journal of Nature*, 2 (1), 49–58.
- Quansah, N. (1988) Ethnomedicine in Maronantsetra region of Madagascar. *Economic Botany* 42 (3), 370–375.
- Rabe, H. (1928) Manuscript de 45 pages sans titre ni date sur la Matière Médicale Malgache. *Archives de l'Institut de Recherche Scientifique de Madagascar*.
- Rabesandratana, R.N. (1978) Résultats d'enquêtes et de localisations de plantes médicinales de la région de Toliara. *Annales de l'Université de Madagascar* 13, 131–150.
- Rakoto-Ratsimamanga, A., Boiteau, P. and Mouton, M. (1969) *Eléments de Pharmacopée Malagasy*, Tome I, Imprimerie Nationale, Antananarivo.
- Ramisiray, G. (1901) La Médecine des Malgaches. *Revue de Madagascar* 3 (8), 549–555.
- Ranaivoarivao (1974) Vers la démocratisation des Plantes Médicinales de Madagascar. *Bulletin de Madagascar* 330, 580–591.
- Randriamahefa, M. and Rakotozafy, A. (1979) *Tari-dàlana ahafantarana ny Raokandro Malagasy*. Antananarivo.
- Rasoanaivo, P., Ratsimamanga-Urverg, S. and Rakoto-Ratsimamanga, A. (1989) Résultats d'Enquêtes Ethnobotaniques dans la Région d'Andasibe et de Beza-Mahafafy. *Mémoires de l'Institut Malgache de Recherches Appliquées* 1.
- Rasoanaivo, P., Ratsimamanga-Urverg, S. and Rakoto-Ratsimamanga, A. (1991) 4 ans de recherche en chimiothérapie antipaludique à Madagascar: bilan et perspectives. In: *Médecine Traditionnelle et Pharmacopée*. Agence de Coopération Culturelle et technique (ACCT), in press.
- Rason, G. (1970) *Zava-maniry, Balisaman'i Gasikara*, Tomes 1 à 9. Imprimerie takariva, Antananarivo.

- Ratsimamanga-Urverg, S., Rasoanaivo, P., Le Bras, J., Ramiaramanana, L. and Rakoto-Ratsimamanga, A. (1990) Les *Burassia* traditionnellement utilisés à Madagascar dans le traitement du paludisme ont-ils réellement une activité antimalariale et qu'en est-il de *Strychnopsis thourarsii*. Communication presented at the Malagasy Academy, 21 July 1990.
- Ratsimamanga-Urverg, S., Rasoanaivo, P., Le Bras, J., ramiaramanana, L., Rakoto-Ratsimamanga, A. and Coulaud, J.P. (1991) In vitro antimalarial activity and cytotoxicity of *Strychnos mostuoides*, *Avicennia marina* and *Urophyllum lyallii*. *Discovery and Innovation*. 3(2) 81-83.
- Ratsimamanga-Urverg, S., Rasoanaivo, P., Rakoto-Ratsimamanga, A., Le Bras, J., Ramiliarisoa, O. and Savel, J. (1991) Antimalarial activity and cytotoxicity of *Ficus pyrifolia* and *Rhus (Baronia) taratana* leaf extracts. *Phytotherapy Research* 5 (1), 32-34.
- Ratsimamanga-Urverg, S., Rasoanaivo, P., Rakoto-Ratsimamanga, A., Le Bras, J., Ramiliarisoa, O., Savel, J. and Coulaud, J.P. (1991) Antimalarial activity and cytotoxicity of *Evodia fatraina* stem bark extract. *Journal of Ethnopharmacology* 33 (1991) 231-236.
- Ravalinera (1909) Lettre sur les plantes médicinales employées en Imerina. Manuscrit inédit suivi des observations de Boiteau sur ce manuscrit. *Archives de l'Institut de Recherche Scientifique de Madagascar*.
- Razafindrakoto, E.J. and Rasoanaivo, P. (1989) Conception et élaboration d'un logiciel pour la systématisation des données ethnobotaniques malgaches. *Mémoires de l'E.E.S. Polytechnique. Université d'Antananarivo*.
- Rozier, Ph. (1942) Notice sur les plantes médicinales du Menabe, Manuscrit inédit adressé à Décary. *Archives de l'Institut de Recherche Scientifique de Madagascar*.
- Schmitt, J.P. (1971) Contribution à l'inventaire des plantes médicinales. *Mémoires de l'ORSTOM de Tananarive*.
- Solo-Andriamihaja (1986) *Essai d'inventaire des plantes médicinio-dentaires malgaches*, Tome I et II, Antananarivo.