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Ethnopharmacology in the work of the British botanist Arthur Francis George Kerr (1877 – 1942)

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Received August 29, 2016, accepted September 23, 2016

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Pharmazie 72: 58–64 (2017)

doi: 10.1691/ph.2017.6817

Reports on traditional use of medicinal plants may be used as starting points for phytochemical and pharmacological research. As has recently been shown, publications, letters, diaries and reports of exploring botanists are a valuable source of historical ethnopharmacological information. In this study, the heritage of the British botanist Arthur Francis George Kerr (1877–1942), mainly working in Thailand, was screened for information about traditionally used medicinal plants. Information given was compared to state-of-the-art scientific knowledge about these species. Many historical uses could be confirmed, some did not, while a number of species reported to be traditionally used have not been sufficiently investigated so far. These, strongly suggested for further research, include *Kurrimia robusta*, *Alpinia siamensis*, *Amomum krervanh* (*A. testaceum*), *Trichosanthes integrifolia* (= *Gymnopetalum scabrum*), *Croton cumingii* (= *C. cascarilloides*), *Lobelia radicans* (= *L. chinensis*), *Willughbeia* sp., *Nyctanthes arbor-tristis*, *Pluchea indica*, *Heliotropum indicum*, as well as some fungi and woods.

1. Introduction

A considerable part of newly developed pharmacologically active agents is of natural origin, derived from nature or has at least some relationship to naturally occurring compounds (Newman and Cragg 2016). Thus, screening of medicinal plants is still a promising strategy to identify new lead structures. Historical knowledge about medicinal plants and their traditional uses may be used as a guide for choosing species to be primarily investigated. It has been shown earlier that, besides many other sources, publications, letters and diaries of botanical and anthropological explorers of the 19th and early 20th century are highly useful sources to detect traditionally used medicinal plants not seriously investigated up to the present day. So from the heritage of the botanist Berthold Seemann (1825–1871) and the anthropologist Melville William Hilton-Simpson (1881–1938) a number of species could be identified, which obviously had a considerable ethnopharmacological tradition but have never been scientifically investigated. It has therefore been suggested to submit them to phytochemical and phytopharmacological screening (Helmstädter 2015, 2016a, b). In the study presented here, some publications, handwritings and letters of Arthur Francis George Kerr (1877–1942), a British botanist mainly working in Thailand, was screened for useful ethnopharmacological information. The material investigated is preserved in the archives of Kew Gardens, Richmond, UK.

2. Investigations and results

2.1. Arthur Francis George Kerr (1877–1942)

According to the extended bio-/bibliography published by Jacobs (1962), Kerr (Fig. 1) was born February 7, 1877 in Kinlough, Ireland. He studied medicine at Trinity College, Dublin, and received his degree in 1901. One year later, at the age of 25, he moved to Siam, now Thailand, to work as a doctor. Initially working in Chiangmai (North Siam) he developed his interest in botany, particularly orchids. These days he turned out to become an extremely skilful painter drawing plant species and maps of the largely unexplored country of Siam. On a trip home in 1908 he brought 215 orchid sketches to Kew. Kew representatives were

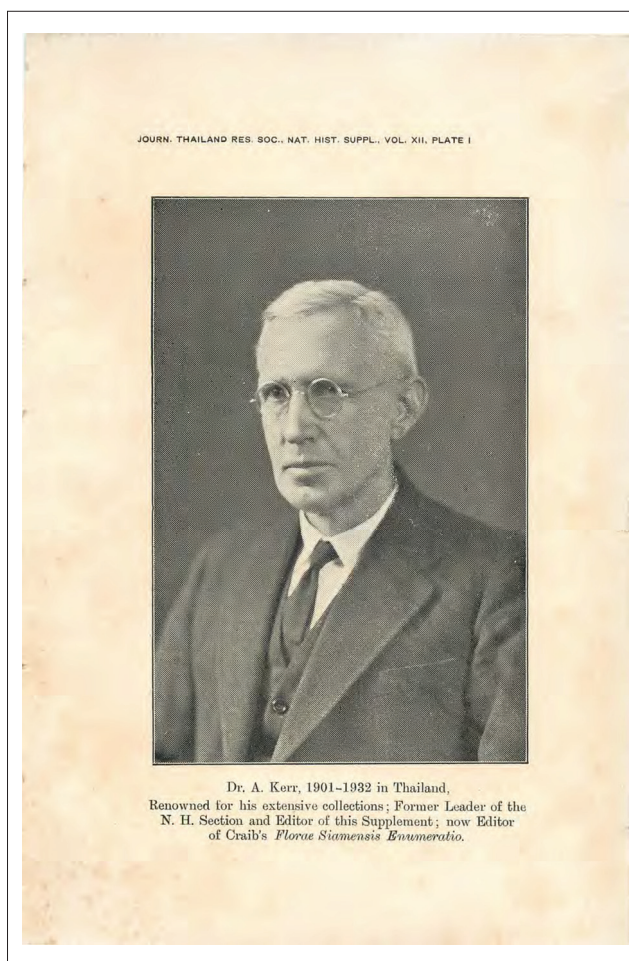


Fig. 1: Arthur Francis George Kerr (1877 – 1942) (Kerr 1939)



Fig. 2: *Butea superba* (Roxburgh 1796, Biodiversity Heritage Library)

excited about the work and convinced Kerr to start collecting plants for a herbarium. Already on his way back to Chiangmai, he started with the collection. Herbarium material was sent to Britain and identified by William Grant Craib (1882–1933), a Kew herbarium employee and later Professor of Botany at the University of Aberdeen. Craib edited the publication series “Contributions to the Flora of Siam” and “Florae Siamensis Enumeratio” relying on Kerr’s discoveries. The Kew staff was always excited about the high quality of the material and its descriptions. Nevertheless, Kerr continued with medical practice in Siam and also showed interest in medical research, e.g. on intestinal parasites. In 1911, he met a woman called Emily Collins (1858–after 1945) and interested her for botany as well. In August 1915, Kerr, who was said to be “intensely patriotic” (Jacobs 1962, p. 433), returned to Europe to serve the Royal Army Medical Corps. After the War he travelled back to the Far East but was unable to regain his former position in Chiangmai where a local physician had been placed in charge after Kerr’s departure for military service. However, he managed to do some private medical practice in Bangkok and did some collecting now and then. Eventually, in September 1920, he was appointed director of the Botanical Section of the Ministry of Commerce, again in Chiangmai. He then gave up medicine, “at 43, himself faced with the task of carrying out a primary botanical-economic survey of a country twice as large as the United Kingdom and four times as large as Java, largely terra incognita from botanical and other points of view” (Jacobs 1962, p. 434). The following years, he undertook two extended excursions in 1921 und 1922. December 1922, the Botanical Section moved to Bangkok. In 1927, Kerr was appointed leader of the Natural History Section of the Siam Society. In April 1931, he became Director General of the now called Department of Agricultural Research. In April 1932, he retired and returned to England where he worked closely with Kew Gardens. It is reported that he had been suffering from

asthma since 1919, a disease which became more serious in later life. After a brief illness he died January 21, 1942 at Hayes, Kent, at the age of 65. The death certificate preserved in the Kew archives is mentioning “myocardial degeneration”, chronic bronchitis, and asthma as causes of death (Kew Archives KER/5/7-32).

2.2. Medicinal plants and their traditional uses

In the material preserved at Kew Gardens Archives, several lists of medicinal plants could be found. Many of them are, however, hardly decipherable. This has, on one hand, to do with bad handwriting ascribed to an injured right elbow (Jacobs 1962, p. 429: “In his youth, Kerr suffered from a form of tuberculosis in his right elbow, which somewhat limited the use of his arm for his future life. It is possible that this accounts for his handwriting, which is hardly legible at first sight ...”). On the other hand, some extended lists give plant names primarily in Thai language. Some of them were transliterated into botanical nomenclature by Kew employees, but the entries in pencil writing vanished almost completely over time. Some documents are discussing terminological uncertainties or complex drug mixtures not giving botanical names for the ingredients. Thus, the investigations here concentrate on published material or typewriter written documents containing information on medicinal plants doubtlessly identified and their therapeutic uses. The information given by Kerr is compared with recent research results and entries in a standard textbook of East Asian phytopharmaceuticals (Wiert 2006) in order to identify knowledge gaps as starting points for further research.

2.2.1. *Hydrocarpus* and *Taraktogenos*

In a publication of November 1930, Kerr discussed the medicinal virtues of *Hydrocarpus* and *Taraktogenos* species (Kerr 1930). Initially he states that the seeds of species of these genera have been used for centuries in India and China. The essay concentrates on *Hydrocarpus anthelminthica*, the species where the well-known Chaulmoogra oil is derived from. The oil has largely been used against cutaneous lesions caused by lepra and similar diseases (Marcan 1927; Parascandola 2003, Sahoo et al. 2014). He states that, despite the name, the plant does not have anthelmintic properties. Instead, Kerr refers to medicinal uses against lepra by “hypodermic infiltration”.

2.2.2. *Butea superba*

In a manuscript for the Natural Bulletin of the Siam Society (Kew Archives KER/3/8/1; Kerr 1932/4), Kerr described the “woody climber” *Butea superba* (kwao krúa, Fig. 2) as a “reputed rejuvenator”. Black tubers had to be cut in slices, dried, crushed, mixed with honey and formed as a pill. Persons under forty years of age were forbidden to take the pills. A given charm (‘kata’) had to be repeated twenty seven times when the drug was compounded. The pills were regarded to heal 96 diseases, to give long live and protect from danger. It is also said to produce a soft, youthful skin, and to turn white hair into black. The author refers to witnesses having testified that women of seventy and eighty starting to menstruate again after taking these pills. Actually, there are many legends about this plant but, in fact, activities potentially classified as “rejuvenating” are known from *Butea superba* (Wiriyakarun et al. 2013). The drug leads to hyperandrogenemia (Chaiyasit and Wiwnaitkit 2012; Malaivijitnond et al. 2009) and improves erectile dysfunction (Tocharus et al. 2006, 2012; Ho and Tan 2011; Cherdshewasart et al. 2010; Cherdshewasart and Nimsakul 2006).

2.2.3. The Collins list

In August 1930, Kerr received a number of medicinal plants collected by Mrs Collins who had been interested for botany by him in former years (Jacobs 1962, p. 477). A document obviously attached to the collection lists 28 species in botanical and Thai nomenclature (Kew Archives KER/3/8/1). For 15 of those, therapeutic indications are given. These are listed in Table 1 along with the number of PubMed entries, which may serve as a rough estimation of the degree of investigation, and some information on recent study results.

Table 1: Medicinal plants in the Collins list

Species	Indications	Nr. of PubMed entries (July 2016)	Study results (examples)	Wiert (2006)
<i>Flagellaria indica</i>	Roots used for fever	2	Hepatoprotective, anti-inflammatory, antioxidant (Gnanaraj et al. 2016); significant potential effect on Dengue fever virus (Abd Kadir et al. 2013, Klawikkan et al. 2011); semi-Paralysis (Kulip 2003); weak lipid peroxidation inhibition activity, anti-oxidant activity, quinone reductase reduction (Bunyapraphatsara et al. 2003)	Tendrils for hair growth, leaves astringent and vulnerary, diuretic, ag. cholera and pox, ag. headache, contraceptive.
<i>Heliotropium indicum</i>	Used for fever	33	Allergic conjunctivitis (Kyei et al. 2015a), glaucoma (Kyei et al. 2015b), kataract (Kyei et al. 2015c), wound healing (Dash and Murthy 2011, Reddy et al. 2002), gastro-protection (Adelaja et al. 2008), anti-tumor (Kugelman et al. 1976)	Ag. fever, inflammation, pneumonia, malaria, cholera, pyoderma, ringworm infection, for wound healing etc. Antibiotic and cytotoxic activities proven.
<i>Gossypium arboreum</i>	Used with Pak Khaw for blebs, bruises together and put on the plebs	95	[no medicinal plant in narrow sense]	
<i>Clerodendron siphonanthus</i> (= <i>C. indicum</i>)	Roots boiled and used for malaria	1 (5)	Contains beta-ethylsterols (Akihisa et al. 1989); antimicrobial activity (Panda et al. 2016); antimalarial activity in a combination product (Nutmakul et al. 2016); trad. use against asthma confirmed (Kundu and Bag 2012)	n.m.
<i>Pluchea indica</i>	Boil with salt for contraction of uterus	15	Cytotoxic activity (Cho et al. 2012; Kao et al. 2016); alpha-glucosidase inhibitors contained (Arsiningtyas et al. 2014); anti-inflammatory effect (Sen et al. 1991, 1993; Buyapool et al. 2013); anti-tuberculous activity (Mohamad et al. 2011); anti-amoebic activities (Biswas et al. 2007); other species known as emmenagogue and abortifacient (Mukhopadhyay 1983).	Ag. dysentery, fever, ulcers, sore throats, headache, rheumatism, lumbago, cold, fractures. Crushed leaves mixed with salt used to “freshen breath or perspiration” Anti-inflammatory activity and sedative confirmed
<i>Kurrimia robusta</i> (= <i>Bhesa robusta</i> , <i>Celastrus robustus</i>)	Skin diseases, used internally, roots and bark used internally	0		n.m.
<i>Baliospermum axillare</i> (= <i>B. montanum</i>)	Laxative for women	16 (B.m.)	Trad. use as purgative confirmed (Charganti and Prasad 2015); hepatoprotective (Kumar and Mishra 2014); several other activities	n.m.
<i>Clerodendron</i> sp.	Leaves uses as poultice for boils, roots boiled and taken internally	228	[sp. unknown]	n.m.
<i>Nyctanthes arbor-tristis</i>	Roots boiled with <i>Adhatoda vasica</i> for “floodings”	26	Pharmacologically active against inflammation, malaria, viral infection, leishmaniasis and as an immunostimulant (Agrawal and Pal 2013)	n.m.
<i>Adhatoda vasica</i> (= <i>Justitia adhatoda</i>)	Used for menstrual disorders	83 (A.v.)	Widely used against respiratory ailments, abortifacient effects known (Claeson et al. 2000)	n.m.
<i>Phyllanthus</i> sp.	Mixed with others used as antidote to poisoning	963 (AND poisoning 40)	Hepatoprotective (Krishnaveni and Mirunalini 2010; Lata et al. 2014; Bawankule et al. 2014; Sarg et al. 2011; Das et al. 2008)	n.m.
<i>Trichosanthes integrifolia</i> (= <i>Gymnopetalum scabrum</i>)	Roots for fever	0		n.m.
<i>Ancistrocladus extensus</i> (= <i>tectorius</i>)	Roots for fever	9	Contains antileukemic and antiplasmodial alkaloids (Jiang et al. 2013; Bringmann et al. 2013)	Trad. use ag. dysentery and malaria (confirmed), antiviral und cytotoxic
<i>Willughbeia</i> sp.	Only roots used in fever	1	Anti-oxidant and skin whitening activity (Arung et al. 2009)	n.m.
<i>Allophylus</i> sp.	For fever, the whole plant is used	25	Antimalarial activity of <i>A. africanus</i> (Oladosu et al. 2013)	n.m.

n.m.: not mentioned

2.2.4. Tropical medicine exhibition

On behalf of the Botanical Section of the Ministry of Commerce and Communications, Kerr cared for a section of “Some Siamese Medicinal Plants” displayed at the “Eight Congress of the Far Eastern Association of Tropical Medicine” in December 1930. In a printed leaflet, descriptions of nature and medicinal uses of 22 species were given (Kew Archives KER/3/8/3). Table 2 compares the uses reported for these plants with recent study results.

2.2.5. Fungi

In 1927 Kerr collected four “Fungi from Siam, said to be used dried and powdered as a soporific”, *Dictyophora indusiata* (= *D. phalloidea*), *Aseroe rubra*, *Dictyophora impicina*, and *Phallus regulosus*. Kerr himself states that he could not confirm “soporific” effects from the literature but refers to traditional uses of “puff-balls in surgical procedures” and the fact that fumes from burning *Calvatia gigantea* was used to drive bees out of their hives. He

Table 2: Medicinal plants displayed at the” Eight Congress of the Far Eastern Association of Tropical Medicine”

Species	Indications	Nr. of PubMed entries (July 2016)	Study results (examples)	Wiert (2006)
<i>Taraktogenos ilicifolia</i> Kerr (= <i>Hydnocarpus ilicifolia</i>) <i>T. kurzii</i> <i>Hydnocarpus anthelminthica</i> <i>Mitragyna speciosa</i>	Cf. Chaulmoogra oil See The Genera Hydnocarpus...			n.m.
	Opium substitute, Treatment of opium dependence, Addictive drug, Stimulant against fatigue	119	Stimulant, analgesic and opioid-like effects (Prozialeck et al. 2012); alleviating morphine and alcohol withdrawal symptoms (Suhaimi et al. 2016), opium substitute (Adkins et al. 2011)	n.m.
<i>Holarrhena antidysenterica</i>	Dysentery	51	Antidiarrheal activity in rats (Sharma et al. 2015; Kavitha et al. 2004); antimalarial activity (Verma et al. 2011; Dua et al. 2013); effective against gut motility disorders (Gilani et al. 2010)	Trad. use. latex ag. conjunctivitis, dysentery, cholera, haemorrhage, worms, tuberculosis, favus; promotes menses. Alkaloid contd, used ag. amebic dysentery, antibacterial.
<i>Combretum quadrangulare</i>	Seeds anthelmintic (particularly against <i>Taenia</i> and <i>Ascaris</i>)	11	Anthelmintic use confirmed, antipyretic, antidiarrheal, hepatoprotective (Banskota et al. 2003), antibacterial (Natachit et al. 2006)	n.m.
<i>Tinospora rumphii</i> (= <i>T. crispa</i>) <i>Tinospora cordifolia</i>	Tonic, fever “In India similarly used”	2 (41) 278	Many traditional uses confirmed, including antipyretic, widely investigated (Ahmad et al. 2016); widely investigated (Panchabai and Panchabai 2008)	n.m.
<i>Strophantus</i> sp.	Well known for action on the heart	164	Contains cardenolides with several effects (Wen et al. 2016)	<i>S. caudatus</i> : Arrow poison, cont. cardiac glycosides
<i>Baliospermum axillare</i> (= <i>B. solanifolium</i> , <i>B. montanum</i>) <i>Croton cumingii</i> (= <i>C. cascarilloides</i>)	Roots, seeds, leaves as purgative Bark against fever	16 (B. m.) 1 (4)	B. m. used for therapeutic purgation in Ayurveda (Chaganti and Prasad 2015) Several other actions Phytochemically but not pharmacologically investigated (Kawakami et al. 2015)	n.m. Trad. used ag. fever and vomiting
<i>Lobelia radicans</i> (= <i>L. chinensis</i>)	Fresh root as vesicant and abortifacient, dried root for “purifying the blood” and as digestive	23	Well known medicinal plant, anti-inflammatory effects confirmed (Li et al. 2015), anticancer activities (Santosa et al. 1986; Chen et al. 2014), Anti-herpes activities (Kuo et al. 2008)	Trad. as diuretic ag. asthma, hypertension, insect bites, snake poisoning, inflammation, syphilis. Contains lobelin ag. asthma, smoking cessation, antidepressant activity
<i>Amomum krervanh</i> (= <i>A. testaceum</i>)	Seeds used as carminative and condiment	0	Trad. use as carminative, antibacterial; very weak antimalarial activity (Thiengsuk et al. 2013), weak cytotoxic activity (Mahavorasirikul et al. 2010)	n.m.
<i>Zingiber officinale</i>	Rhizome used as carminative and condiment	834	[Well known medicinal plant]	n.m.
<i>Alpinia siamensis</i>	Rhizome used as carminative and condiment	0	Some antimicrobial activity (Mahadi 2002) CAVE: Galanga	n.m.
<i>Hedyotis auricularia</i>	No indication given	6	Trad. use against colitis, dysentery and diarrhoea (ADB 1929) incl. amoebiasis, cholera (AGN 1931), Ag. colitis, cholera, hypertension, as cardiogenic (Mukherjee et al. 1967) weak anti-dengue-virus activity (Rothan et al. 2014)	n.m.

n.m.: not mentioned

then concluded “that there appears to be no scientific evidence to confirm the existence of the alleged anaesthetic properties in these fungi (Kew Archives KDCAS 3696, DC149/454). Thus, Kerr handed some species over to the physiologist Dr. Albritton at Chulalongkorn University for physiological tests. Results are unknown. However there is another, independent report on the use of *Dictyophora* fumes as a narcotic, given by a colleague of Kerr, the chemist Alexander Marcan (1883-1953; Marcan 1927). In recent literature, *Dictyophora indusiata* was reported to be used as “aphrodisiac in China”, against hypertension and to lower cholesterol levels and *Phallus regulosus* to be regarded as toxic in China (Kreisel 2014, p. 136), but there are also no reports on “soporific” or similar actions. Studies, which are available for

Dictyophora indusiata, report immunostimulatory (Deng et al. 2016), and anti-tumor activities (Deng et al. 2013) and found neuroprotective compounds (Lee et al. 2002). There are no investigations about the other species.

2.2.6. Scented woods

In a manuscript later to be published (Kew Archives KER/3/8/2, Kerr 1941), Kerr gave some descriptions of “scented woods”. Some of them are described as medicinally used, but unfortunately, no details are given. Among those were *Aglaia pyramidata* (“used medicinally, not an article of commerce”), *Celtis cinnamomea* (“used medicinally and as a protection against evil spirits, no

Table 3: Recent study results with “scented woods” from Thailand

Species	Nr.of PubMed entries (July 2016)	Study results (examples)
<i>Aglaia pyramidata</i> (= <i>A. silvestris</i>)	1 (A.p.) 2 (A. s.)	Alkaloid (Saifah et al. 1993) and cytotoxic compounds isolated (Hwang et al. 2004; Pointinger et al. 2008)
<i>Celtis cinnamomea</i> (= <i>C. timoensis</i>)	0	
<i>Dracaena loureiri</i>	7	Antimalarial activity (Thiengsusuk et al. 2013); estrogen agonistic activity (Ichikawa et al. 1997)
<i>Hymenocardia wallichii</i> (= <i>H. punctata</i>)	1	13 compounds identified (Suthiwong et al. 2012)
<i>Tarenna hoagensis</i>	0	

great commercial value”), *Dracaena loureiri* (“chiefly valued for medicinal purposes”), *Hymenocardia wallichii* (“used chiefly in medicine”), and *Tarenna hoagensis* (“not of commercial value, but used for medicinal purposes”). As shown in Table 3, the therapeutic value of most of these species have not been investigated yet.

2.3. Results

A comparison of the traditional uses reported by Kerr and state-of-the-art pharmacological knowledge shows that a great deal of the botanists reports could be confirmed. However, there are some species not widely or not at all investigated so far. These, which are strongly suggested for further research can be seen from Tables 1–3. According to Kerr, *Kurrimia robusta* was used against skin diseases, *Alpinia siamensis* and *Amomum krervanh* (*A. testaceum*) as carminatives, *Trichosanthes integrifolia* (= *Gymnopetalum scabrum*) against fever. All these species have never been studied so far. *Croton cumingii* (= *C. cascarilloides*), also recommended against fever and vomiting, was investigated phytochemically but not pharmacologically, while a traditional use against fever was independently confirmed by Wiart (2006). Species investigated for other indications than those given by Kerr include *Lobelia radicans* (= *L. chinensis*) as a vesicant and abortifacient, *Willughbeia* sp. (against fever), *Nyctanthes arbor-tristis* (against “floodings”), *Pluchea indica* (for contraction of the uterus) and *Heliotropium indicum* (against fever). Any “soporific” effect of the fungi mentioned could also not be confirmed so far, and most of the “scented woods” described by Kerr as medicinally useful are awaiting further research as well.

3. Discussion

As already shown for the botanist Berthold Seemann (Helmstädter 2015) and the anthropologist Melville William Hilton-Simpson (Helmstädter 2016a), writings of explorers of the 19th and early 20th century could serve as a guide for pharmaceutical screening of traditionally used medicinal plants. In this study we investigated publications, notes and letters of Arthur Francis George Kerr (1877–1942), a British physician who devoted himself to the botanic exploration of Siam (Thailand) between 1902 and 1932. It could be shown that many traditional uses of Siamese medicinal plants reported by Kerr could meanwhile be confirmed in phytochemical and pharmacological studies. This, again, shows that there might be some reliability in the reports given by the explorers. Kerr, who had a formal medical training and worked in a period of time with an already considerable medical and scientific knowledge, may be more reliable than others only trained in botany or working much earlier. Unfortunately, despite being a medical expert, Kerr usually did not record details concerning indications, plant parts or dosage forms used. The writings often just contain remarks like “medicinally used” without further specification. Despite being a physician, he was less interested in phytopharmaceutical research than other exploring botanists and even his co-workers. So Alexander Marcan, a plant collector in Thailand the same years than Kerr, gave a comprehensive and rather modern sounding outline about investigations of traditionally used medicinal plants in 1927. He suggested to firstly confirming the botanical nature of a traditionally used drug and see if related species do contain pharmacologi-

cally active compounds already known. This should be followed by chemical examination and eventually, pharmacological studies in animals and humans (Marcan 1927). This way of thinking, however, seems not to be adopted by Kerr.

Unfortunately not all the material available could be included into this study, as a great deal of archive material was undecipherable due to bad handwriting, undissolved Thai vernacular names and almost completely vanished pencil entries, as in the lists of synonyms elaborated by the staff of Kew Gardens in the 1920s and 1930s. Thus, the study had to concentrate on published material and documents written by means of a typewriter. As with any historical texts, problems arise from terminological uncertainties about plants and indications. However, botanical nomenclature of the 1930s seems much more reliable than for example, terminology of Early Modern herbals. Although medical terminology was already in an advanced state in the 1930s, the indications given by Kerr are mostly rather broad, so there are many diseases accompanied by “fever”, a term which might often, but not always be synonymous for malaria.

Despite these shortcomings, it seems worth screening the plants mentioned by Kerr as medicinally useful but not scientifically investigated so far, primarily those also described as useful in other, independent sources or ethnopharmacological surveys. This procedure should be more promising than screening plant species at random.

Acknowledgement: The author sincerely thanks the staff of Kew Gardens archive, for support.

Conflicts of interest: None reported.

References

- Abd Kadir SL, Yaakob H, Zulkifli RM (2013) Potential anti-dengue medicinal plants: a review. *J Natural Med* 67: 677-689
- ADB (1929) *Hedyotis auricularia*: a new remedy against colitis. *Can Med Assoc J* 21: 591.
- Adelaja AA, Ayoola MD, Otulana JO, Akinola OB, Olayiwola A, Ejiwunmi AB (2008) Evaluation of the histo - gastroprotective and antimicrobial activities of *Heliotropium indicum* Linn (Boraginaceae). *Malays J Med Sci* 15: 22-30.
- Adkins JE, Boyer EW, McCurdy CR (2011) *Mitragyna speciosa*, a psychoactive tree from Southeast Asia with opioid activity. *Curr Top Med Chem* 11: 1165-1175.
- Agrawal J, Pal A (2013) *Nyctanthes arbor-tristis* Linn--a critical ethnopharmacological review. *J Ethnopharmacol* 146: 645-658.
- Ahmad W, Jantan I, Bukhari SN (2016) *Tinospora crispa* (L.) Hook. f. & Thomson: A Review of its ethnobotanical, phytochemical, and pharmacological aspects. *Front Pharmacol* 7: 59.
- Akihisa T, Matsubara Y, Ghosh P, Thakur S, Tamura T, Matsumoto T (1989) Sterols of some *Clerodendrum* species (Verbenaceae): occurrence of the 24 alpha- and 24 beta-epimers of 24-ethylsterols lacking a delta 25-bond. *Steroids* 53: 625-638.
- AND (1931) *Hedyotis auricularia* in amoebiasis, cholera, and colitis. *Can Med Assoc J* 24: 703.
- Arsiningtyas IS, Gunawan-Puteri MD, Kato E, Kawabata J (2014) Identification of α -glucosidase inhibitors from the leaves of *Pluchea indica* (L.) Less., a traditional Indonesian herb: promotion of natural product use. *Nat Prod Res* 28: 1350-1353.
- Arung ET, Kusuma IW, Christy EO, Shimizu K, Kondo R (2009) Evaluation of medicinal plants from Central Kalimantan for antimelanogenesis. *J Nat Med* 63: 473-480.
- Banskota AH, Tezuka Y, Le Tran Q, Kadota A (2003) Chemical constituents and biological activities of Vietnamese medicinal plants. *Curr Topics Med Chem* 3: 227-248.
- Bawankule DU, Trivedi P, Pal A, Shanker K, Singh M, Sharma P, Khan F, Maurya AK, Verma RK, Gupta MM (2014) Protective mechanism of lignans from *Phyllanthus amarus* against galactosamine/ lipopolysaccharide-induced hepatitis: an in-vivo and in-silico studies. *Curr Top Med Chem* 14: 1045-1055.
- Biswas R, Dutta PK, Achari B, Bandyopadhyay D, Mishra M, Pramanik KC, Chatterjee TK (2007) Isolation of pure compound R/J/3 from *Pluchea indica* (L.) Less. and its anti-amoebic activities against *Entamoeba histolytica*. *Phytomedicine* 14: 534-537.

- Bringmann G, Zhang G, Olschlager T, Stich A, Wu J, Chatterjee M, Brun R (2013) Highly selective antiplasmodial naphthylisoquinoline alkaloids from *Ancistrocladus tectorius*. *Phytochemistry* 91: 220-228.
- Buapool D, Mongkol N, Chantimal J, Roytrakul S, Srisook E, Srisook K (2013) Molecular mechanism of anti-inflammatory activity of *Pluchea indica* leaves in macrophages RAW 264.7 and its action in animal models of inflammation. *J Ethnopharmacol* 146: 495-504.
- Bunyapraphatsara N, Jutiviboonsuk A, Sornlek P, Therathanathorn W, Aksornkaew S, Fong HHS, Pezzuto JM, Kosmeder J (2003) Pharmacological studies of plants in the mangrove forest. *Thai J Phytopharm* 10: 2546.
- Chaganti S, Prasad BS (2015) Analysis of Virechana karma with *Danti avaleha*: A retrospective study. *J Ayurveda Integr Med* 6: 300-304.
- Chaiyasit K, Wiwnaitik W (2012) Hyperandrogenemia due to ingestion of *Butea superba*. *Indian J Endocrinol Metab* 16: 485-486.
- Chen MW, Chen WR, Zhang JM, Long XY, Wang YT (2014) *Lobelia chinensis*: chemical constituents and anticancer activity perspective. *Chin J Nat Med* 12: 103-110.
- Cherdshewasart W, Nimsakul N (2003) Clinical trial of *Butea superba*, an alternative herbal treatment for erectile dysfunction. *Asian J Andro* 5: 243-246.
- Cherdshewasart W, Sutjit W, Pulcharoen K, Chulasiri M (2010) Mutagenic and antimutagenic effects of the traditional herb used for treating erectile dysfunction, *Butea superba* Roxb. *Biosci Biotechnol Biochem* 74: 923-927.
- Cho JJ, Cho CL, Kao CL, Chen CM, Tseng CN, Lee YZ, Liao LJ, Hong YR (2012) Crude aqueous extracts of *Pluchea indica* (L.) Less. inhibit proliferation and migration of cancer cells through induction of p53-dependent cell death. *BMC Complement Altern Med* 12: 265.
- Claeson UP, Malmfors T, Wikman G, Bruhn JG (2000) *Adhatoda vasica*: a critical review of ethnopharmacological and toxicological data. *J Ethnopharmacol* 72: 1-20.
- Das BK, Bepary S, Datta BK, Chowdhury AA, Ali MS, Rouf AS (2008) Hepatoprotective activity of *Phyllanthus reticulatus*. *Pak J Pharm Sci* 21: 333-337.
- Dash GK, Murthy PN (2011) Studies on wound healing activity of *Heliotropium indicum* Linn. leaves on rats. *ISRN Pharmacol* 2011: 847980.
- Deng C, Fu H, Teng L, Hu Z, Xu X, Chen J, Ren T (2013) Anti-tumor activity of the regenerated triple-helical polysaccharide from *Dictyophora indusiata*. *Int J Biol Macromol* 61: 453-458.
- Deng C, Shang J, Fu H, Chen J, Liu H, Chen J (2016) Mechanism of the immunostimulatory activity by a polysaccharide from *Dictyophora indusiata*. *Int J Biol Macromol* 91: 752-759.
- Dua VK, Verma G, Singh B, Rajan A, Bagai U, Agarwal DD, Gupta NC, Kumar S, Rastogi A (2013) Anti-malarial property of steroidal alkaloid conessine isolated from the bark of *Holarhena antidysenterica*. *Malar J* 12: 194.
- Gilani AH, Khan A, Khan AU, Bashir S, Rehman NU, Mandukhail SU (2010) Pharmacological basis for the medicinal use of *Holarhena antidysenterica* in gut motility disorders. *Pharm Biol* 48: 1240-1246.
- Gnanaraj C, Shah MD, Makki JS, Iqbal M (2016) Hepatoprotective effects of *Flagellaria indica* are mediated through the suppression of pro-inflammatory cytokines and oxidative stress markers in rats. *Pharm Biol* 54: 1420-1433.
- Helmstädtler A (2015) Ethnopharmacological information from the botanical correspondence of Berthold Seemann (1825 - 1871) – a pilot study. *Pharmazie* 70: 616-626.
- Helmstädtler A (2016a) Ethnopharmacology in the work of Melville William Hilton-Simpson (1881-1938) - historical analysis and current research opportunities. *Pharmazie* 71: 352-360.
- Helmstädtler A (2016b) Botanical explorer's legacy – a promising bioprospecting tool. *Drug Discov Today*, in print. doi: 10.1016/j.drudis.2016.11.011
- Ho CC, Tan HM (2011) Rise of herbal and traditional medicine in erectile dysfunction management. *Curr Urol Rep* 12: 470-478.
- Hwang BY, Su BN, Chai H, Mi Q, Kardono LB, Afriastini JJ, Riswan S, Santarsiero BD, Mesecar AD, Wild R, Fairchild CR, Vite GD, Rose WC, Farnsworth NR, Cordell GA, Pezzuto JM, Swanson SM, Kinghorn AD (2004) Silvestrol and episilvestrol, potential anticancer roscoglate derivatives from *Aglaia silvestris*. *J Org Chem* 69: 3350-3358.
- Ichikawa K, Kitaoka M, Taki M, Takaishi S, Iijima Y, Boriboon M, Akiyama T (1997) Retrodihydrochalcones and homoisoflavones isolated from Thai medicinal plant *Dracaena loureiri* and their estrogen agonist activity. *Planta Med* 63: 540-543.
- Jacobs M (1962) *Reliquiae Kerrianae*. *Blumea* 11: 427-493.
- Jiang C, Li ZL, Gong P, Kang SL, Liu MS, Pei YH, Jing YK, Hua HM (2013) Five novel naphthylisoquinoline alkaloids with growth inhibitory activities against human leukemia cells HL-60, K562 and U937 from stems and leaves of *Ancistrocladus tectorius*. *Fitoterapia* 91: 305-312.
- Kao CL, Cho J, Lee YZ, Cheng YB, Chien CY, Hwang CF, Hong YR, Tseng CN, Cho CL (2015) Ethanolic extracts of *Pluchea indica* induce apoptosis and antiproliferation effects in human nasopharyngeal carcinoma cells. *Molecules* 20: 11508-11523.
- Kavitha D, Shilpa PN, Devaraj SN (2004) Antibacterial and anti-diarrhoeal effects of alkaloids of *Holarhena antidysenterica* WALL. *Indian J Exp Biol* 42: 589-594.
- Kawakami S, Matsunami K, Otsuka H, Inagaki M, Takeda Y, Kawahata M, Yamaguchi K (2015) Crotonoscarins I-K: crotofolane-type diterpenoids, crotonoscarin γ , isocrotofolane glucoside and phenolic glycoside from the leaves of *Croton cascarilloides*. *Chem Pharm Bull* 63: 1047-1054.
- Kerr (1939) Early Botanists in Thailand. *J Thai Res Soc Nat Hist Suppl* 12: 1-27.
- Kerr (1941) Notes on the scented woods of Thailand. *Nat Hist Bull Siam Soc* 13: 35-41.
- Kerr A (1930) The genera *Hydrocarpus* and *Taraktogenos* in Siam. In: Ministry of Commerce and Communications (ed.): Technical and Scientific Supplement to the Record N. 7, Bangkok, Siam (Kew Archives KER/5/5 Box 39e)
- Kerr A (1932/4) A reputed rejuvenator. *Nat Hist Bull Siam Soc* 8: 336-338.
- Klawikann N, Nukoolkarn V, Jirakanjanakit N, Yoksan S, Wiwat C (2011) Effect of Thai medicinal plant extracts against dengue virus in vitro. *Mahidol Univ J Pharm Sci* 38: 13-18.
- Kreisel H (2014) Ethnomykologie. Verzeichnis der ethnomykologisch, biotechnologisch und toxikologisch relevanten Pilze. Jena.
- Krishnaveni M, Mirunalini S (2010) Therapeutic potential of *Phyllanthus emblica* (amla): the ayurvedic wonder. *J Basic Clin Physiol Pharmacol* 21: 93-105.
- Kugelmann M, Liu WC, Axelrod M, McBride TJ, Rao KV (1976) Indicine-N-oxide: the antitumor principle of *Heliotropium indicum*. *Lloydia* 39: 125-128.
- Kulip J (2003) An ethnobotanical survey of medicinal and other useful plants of Muruts in Sabah, Malaysia. *Teloepa* 10: 81-98.
- Kundu S, Bag A (2012) Indigenous health care practices among Rajbanshi of Dakshin Dinajpur, West Bengal. *Ethno Med* 6: 117-120.
- Kuo YC, Lee YC, Leu YL, Tsai WJ, Chang SC (2008) Efficacy of orally administered *Lobelia chinensis* extracts on herpes simplex virus type 1 infection in BALB/c mice. *Antiviral Res* 80: 206-212.
- Kyei S, Koffuor GA, Ramkissoon P, Abokyi S, Owusu-Afriyie O, Wiredu EA (2015a) Possible mechanism of action of the antiallergic effect of an aqueous extract of *Heliotropium indicum* L. in ovalbumin-induced allergic conjunctivitis. *J Allergy (Cairo)* 2015:245370.
- Kyei S, Koffuor GA, Ramkissoon P, Afari C, Asiamah EA (2015c) The claim of anti-cataract potential of *Heliotropium indicum*: a myth or reality? *Ophthalmol Ther* 4: 115-128.
- Kyei S, Koffuor GA, Ramkissoon P, Owusu-Afriyie O (2015b) Anti-glaucoma potential of *Heliotropium indicum* Linn in experimentally-induced glaucoma. *Eye Vis (Lond)* 2: 16.
- Lata S, Singh S, NathTiwari K, Upadhyay R (2014) Evaluation of the antioxidant and hepatoprotective effect of *Phyllanthus fraternus* against a chemotherapeutic drug cyclophosphamide. *Appl Biochem Biotechnol* 173: 2163-2173.
- Lee IK, Yun BS, Han G, Cho DH, Kim YH, Yoo ID (2002) Dicytoquinazols A, B, and C, new neuroprotective compounds from the mushroom *Dictyophora indusiata*. *J Nat Prod* 65: 1769-1772.
- Li KC, Ho YL, Huang GJ, Chang YS (2015) Anti-oxidative and anti-inflammatory effects of *Lobelia chinensis* in vitro and in vivo. *Am J Chin Med* 43: 269-287.
- Mahadi GB (2002) Are medicinal plants a potential alternative for conventional antibiotics in animal husbandry? *Thai J Phytopharm* 9: 50-63.
- Mahavorasirikul W, Viyanant V, Chaijaroenkul W, Itharat A, Na-Bangchang K (2010) Cytotoxic activity of Thai medicinal plants against human cholangiocarcinoma, lymphatic and hepatocarcinoma cells in vitro. *BMC Complement Altern Med* 10: 55.
- Malaivijitnond S, Ketsuwan AN, Watanabe G, Taya K, Cherdshewasart W (2009) Androgenic activity of the Thai traditional male potency herb, *Butea superba* Roxb., in female rats. *J Ethnopharmacol* 121: 123-129.
- Marcantoni A (1927) The story of drugs, with special reference to Siamese medicinal plants. *J Siam Soc Nat Hist Suppl* 7: 107-117.
- Mohamad S, Zin NM, Wahab HA, Ibrahim SF, Zairiluddin AS, Noor SS (2011) Antituberculous potential of some ethnobotanically selected Malaysian plants. *J Ethnopharmacol* 133: 1021-1026.
- Mukherjee A, Chavan SR, Dutta NK (1967) Pharmacological actions of an alkaloidal fraction isolated from *Hedyotis auricularia*, Linn. and *H. hispida*, Retz. N.O.-(Rubiaceae): preliminary study. *Ind J Med Res* 55: 1103-1106.
- Mukhopadhyay S, Cordell GA, Ruangrunsi N, Rodkird S, Tantivatana P, Hylands PJ (1983) Traditional medicinal plants of Thailand. IV. 3-(2',3'-Diacetoxy-2'-methyl butyryl)-cuautehone from *Pluchea indica*. *J Nat Prod* 46: 671-674.
- Natachit K, Santiavorn D, Khantawa B (2006) Antibacterial activity of the seeds of *Combretum quadrangulare* Kurz (Combretaceae). *CMU J* 5: 330.
- Newman DJ, Cragg JM (2016) Natural products as sources of new drugs from 1981 to 2014. *J Nat Prod* 79: 629-661.
- Nutmakul T, Pattanapanyasat K, Soonthornchareonnon N, Shiomi K, Mori M, Prathantururug S (2016) Antiplasmodial activities of a Thai traditional antipyretic formulation, Bencha-Loga-Wichian: a comparative study between the roots and their substitutes, the stems. *J Ethnopharmacol* 193: 125-132.
- Panchabhai TS, Panchabhai TS (2008) Validation of therapeutic claims of *Tinospora cordifolia*: a review. *Phytother Res* 22:425-441.
- Panda SK, Mohanta YK, Padhi L, Park YH, Mohanta TK, Bae H (2016) Large scale screening of ethnomedicinal plants for identification of potential antibacterial compounds. *Molecules* 21: 293.
- Parascandola J (2003) Chaulmoogra oil and the treatment of leprosy. *Pharm in Hist* 45: 47 - 57.
- Pointinger S, Promdang S, Vajrodaya S, Pannell CM, Hofer O, Mereiter K, Greger H (2008) Silvaglins and related 2,3-secodammarane derivatives - unusual types of triterpenes from *Aglaia silvestris*. *Phytochemistry* 69: 2696-2703.
- Prozialeck WC, Jivan JK, Andurkar SV (2012) Pharmacology of kratom: an emerging botanical agent with stimulant, analgesic and opioid-like effects. *J Am Osteopath Assoc* 112: 792-799.
- Reddy JS, Rao PR, Reddy MS (2002) Wound healing effects of *Heliotropium indicum*, *Plumbago zeylanicum* and *Acalypha indica* in rats. *J Ethnopharmacol* 79: 249-251.
- Rothan HA, Zulfarnain M, Ammar YA, Tan EC, Rahman NA, Yusof R (2014) Screening of antiviral activities in medicinal plants extracts against dengue virus using dengue NS2B-NS3 protease assay. *Trop Biomed* 31: 286 - 296.
- Roxburgh W (1795) *Plants of the Coast of Coromandel*, Vol. 1, London.
- Sahoo MR, Dhanabal SP, Jadhav AN, Reddy V, Muguli G, Babu UV, Rangesh P (2014) *Hydnocarpus*: an ethnopharmacological, phytochemical and pharmacological review. *J Ethnopharmacol* 154: 17-25.
- Saifah E, Puripattananong J, Likhitwitayawuid K, Cordell GA, Chai H, Pezzuto JM (1993) Bisamides from *Aglaia* species: structure analysis and potential to reverse drug resistance with cultured cells. *J Nat Prod* 56: 473-477.
- Santosa MH, Herzog R, Voelter W (1986) Antitumor activity of the hot water extract of *Lobelia chinensis*. *Planta Med* 6: 555.

- Sarg T, Ghani AA, Zayed R, El-Sayed M (2011) Antihepatotoxic activity of *Phyllanthus atropurpureus* cultivated in Egypt. *Z Naturforsch C* 66: 447-452.
- Sen T, Nag Chaudhuri AK (1991) Antiinflammatory evaluation of a *Pluchea indica* root extract. *J Ethnopharmacol* 33: 135-141.
- Sharma DK, Gupta VK, Kumar S, Joshi V, Mandal RS, Prakash AG, Singh M (2015) Evaluation of antidiarrheal activity of ethanolic extract of *Holarrhena antidysenterica* seeds in rats. *Vet World* 8: 1392-1395.
- Suhaimi FW, Yusoff NH, Hassan R, Mansor SM, Navaratnam V, Müller CP, Hassan Z (2016) Neurobiology of Kratom and its main alkaloid mitragynine. *Brain Res Bull* S0361-9230 (16) 30058-2.
- Suthiwong J, Poopasit K, Yenjai C (2012) A new phenolic compound from the stem of *Hymenocardia wallichii*. *J Asian Nat Prod Res* 14: 482-485.
- Thiangsusuk A, Chaijaroenkul W, Na-Bangchang K (2013) Antimalarial activities of medicinal plants and herbal formulations used in Thai traditional medicine. *Parasitol Res* 112: 1475-1481.
- Tocharus C, Sooksaeen P, Shimbhu D, Tocharus J (2012) *Butea superba* (Roxb.) improves penile erection in diabetic rats. *Andrologia* 44 Suppl 1: 728-733.
- Verma G, Dua VK, Agarwal DD, Atul PK (2011) Anti-malarial activity of *Holarrhena antidysenterica* and *Viola canescens*, plants traditionally used against malaria in the Garhwal region of north-west Himalaya. *Malar J* 10: 20.
- Wen S, Chen Y, Lu Y, Wang Y, Ding L, Jiang M (2016) Cardenolides from the Apocynaceae family and their anticancer activity. *Fitoterapia* 112: 75-84.
- Wiart C (2006) *Medicinal Plants of the Asia-Pacific: Drugs for the future?* World Scientific Publ., New Jersey et al.
- Wiriyakarun S, Yodpetch W, Komatsu K, Zhu S, Ruangrungrasi N, Sukrong S (2013) Discrimination of the Thai rejuvenating herbs *Pueraria candollei* (White Kwao Khrua), *Butea superba* (Red Kwao Khrua), and *Mucuna collettii* (Black Kwao Khrua) using PCR-RFLP. *J Nat Med* 67: 562-570.