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Ethnopharmacological information from the botanical correspondence of Berthold Seemann (1825 - 1871) – a pilot study

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Historical research may be able to contribute to the exploration of traditional knowledge about medicinal plants and promising attempts have been made investigating Byzantine texts, Early Modern herbals, and writings of Christian missionaries. In this pilot study it should be explored if publications, travel reports, diaries or correspondence of the botanical explorers of the 19th and early 20th centuries may serve a source of ethnopharmacological information as well and may be able to guide modern phytopharmacological research. Writings of Berthold Seemann (1825-1871), a German investigator exploring the botany of Middle America, the Fiji islands and other regions, are investigated as a first example. It could be shown that Seemann's heritage mainly kept at Kew Garden Archives, does contain ethnopharmacological information which in part has already been confirmed by recent study results indicating some reliability of his observations. However, there are also reports about traditional medicinal plants scarcely investigated so far, including *Schultesia stenophylla* Mart. (syn. *S. guainensis* (Aubl.) Malme), *Trixis inula* Crantz, *Waltheria glomerata* Presl., *Gonophlebium attenuatum* (Humb. & Bonpl. Es Willd) C. Presl., or *Pseudoelephantopus spicatus* (Juss ex Aubl.) C.F. Baker. It is suggested to further explore their potential as medicinal plants. In general, as Seemann's example has shown, publications and correspondence of botanical explorers of the past seem to be a valuable and hitherto almost neglected source of information to be considered in further historical and ethnopharmacological research.

1. Introduction

The plant kingdom is still a highly relevant source of new therapeutic agents and lead structures for drug development (Cragg and Newman 2013). Most of the new active agents are of natural origin or have at least any relationship to nature (Newman and Cragg 2012). The search for new active agents is, to some extent, guided by the traditional use of medicinal plants, which can be unveiled by careful ethnopharmacological studies (Heinrich 2000) and has also its value as a source of therapeutic evidence (Helmstädter and Staiger 2014). Historical research is also able to contribute, as important and largely unknown information about the medical tradition of a plant may be hidden in textbooks, pharmacopoeias, correspondence, diaries, travel reports etc., many of which have been neglected by research mainstream. Careful historical evaluation of these texts may lead to the rediscovery of uses, indications and side effects of traditionally used plants and may also be able to give useful suggestions for modern natural product research (Holland 1994; Riddle 2002; Buenz et al. 2004). Recently, this approach has been followed in different ways, so by the systematic examination of pharmacopoeias from the 16th and 17th century searching for entries about plants traditionally used against brain disorders (Adams et al. 2007), rheumatic diseases (Adams et al. 2009), malaria (Adams et al. 2011), or epilepsy (Adams et al. 2012). Another approach is considering the heritage of Christian missionaries as a source of traditional phytopharmaceutical knowledge (Anagnostou 2005, 2015). Lardos and Heinrich evaluated certain Byzantine texts belonging to the iatrosophia genre in view of information useful for recent drug development (Lardos et al. 2011; Lardos and Heinrich 2013).

This study is focused on a hitherto almost neglected kind of historical texts which, most probably, contain valuable information for natural product research: publications and correspondence of botanists, sent from Europe to the so called new world in order to explore the indigenous flora. This happened largely between the 18th and the early 20th century. Of course, botanists were primarily interested in the registration of the local plants, the identification of new species, and the collection of herbarium items, but also recorded medicinal uses now and then which may be useful from a today's perspective. In fact, botanists sent abroad from Kew Gardens, London, were formally obliged to record medicinal uses as has been shown for the explorer Charles Wilford (Helmstädter 2013). Wilford actually did not care about that, while others took it more seriously. Among those was botanist Berthold Seemann (1825-1871), Kew employee from 1844 until 1851. Thus it seemed worth looking into his writings to investigate if there is relevant information about medicinal plants and their indigenous uses and to evaluate if findings could enlarge ethnopharmacological knowledge and exert any impact on phytopharmaceutical research.

Fig. 1: Berthold Seemann (1825–1871) from 'Flora Vitiensis'.

2. Berthold Seemann

Seemann (Fig. 1) was born in Hannover, Germany, February 25, 1825 (NN 1872; Wunschmann 1891). He started studying botany at Kew Gardens, London, in 1844, initially working as a gardener. Soon thereafter he was appointed naturalist on the voyage of exploration of the American west coast and Pacific on the HMS Herald. The expedition returned via Hawaii, Hong Kong, the East Indies and South Africa in June 1851. During the journey, Seemann did a great deal of botanical studies and published a diary (Seemann 1853a) as well as an extended summary of his botanical elaborations (Seemann 1852/1854). He used a second journey starting in 1860 to explore the botany of Polynesia, in particular the Fiji islands which resulted in a series of publications later summarized in a single volume (Seemann 1865-1873). He published several other botanical works of great impact and also founded and edited two journals, named *Bonplandia* (1853–1862) and *Journal of Botany, British and Foreign* (1863–1871), the latter surviving until 1938. In the late 1860s he retracted himself more and more from botany, besides other occupations working as the director of a gold mine in Javali, Nicaragua. He died there from a febrile disease with cardiac complications October 10, 1871 (NN 1872).

3. Investigations and results

Seemann published a lot and also continuously corresponded with his colleagues, of course with contributors to his botanical journals, but in particular with experts at Kew Gardens, London, who had sent him to the new world for botanical exploration. Kew Archives are keeping a great deal of his letters and original reports, mainly from his extended journal on HMS Herald from 1845-1851. This material was investigated in view of any information about the nature and use of medicinal plants. In general, the material is about botanical problems, collection of herbarium items etc., but does also contain descriptions of ethnopharmaceutical relevance now and then. Some medicinal plants are mentioned in Seemanns printed summary (Table) but a few are described in more detail in his handwritten diary and correspondence. In some cases the author is highly convinced of the plants great relevance for local pharmacotherapy. This information is presented here and is compared with today's state-of-the art knowledge and study results. It is also intended to find out if Seemann's heritage may have any potential to further stimulate phytopharmaceutical research.

3.1. Simaba cedron Planch. (Simarubaceae)

In a detailed report from his Herald journey, Seemann presented an extended description of the medicinal uses of *Simaba cedron* fruits in Panama, particularly against snake bites and bites of almost all venomous animals (Seemann 1847-1857, fol. 10). He says that no inhabitant will leave his house without carrying Cedron with him. It shall also be useful against "fever" and Seemann tells that he had cured several patients with Cedron himself. After a bite, 3-4 grain of Cedron seeds should be taken internally in brandy or water. In addition, a similar mixture should be applied onto the wound. Seemann himself was never bitten by a snake but stung by scorpions and he reported immediate success and complete recovery from initial symptoms like pain and swelling after having taken seeds suspended in brandy. The report on Cedron is the most extensive one among those on medicinal plants in Seemann's correspondence; he also devoted a separate chapter of the first *Bonplandia* issue to the plant and its virtues (Seemann 1853b) and included an extensive description in his botanical report of the Panama excursion (Seemann 1852/54, pp. 95-97). Here it is mentioned that the plant has been used as an effective remedy against the bite of snakes, scorpions, reptiles, millipedes and other animals but also against malaria. Cedron is said to be known in Europe since 1699 and botanical investigations were already under way at the time of Seemann's observations. Seeds had been sent to Kew Gardens, not by Seemann but by other researchers like William Purdie (1817-1857). Already in the early 1850 s, phytochemical investigations about Cedron constituents started (Lewy 1851) and continued up to recent years (Krebs and Rüber 1960; Hammarlund 1963; Ozeki at al. 1998; Hitotsuyanagi et al. 2001; Moreira et al. 2006). They should not be discussed in detail here, as they usually are of pure phytochemical nature and do not contain relevant pharmacological information. In the context of this study it seems more important if, and how far Seemann's reports could be confirmed by pharmacological research or even animal or clinical studies. *Simaba cedron* has been tested among other plants for its potential to antagonize snake bite poisoning. Bonsmann (1942) concluded that a preparation containing three *Aristolochia* extracts and *Simaba cedron* fruit extract (Gauckler 1935) was not suitable as a remedy against nine different snake poisons in mice, rats, and guinea pigs. Otero et al. (2000) tested several plant extracts, including those of *Simaba cedron* whole plant and seeds, for their potential to neutralize the haemorraghic effect of *Bothrops athrox* venom in mice and found some, but relatively weak activity. Concerning prophylactic use, Hartwich (1885) suggested that continued intake of an alcoholic extract of seeds or bark will lead to a characteristic perspiration driving off snakes, insects and spiders, but this has never been proven. *Simaba cedron* extracts have also been tested against malaria several times, an indication already mentioned by Seemann, with considerable success. Spencer at al. (1947) found excellent antimalarial activity with a *Simaba cedron* kernel extract, and weak activity with root and bark methanolic extract in a chicken model. More or less activity was seen with 68 Simaroubaceae

Fig. 2: *Schultesia stenophylla* Mart. (now *S. guainensis* (Aubl.) Malme.

species which, however, were considered to be remarkably toxic (see also Muhammad and Samoylenko 2007). Moretti at al. (1994) found a considerable antimalarial activity of cedronin (IC_{50} 15 μg/ml), a compound isolated from *Simaba cedron*. Joly et al. (1987) confirmed the anti-malarial activity of a chloroform extract of *Simaba cedron* as did Mojab (2012). O'Neill et al. (1985) found some activity with the chloroform extract of *Simaba cedron* leaves and fruits, however, the petroleum ether and methanol fraction remained inactive.

The plant contains several quassinoids, namely cedronolactones A-E, compounds which have recently been recognized as lead compounds in drug research, showing significant cytotoxic activity against leukemia cells (Polonsky 1985; Guo et al. 2009) as well as anti-inflammatory activities. Anti-inflammatory but also toxic properties have already been reported in the 1960s (Hammarlund 1963; Geissmann 1964).

In conclusion, the medicinal properties reported by Seemann could only be confirmed in part. In fact the plant seems to contain compounds with antimalarial activity. Activity against snake-bites seems to be uncertain, a weak anti-inflammatory effect may explain some effects against animal bites and stings usually accompanied by some degree of inflammation. Unfortunately most of the investigations were done with methanolic or chloroform extracts, while Seemann had clearly reported a preparation in an ethanol/water mixture. Independent from ethnopharmacological reports, phytochemical investigations revealed constituents with significant antileukemic activity *in vitro*, an indication Seemann could not know about. These constituents may serve as lead compounds in further drug research, although several studies report considerable toxicity of *Simaba cedron* extracts.

3.2. Mikania guaco Humb. & Bonpl.

Mikania guaco is also reported as an antidote against snakebites and to treat hydrophobia (rabies) (Seemann 1847-1857, fol. 22 v). In his "Botany of the Voyage of HMS Herald" Seemann wrote: "Antidotes for the bites of snakes are found in the stem and leaves of the Guaco (*Mikania guaco* H.B.K.) . . ." (Seemann 1852/54, p. 68). Although Seemann, on one hand, clearly assigned the species *Mikania guaco* Humb & Bonpl. to what has been called "guaco" in Middle America (Seemann 1952/54, p.150), it seems somewhat unclear which species he exactly meant. The vernacular name included many different species, a fact already seen by the botanist himself ("Every country has its peculiar Guaco", including *Aristolochia*, *Mikania* and *Convolvulacea* species; Seemann 1852/54, p. 150). Otero et al.

(2000) found some, but very weak inhibitory activity of *M. guaco* extract on *Bothrox* venom, but the species seems not to be intensely investigated otherwise, opposite to several other *Micania* species like *M. laevigata* and *M. glomerata*, also called "Guaco" and recommended against snake bites in the countries of origin. Napimoga and Yatsuda (2012) found a considerable anti-inflammatory potential, which, again, may partly explain ethnomedicinal uses. Several other studies suggest activities against snake bite symptoms for *M. glomerata* which mostly were anti-inflammatory and/or antihemorragic effects (Mourão et al. 2014), but proteolytic degradation of *Bothrops* and *Crotalus* snake venom has also been reported (Maiorano et al. 2005). An extract improved the effect of *Crotalus* antivemon in rats when administered concomitantly (Floriano et al. 2009).
Because of the uncertainty about the species described by Seemann the historical information is of limited value for the particular species *M. guaco*. However, the genus *Mikania* has widely been investigated with considerable success.

3.3. Schultesia stenophylla Mart. (syn. S. guainensis (Aubl.) Malme)(Gentianaceae)

In his diary, Seemann noted that *Schultesia stenophylla* Mart. (now *S. guainensis* (Aubl.) Malme) was successfully used against fever in Panama. It is said that dried plants could be found in every house (Seemann 1847-1857, fol. 15r). The botanist writes that he sent a species sample to Kew; it is, however, not recorded in the botanical garden's herbarium database and therefore the species determination could not be verified. Seeman also noted that *S. stenophylla* could be substituted by "*Eustoma exaltatum* Griesb., also called Canchalagua by the natives", an assignment presenting some taxonomically uncertainties (for the rather complicated *Eustoma* taxonomical history see Turner 2014). Some questions about plant identity are also raised as Seemann later assigned the vernacular name "Canchalagua" to *S. stenophylla* and *S. heterophylla* which, however, could not be verified in the napralert database (www.napralert.org): "Both of these Schultesias are called Canchalagua by the natives, and are used as febrifuges; the name Chanchalagua [!], probably derived from the Quichua language, is applied by the Spanish Americans to several other Gentianae" (Seemann 1952/1854, p. 169).
Schultesia stenophylla Mart. (now *S. guainensis* (Aubl.) Malme) has hardly been investigated regarding its medicinal virtues but is well known as a plant poisonous for cattle in Brazil affecting the digestive tract (Nobrega et al. 1988; Hubinger Tokarnia et al. 1994, 2002). Hubinger Tokarnia et al. (1994) calculated a lethal dose of 30 g/kg for cattle and but later (2002) classify the plant as "causing experimental poisoning but of unclean [sic!] practical importance". Monte et al. (2001) confirmed medicinal uses as a "tonic" and antipyretic and isolated an otherwise unknown alkaloid. Nobrega et al. (1998) had already isolated and characterised a new xanthone derivative along with the alkaloids gentianine, gentiocrucine, and gentianidine, well known from other Gentianaceae species. They may, however, be formed during the extraction procedure as terpenoid reaction products (Nobrega et al. 1988). Spencer at al. (1947) could not find antimalarial activity of a whole plant methanolic extract, but found some activity of the ethanolic extract of S. *lisianthoides*, a related species.
Nevertheless, the case of *Schultesia guainensis* shows a large gap between the rather enthusiastic report given by Seeman and the *status quo* of phytopharmaceutical knowledge, as only few phytochemical and almost no pharmacologic studies have been conducted so far. Thus, *S. guainensis* may be worth to be further investigated in ethnopharmacological surveys and eventually pharmacological trials, mainly in view of the reported antipyretic (antimalarial?) activity. The same is the case for *Eustoma* sp.

3.4. Calophyllum inophyllum L.

From his later journey to the Fiji islands, Seemann sent a sample of oil and fruit of *Calophyllum inophyllum*, also called "Dilo", arriving at Kew May 2, 1861 (Kew 1955-1861). The samples are listed in the economic botany collection's database (Catalogue number 66531) but have obviously been lost. The description says that it should be "a sovereign remedy for rheumatism in Polynesia". Another entry (Catalogue number 66748) says "oil used for rheumatism, sprains and bruises". *Calophyllum* has also been described and praised as a liniment in Seemann's "Flora Vitiensis" (Seemann 1865-1873, p. 12), where the author stated: "The most valuable oil produced in Fiji is that extracted from the seeds of this tree, the dilo of the natives [...]. But the great reputation this oil enjoys throughout Polynesia and the East Indies rests upon its medicinal properties, as a liniment in rheumatism, pains in the joints, and bruises. Its efficacy in this respect can hardly been exaggerated, and recommends it to the attention of European practitioners."
Indeed *Calophyllum inophyllum* oil has been confirmed to have significant anti-inflammatory and several other activities. Lim (2012) who reviewed properties und medicinal uses of the plant, considered the anti-inflammatory activity to be significant and related to the 4-phenyl coumarin calophyllolide and several xanthones contained. Tsai et al. (2012) reported anti-inflammatory activity of an acetone leave extract. The extract markedly suppressed lipopolysaccharide-induced production of nitric oxide, as well as the expression of iNOS, cyclooxygenase-2 and nuclear factor-kappaB. Other properties of different plant extracts described were antiviral, anticancer, antiplatelet, antimicrobial, would healing, central nervous system depressant, antiulcer, molluscicidal, stable fly repellant and UV protective activities (Lim 2012; Sundur et al. 2014). Coumarins from *C. inophyllum* oil also show activity against HIV (Spino et al. 1998).
Obviously, Seemann's opinion about the anti-infammatory effects of *C. inophyllyum* seed oil has been supported by recent phytochemical and pharmacological studies. Several parts of the plant, however, exert significant toxicity, so Lim (2012, p.15) stated that the "plant is a virulent poison including the mature fruit and seed kernel. The milky juice caused blindness when brought in contact with the eyes and the sap, when brought into the circulation, causes death and is therefore used by the Samoans as an arrow poison."

3.5. Further medicinal plants described in Seemann's correspondence

There are some more species mentioned by Seemann as having medicinal properties, but being hard to identify. Similar to the case of "guaco", Seemann mentioned a plant with vernacular name of "Culantrillo" (Kew Directors Correspondence DC 70, p. 304, January 20, 1848, Seemann to Sir William Hooker) which may include several totally different species, most of them belonging to the genus *Adiantum* (www.napralert.org). Seemann, however, regarded the species to be *Anemia seemannii*, which is somewhat unlikely as it is not among the plants usually called "Culantrillo". William Hooker had named the fern in honour of Seemann, who assigned gynaecological indications to it: "The women take it after delivery. They also employ it to produce premature birth." However, what species Seemann actually collected, remains unclear.

The same is the case with "a new *Cypripedium*, perhaps the first discovered within the tropics"; he sent roots to Hooker, which he were said to be used "by the natives as a purgative" (Kew Directors Correspondence DC 70, p. 308, November 20, 1847, Seemann to Sir William Hooker). Unfortunately, neither the exact species nor the plant part used is given. It is, however, interesting to note that roots of *Cypripedium calceolus pubescens* (Willd.) Correll are known in traditional medicine for a variety of activities including diarrhea and dysentery (Singh and Suggal 2009). Antidiarrheal action is the oldest reported indication for orchids in general dating back to Disokurides' times. In Early Modern herbals, they were also said to "strengthen the stomach" (Kreutzer 1988, p. 51).

3.6. Medicinal plants solely mentioned

In an account on the "Flora of the Isthmus of Panama" (Seemann 1852/1854, pp. 67-68), Seemann gives a list of medicinal plants arranged by indications without further discussing them. This list does contain a couple of plants not mentioned in the handwritten correspondence (see Table). It is evident that some of the plants listed were scientifically investigated very well while others were not. This is reflected by the number of entries in the PubMed database ranging from zero to several hundreds, what may serve as a rough estimation about the degree of investigation. The gives some examples for confirmed medicinal uses of extracts or single components which are most often considerably different from the rough and very broad indications given by Seemann. In some cases, however, the ethnomedicinal uses reported could be substantiated. This is the case with some plants listed as being used against "cutaneous disorders" like *Byrsonima crassifiolia* which has been shown to improve wound healing and to act against dermatitis and topical fungal infections. Anti-dermatophytic and anti-inflammatory activities have also been confirmed for *Jacaranda filicifolia,* belonging to a genus identified as a promising research object: "The pharmaceutical potential of this genus has been underestimated and deserves closer attention" (Gachet and Schühly 2009). This may hold true for several other species listed in the Table, as in some cases a considerable gap between ethnopharmacological reporting and recent research could be identified. Many of the species have never been seriously investigated at all, like *Trixis inula*, *Waltheria glomerata* or *Gonophlebium attenuatum*, some were, but not in terms of their traditional indications. So, for example, *(Pseudo)elephantopus spicatus* is listed as febrifuge, but has never been investigated against malaria.

4. Discussion

As still a great deal of drugs are natural products or more or less strongly related to nature (Newman and Cragg 2012), investigations of the traditional uses of medicinal plants may show the way for the development of phytopharmaceuticals or the identification of lead structures from their constituents. This kind of "reverse pharmacology" approach was assumed to accelerate the development of clinical drug candidates (Patwardhan and Vaidya 2010) and has recently proven to be successful in the case of an anti-malarial preparation (Graz et al. 2010; Simoes-Pires et al. 2014). As has already been proposed more than 20 years ago, historical research may be able to considerably contribute to the exploration of traditional knowledge about medicinal plants, as "the mass screening of plants in the search for new drugs is vastly expensive and inefficient" and "it would be cheaper and perhaps more productive to re-examine plant remedies described in ancient and medievel texts" (Holland 1994). In the meanwhile, promising attempts have been made investigating Byzantine texts (Lardos et al. 2011; Lardos and Heinrich 2013), Early Modern herbals (Adams et al. 2007, 2009, 2011, 2012), and writings of Christian missionaries (Anagnostou 2005, 2015).

It has been hypothesised here that the correspondence of botanical explorers, which were sent out from Europe throughout the world in the 18th to early 20th century might also serve as a valuable source of information in the development of phytopharmaceuticals and drug candidates of natural origin. As a first example, we investigated the correspondence of Berthold Seemann (1825–1871) who travelled to Middle and South America as well as to Polynesia to explore the indigenous flora. He published several books and communicated intensely with Kew Gardens London, a leading centre of botanical research at least in the 19th century. It could be shown here that Seemann's writings, largely kept at Kew Gardens archives, do contain relevant ethnopharmaceutical information, although his primary interest was, of course, devoted to botany. So several medicinal plants are mentioned in his publications, while a few (*Simaba cedron, Mikania guaco, Schultesia guainensis, Calophyllum inophyllum*) are described in more detail, particularly in his diaries and letters. These were presented in this study and Seemann's reports were compared to state-of-the-art knowledge in order to disclose potential for further research. It could be shown that several uses reported by the botanist could be confirmed or rendered plausible in more recent scientific studies. This includes the anti-malarial activity of *Simaba cedron* preparations, the anti-inflammatory properties of *Calophyllum inophyllum* oil, or the activities of *Jacaranda filicifolia* and *Byrsonima crassifolia* against cutaneous diseases. Reported activities of *S. cedron* and *Guaco* preparations against animal bites might be explained by some anti-inflammatory activities of the plants and their constituents. This confirmation of Seemann's reports suggests a considerable reliability of his writings. An obvious gap between Seemann's description and study results was detected for *Schultesia stenophylla* Mart. (syn. *S. guainensis* (Aubl.) Malme), *Trixis inula* Crantz, *Waltheria glomerata* Presl., *Gonophlebium attenuatum* (Humb. & Bonpl. Es Willd) C. Presl, *Pseudoelephantopus spicatus* (Juss ex Aubl.) C.F. Baker and others. In these cases, there are only a few phytochemical reports but hardly any pharmacological, animal, or clinical studies which offers potential for further research.

A similar approach has recently been followed by Fagg et al. (2015) who investigated a manuscript about Brazilian plants authored by George Gardner (1812-1849) and also kept in Kew Gardens archives. The authors found that "fewer than 50% of the species which Gardner recorded to be useful have been investigated in detail through published laboratory studies, yet all of those thus far examined have had their traditional uses to some extend confirmed". Roughly estimated we could confirm this and conclude that historical investigations into the heritage of 19th century botanists like Gardner, Seemann, and many others may serve as a promising strategy for guiding phytopharmaceutical research. It has to be admitted that the species mentioned in the Gardner list are significantly different from those described by Seemann, although the flora of Panama and Brazil should be somewhat similar. They have only two entries in common, *Jatropha mollissima* (= *gossypifolia*) and *Argemone mexicana*.

There have been attempts to estimate the reliability of ethnopharmaceutical reports. Heinrich (2000) proposed that "culturally important plants are those that are used by a large number of healers preferably for the same category of indigenous use, while plants that are cited as useful by only one or two informants are considered to be of low cultural importance". This is also the background for the quantitative algorithm suggested by Trotter and Logan (1986) and discussed by Heinrich (2000). It is impossible to judge, how many single reports Seemann

Table: Medicinal plants mentioned by Seemann (1852/1854) and recent studies about their activities

Vernacular Names	Botanical names	Medicinal values (examples from recent studies)[a]	No. of PubMed entries (March 2015)
Febrifuges			
Chicoria	*Elephantopus spicatus* Juss. [Syn. *Pseudoelephantopus spicatus* (Juss. ex Aubl.) C.F. Baker]	Anti-inflammatory (Tsai and Lin 1999) and hepatoprotective activity (Lin et al. 1995) of a preparation containing crude drug Moderate hepatoprotective activity (Lin et al. 1991) Moderate antifungal activity of a cadinanolide contained (Ragasa and Rideout 2001)	7
Corpachi	Croton.	n.a.[c]	
Guavito amargo	*Quassia amara* L.	Antimalarial activity of aqueous preparations and compounds contained, in particular simalikalactone D (Bertani et al. 2005, 2006, 2007, 2012; Cachet el al. 2009) Activity of a topical *Q. amara* gel against seborrheic dermatitis (Diehl and Ferrari 2013) Activity of a methanolic stem bark extract against gastric ulcers (Raji and Oleyede 2011; García-Barrantes and Badilla 2011) Anti-diabetic extract of a methanol exract (Husain et al. 2011)	42
Cedron	*Simaba cedron* Planch.	See text	6
Canchalayunas [i.e. Canchalagua]*	Several Gentianaceae	n.a.[c]	
Purgatives			
Nino muerto		n.a.[c]	
Malcasada	*Asclepias curassavica* L.	*In vitro* cytotoxicity of calotropin (Kupchan et al. 1964), cardenolides (Li et al. 2009; Zhang et al. 2014) and an whole plant extract (Baskar et al. 2012) Thrombin like activity of the latex (Shivaprasad et al. 2009) Antifungal activity of latex saps (Moulin-Traffort et al. 1990)	32
Frijolillo[b, e]	*Cossia* [i.e. *Cassia*] *occidentalis* L.	Anthelminthic activity of an ethanolic extract (Kundu et al. 2014) Anti-inflammatory activity of an ethyl acetate extract (Patel et al. 2014) Anti-allergic activity of whole plant ethanolic extract (Sreejith et al. 2010) Anti-diabetic activity of ethanolic extract (Verma et al. 2010) Anti-malarial activity of root bark extracts (Tona et al. 2001)	80
Canafistola de purgar[b]	*Cossia* [i.e. *Cassia*] *fistula* L.	Emulsion active against constipation (Mozaffarpur et al. 2012) Antibacterial activity of organic extracts (Seyyednejad et al. 2014) Antifungal activity of seed extract (Jothy et al. 2012) and oil (Irshad et al. 2013) Antidiabetic activity of different flower extracts (Jarald et al. 2013) Acaricidal activity of ethanolic leaf extract (Sunil et al. 2013) Anti-ulcer activity of ethanolic leaf extract (Karthikeyan and Gobianand 2010) Wound healing activity of alcoholic leaf extract (Senthil Kumar et al. 2006)	109
Laureno	*Cossia* [i.e. *Cassia*] *alata* L.	Laxative effect of leaf infusion containing anthraquinones (Thamlikitkul et al. 1990) Anthelminthic activity of ethanolic leaf extract (Kundu et al. 2012, 2014) Anti-inflammatory activity of leaf extract (Moriyama et al. 2003; Levy and Lewis 2011a; Sagnia et al. 2014), of component cassiaindoline (Villasenor and Sanchez 2009) Antidiabetic effects through alpha-glucosidase inhibition (Varghese et al. 2013) *In vitro* cytotoxicity of leaf extract against A549 lung cancer (Levy and Lewis 2011b) or several other cell lines (Olarte et al. 2013)	60
Javilla	*Hura crepitans*	Antileishmanial activity of an alcoholic extract (Garcia et al. 2012) Activity against hair loss (Uchiyama et al. 2012)	20

Table: *(Continued)*

Vernacular Names	Botanical names	Medicinal values (examples from recent studies)[a]	No. of PubMed entries (March 2015)
Coquillo[b]	*Jatropha curcas*	Anti-inflammatory activity of isolated compounds (Othmann et al. 2015) Moderate antimicrobial activity of ethyl acetate extract (Rampadarath et al. 2014), leaf extract (Rahman et al. 2014; Dada et al. 2014) Anti-oxidant activity of lignans contained (Li et al. 2014) Anti-malarial activity of different extracts (Abiodun et al. 2011) and a multi-component decoction containing *J. curcas* (Ankrha et al. 2003) Insulin sensitizing activity (Rau et al. 2006) Various properties (Thomas et al. 2008)	469[d]
Emetics			
Garriba de Pena	*Begonia sp.*	n.a.[c]	
Freilecillo[e]	*Jatropha gossypifolia* L.	Molluscicidal activity of latex, leaves and stem bark (Yadav and Singh 2014) Cytotoxicity of ethanolic extract against MCF-7 (Engel et al. 2014) Anti-fertility effects of leaf extracts in rats (Jain et al. 2013) Analgesic, neuropharmacological and anti-diarrheal properties of methanolic fruit extracts (Apu et al. 2012) Anti-cancer activity of a diterpenoid contained (Falodun et al. 2012) Internal organs wound healing (ethanolic extract: Aquino et al. 2006; Servin et al. 2006)	36
Vulneraries			
Chiriqui	*Trixis frutescens* [Syn. *Trixis inula* Crantz]		0
Guazimillo, Palo del soldado	*Waltheria glomerata* Presl.	Diuretic? (Esposito-Avella et al. 1985)	0
Cope chico de suelo	*Clusia* sp.	n.a.[c]	
Anti-syphilitics			
Cordo santo	*Argemone mexicana*	Activity against several cancer cell lines (Tariq et al. 2015) Anti-epileptic activity of ethanolic extract (Asuntha et al. 2015) Antimalarial activity of decoction (Graz et al. 2010; Willcox 2011; Simoes-Pires et al. 2014) Larvicide against *Aedes aegypti* (Warikoo and Kumar 2013) Various properties (Rubio-Pina and Vazquez-Flota 2013) Hepatoprotective effect of an aqueous extract (Das et al. 2009)	87
Zarzaparilla[b]	*Smilax* sp.	n.a.[c]	
Cabeza del negro	*Disocorea* sp.	n.a.[c]	
Calahuala	*Goniophlebium attenuatum* (Humb. & Bonpl. ex Willd.) C. Presl *[Syn. Serpocaulon attenuatum*]		0
Doradilla de palo	*Goniophlebium* Swartz	n.a.[c]	
Antidotes for snake-bites			
Guaco[b]	*Mikania guaco* H.B.K. stem and leaves	See text	3
Cedron	*Simaba cedron* seeds	See text	6
Cutaneous diseases			
Palo de Buba	*Jacaranda filicifolia* Don bark	Lipoxygenase inhibitory effect of a fatty acid ester contained (Ali and Houghton 1999) Antifungal activity of a dichloromethane extract against dermatophytes (Ali et al. 1998)	1
Nanci	*Byrsonima continifolia* [i.e. *crassifiolia* Kunth] H.B.K.	Hexane seed extract accelerates diabetic wound healing (Pérez Gutiérrez and Muñiz Ramirez 2013)	31

Table: *(Continued)*

Vernacular Names	Botanical names	Medicinal values (examples from recent studies)[a]	No. of PubMed entries (March 2015)
		Antifungal activity of aqueous extracts against dermatophytes (Cáceres et al. 1991, 1993) Effects of different extracts on experimental dermatitis (Maldini et al. 2009) Anti-inflammatory activity of an hexane extract (Muniz Ramirez et al. 2013) Antimicrobial effects of organic root and stem extracts (Martínez-Vázquez et al. 1999) Anti-depressant effect of flavonoids containes (Herrera-Ruiz et al. 2011)	
Malva[b]	*Malachra capitata L.*	Weak antiviral activity of an ethanolic extract against foot and mouth disease virus (Chungsamarnyart et al. 2007) Anti-ulcerogenic effect of an aqueous extract (Pratyusha et al. 2012) Anti-epileptic activity of an aqueous extract (Gopi et al. 2012)	0

[a] Preferentially, recent clinical studies are quoted, if not available it is referred to studies about pharmacological properties of components. Reports of predominantly phytochemical nature are not listed. [b] Assignment to botanical name confirmed in NAPRALERT database. [c] not applicable as exact species not given or not identifiable [d] Although listed in the PubMed database, most articles refer to the non-medical but technical usefulness of the plant. [e] Assignment to botanical name confirmed by Gupta et al. (1979)

received before he regarded an information as reliable. As a botanist just peripherically interested in medicinal uses, he did certainly not do systematic research and most probably did not carefully judge the actual significance of his observations. It may, however, be assumed that medicinal plants he discussed in detail were actually used rather broadly.

In general, it is a great challenge to doubtlessly identify the species described in historical writings, which is also admitted by Fagg et al. (2015). They were able to verify most of the entries by actual herbal material which was not possible in our study. However, cutting edge botanists of the 19th century like Seemann were highly familiar with botanical classification and should usually have known what exactly they were talking about. Nevertheless, as shown above, some of Seemann's descriptions are leaving considerable room for interpretation, for example regarding the true nature of "guaco", "culantrillo", "canchalagua", and *Cypripedium*. Another problem to be addressed is the uncertainty about the plant parts traditionally used and the preparation methods of traditional remedies. Seemann usually did not go into detail, apart from describing the use of Cedron seeds in an ethanol/water mixture, i.e. brandy. All this makes it difficult to set up a valid experimental design for clinical studies. Despite all the limitations discussed, it could be proven that the heritage of Berthold Seemann as a typical botanist of the 19th century may serve as a somehow reliable source of ethnomedicinal information. It seems therefore promising to further evaluate his publications, diaries and correspondence as well as those of other botanists, having been, at least in part, interested in ethnopharmacological traditions of the plants they harvested. In the study presented here, some candidates for further research could already been suggested, like *Schultesia stenophylla* Mart. (syn. *S. guainensis* (Aubl.) Malme), *Trixis inula* Crantz, *Waltheria glomerata* Presl., *Gonophlebium attenuatum* (Humb. & Bonpl. Es Willd) C. Presl, or *Pseudoelephantopus spicatus* (Juss ex Aubl.) C.F. Baker. In a first step, additional ethnopharmacological sources should be consulted to clarify terminology and further verify Seemann's observations. In case of phytochemical, pharmacological or clinical trials, traditional modes of preparation and plant parts traditionally used need to be seriously considered in experimental and study designs.

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