Medical Ethnobotany, Phytochemistry, and Bioactivity of the Ferns of Moorea, French Polynesia

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Abstract: The purpose of this paper is to create a resource for the future scientific study of the medical ethnobotany and bioactivity of pteridophytes on Moorea, French Polynesia. Pteridophytes comprise a small fraction of the Moorean pharmacopoeia; however they are a highly abundant resource on this tropical island. Compiled here are all the relevant data available on phytochemistry, bioactivity and medical ethnobotany of all the genera present on Moorea. Included are data collected in interviews with Moorean healers and elders collected in 2005.

INTRODUCTION

Tahitian Medicine

Tahitian medicine, in its present form, is a combination of herbal remedies and activities to address demonic and divine influence. Ideas about sickness causation were developed before the introduction of European diseases and medicines. In the early Polynesian model, illness is the result of either apparent external forces, such as in warfare injuries and childbirth, or supernatural beings (Whistler 1992, pg.16).

Causation is of supreme importance in western medicine and it is a physician's goal to identify the source of illness and address this malfunction. However, Tahitian medicine, because diagnosis of internal ailments can be difficult from outside the body, is more treatment-focused. Multiple treatments, often from multiple healers, will be tried until the person is cured. The treatment that works will delineate what kind of illness the person must have been suffering from (Whistler 1992, pg. 84).

The use of herbs in ancient Polynesia was limited to the treatment of infants, cuts and wounds, purgatives, and the creation of putrid smelling potions to drive away spirits. Because the ancient herbal medicine was directed towards children, most of the healers were women and this is still true today, though the patient population has expanded (Whistler 1992, pg. 17). In present times, the pharmacopoeia has greatly expanded to address growing health concerns. While most healers rely on recipes passed down from the previous generation (or from dreams), some healers actually experiment with new herbs (Whistler 1992, pg. 75).

Tahitian healers today do not take money for their services and still consider their abilities to be passed down from God. Each healer has her own recipes, which are not readily shared, and she is usually a specialist in certain treatments (Personal communication 2005). Many treatments in Tahitian medicine involve a purgative agent because of the belief that the cause of sickness is the accumulation of some bodily contaminant. Cleansing the body with a purgative is thus a common solution (Whistler 1992, pg. 86).

Pteridophytes of Moorea

Currently there are 83 species of ferns that grow on Moorea, an island that, for its small diameter, represents a diverse range of habitats from sea level littoral zones to high mountain cloud forests. Tahiti, only 14.5 km away, hosts roughly 200 pteridophyte species mostly due to the higher elevations found on Tahiti- 2300 m compared to 1207 m on Moorea (Murdock and Smith 2003).

Due to the isolation and volcanic origin of Moorea, like other islands in the archipelago, the floral composition is completely dependent on introductions, whether they are natural or human aided. This pattern of colonization will lead to over-representation of certain taxa that are capable of making the great journey from the continents. The overrepresentation of pteridophytes on Moorea is striking. Of the 459 species of monocots, dicots, gymnosperms and pteridophytes present on the island, about 18% are ferns and fern allies (Moorea Digital Flora Project).

Most of the fern species present on Moorea are found throughout Polynesia and other tropical areas. Only eight species are considered endemic to the Society Islands, and eleven more occur in Polynesia and Fiji alone. Other species range from Moorea to India, Southeast Asia, Australia and Micronesia. Because Moorea is a geologically young island, very close to Tahiti, a larger more diverse island, and because of the wind patterns in the southern Pacific it is not surprising that Moorea has such overlaps of flora and has no endemic species of it own (Murdock and Smith 2003).

With a traditional healing system that is actively searching and expanding its pharmacopoeia in order to treat a growing number and range of complaints, an environment with great floral diversity, and the danger of traditional knowledge slipping

away unlearned by a new generation of healers documentation of this information is needed. The scientific and traditional communities need a resource where data on the ethnobotany as well as the phytochemistry and bioactivity of all of these pteridophyte species are collated. With all of this information in one source, future studies of these pteridophytes can be more efficient and directed. This paper attempts to create this comprehensive tool including data for all species of ferns known to grown on Moorea; for each species the known uses worldwide are reported, as well as tested bioactivity and phytochemistry.

METHODS

On Site Interviews

In order to assess the local use of Pteridophytes in medicine interviews were conducted on Moorea, French Polynesia in the fall of 2005. Two healers (Rita You-Sing and Mama Lucie), along with three elders (Papa Matarau, Papa Mehai, and Papa Mape) were elders were interviewed. They were shown a selection of pteridophytes and asked: 1) *Can you identify this plant? What is its Tahitian name?*, 2) *Is this plant used for medicine?* Rita You-Sing was asked about 20 ferns while the other informants were asked only about 12 different species. The informants were also asked whether they used, or knew of uses for, any other ferns in traditional medicine.

Healers and elders were also questioned regarding their use and knowledge of medicine specifically for women and children. Mama Lucie was not asked about her knowledge in this area because she was reluctant to speak of her specific remedies, and was pressed for time. This gathered information stands independently from the

investigation of pteridophyte use specifically as it includes treatments lacking fern components.

Literature Review

A comprehensive search was conducted using databases available through the University of California system. BIOSIS, PubMed, Google Scholar, and book Databases were searched for all relevant materials using species names as well as genus names. Much of the material found using the different search engines and databases was redundant suggesting that each search was relatively thorough. No databases that scanned grey literature were used. Articles in languages other than English and lacking abstracts in English were not included. These are additional sources of information that could be accessed in the future.

RESULTS

Interviews: Pteridophyte Use

Communication between healers in French Polynesia is very scant because of their isolation, and also because of the belief that certain recipes will only work for the healers who "own" them (Whistler 1992). However, local healers in Moorea often refer to Paul Petard's book Plantes Utiles de Polynesie Raau Tahiti for information on the medicinal uses of plants. When interviewed about the use of pteridophytes in Tahitian medicine, Rita You Sing, Mama Lucie, and the group of elders all consulted this reference (Personal communication 2005). Thus, the need for a complete and up to date

resource is apparent. A resource that can be circulated and updated more frequently, perhaps a newsletter, would be ideal.

Rita You-Sing identified twelve of the twenty ferns presented as being used only in decorations. She only used two ferns, *Davallia solida* and *Microsorum grossum*, in her medicines. However, she suggested that two others, *Asplenium caudatum* and *Antrophyum plantagineum*, might have been used by other healers (Baltrushes 2005).

Mama Lucie was only asked about 12 ferns, eight of which (*Microsorum grossum, Davallia solida, Nephrolepis hirsutula, Microsorum commutatum, Lycopodiella cernua, Bolbitis lonchophora, Asplenium caudatum,* and *Dicranopteris linearis*) she uses or has used in medicines. Mama Lucie, a well-respected healer on Moorea, experiments with new recipes and herbs on herself, and then incorporates the effective plants into her prescriptions (Personal communication 2005). This may explain the high proportion of ferns she reports using, compared to Rita You-Sing. It is in this way, though, that the pharmacopoeia expands. The group of three elders knew medicinal uses for five of the 12 species questioned about (Baltrushes 2005). See the Appendix for tabulated uses from these healers and elders.

Interviews: Women and Children's Health

In regards to women's health concerns, the three elders spoke of the importance of preventative medicine. For example, in order to prevent yeast infections later in life, girls are given specific medicines just after birth. The elders explained that there are three preventative medicines ("Ira," "He'a," and "Tui"), and each treatment is aligned in a

different manner with the "moon cycle" to prevent different ailments (Personal communication 2005).

Some preventative treatments, they explain, start when the child is still in the womb. A pregnant woman will see a healer from the beginning of pregnancy, and this healer will make different teas and medicines for the woman to drink. When the baby is born, regardless of its sex, it is bathed in a medicinal tea to cleanse it and the mother is given a medicine to drink in order to cleanse her body as well (Personal communication 2005). These elders, though not healers themselves, demonstrated a wide knowledge of their culture's traditional medicine. This demonstrates the vital role as culture keepers and preservers that these important community figures play.

Rita You-Sing, a Moorean healer, knew and used many treatments for women's health concerns. She explained that women have more health concerns in the present compared to the past because in the past women had only one sexual partner, but now they have multiple and infections are passed more widely. Also, she suggested that the use of tampons has increased infections. As a treatment for yeast infections, You-Sing uses a mixture of plants, including green coconut juice, which is cooked for 1.5 hours, filtered, and drunk hot. This tea is drunk a cup a day until it is used up cleansing the infection from the inside of the body. This same recipe can be drunk to cleanse a woman directly after she gives birth (Personal communication 2005).

To treat an itchy rash in the groin, the seeds of Miro, *Thespesia populnea*, are mashed and put on the rash along with Ti, *Cordyline fruticosa*, leaves. As an interesting side note, when the seeds of Miro are dried they are used as a febrifuge (Personal Communication 2005).

The Menstrual cycle can be the source of pain and emotional trauma for women everywhere. To ease "hard and painful" periods (dysmennorhea), a recipe of guava and lemon leaves is combined in two liters of water and boiled down to one liter of tea. A full liter of tea must be drunk every day for three days. This is a treatment that is easily and often prepared by Tahitian women themselves without healers. However for an irregular period, a healer will provide a medicine ("Raou hea Opitapu), which must be drunk hot in order to "push out" the menstrual blood (Personal Communication 2005).

An interesting treatment for menstrual related back pain involves Hotu, *Barringtonia asiatica*. This plant, which is used otherwise as an antiseptic in Tahiti (Whistler 1992), is grated and put into a large clamshell. The clamshell is then heated in the coals of a fire and placed on the back to ease pain (Personal Communication 2005). Perhaps it is the heat of the clamshell that provides the pain relief in this treatment, however the hotu seeds may play some additive roll.

Finally in the treatment of infants, You-Sing spoke of cleansing baths. A cleansing bath with mango leaves will help to soothe an excited baby, suffering form an "Ira" ailment. Further, to calm a baby he/she may be massaged in a bath with "Tahitian oil" (Personal Communication 2005).

DISCUSSION*:* Literature Review

Pteridophyte Ethnobotany: Women's Health

Women's health focuses on conditions that are particular to women and childbearing. These issues are separated from general health concerns in many cultures

possibly because of the taboo and rituals often associated with the menstrual cycle. Also a woman's health, and thus her ability to bear healthy progeny, is vitally important to the maintenance of a group.

Table 1 outlines the pteridophytes used in the maintenance of women's health in French Polynesia, including the use of the Pteridophytes present on Moorea in other locales around the world. Four different pteridophytes, *Microsorum grossum, Microsorum commutatum, Ophioglossum reticulatum*, and *Davallia solida*, are used in the treatment of women's health concerns in French Polynesia. *Microsorum grossum* is by the far the most prevalent pteridophyte used: out of the seven ailments treated with pteridophytes in French Polynesia, *Microsorum grossum* is used in five (Grepin and Grepin 1994, Petard 1972).

Complaints about (and irregularities in) a woman's menstrual cycle are some of the issues addressed with Tahitian medicine. One of three remedies for Amenorrhea, the absence of menstruation, utilizes a pteridophyte (*Microsorum grossum*). Whereas, both remedies for dysmenorrhea, painful menstruation, entail a hot drink steeped with the pteridophyte *Microsorum commutatum* (Petard 1972). However, out of the four formulas collected in Tahiti by Grepin and Grepin for treating dysmenorrhea, only one formula uses pteridophytes (*Davallia solida and Microsorum grossum*) (1994). This variation is surely a result of time of collection and the informant healers consulted. Nonetheless, pteridophytes play a part in easing the menstrual cycle for Tahitian women.

Beyond menstruation, pregnancy and childbirth are other realms of critical care. In order to maintain a healthy pregnancy and prevent abortion, Tahitian healers might prescribe a pregnant woman a cold drink, called "Raau Haamau Tamarii." Three recipes

are recorded for this remedy, two of which employ *Microsorum grossum* (metuapuaa) and *Davallia solida* (tiatiamoua) rhizomes in conjunction (Petard 1972). Overall, Grepin and Grepin cite the use of pteridophytes in seven of the 20 collected remedies for various gynecological and obstetric concerns (1994).

Thirteen of the pteridophytes growing on Moorea, though they are not recorded as medicinal in this locale, are used by people elsewhere in the world to treat women's complaints, and *Microsorum grossum* is used both in Tahitian medicine and abroad. For example, Tahitian healers use a combination of ground sugar cane, *M. grossum,* and *Gardenia tahitensis* in the treatment of sterility (Petard 1972). *Microsorum grossum* is also used in Fiji for post-partum care and strengthening (Cambie and Ash 1994).

Based on the uses of these ferns world wide, studies could be tailored to illuminate the possible bioactivity of these plants. An overlap in the use of a species or genera from locale to locale would more strongly suggest the presence of a specific active agent. This sort of overlap is not seen in these treatments; however, this may be the result of differing access to plants, different traditions of use, or different times of introduction of plant.

Pteridophyte Ethnobotany: Children and Infant's health

Treatments for children are separated from the rest of Tahitian medicine, and for these only three different pteridophytes (*Microsorum grossum, Davallia solida and Ophioglossum reticulatum*) are used. See Table 2 for listings of ailments and pteridophyte remedies. *Ophioglossum reticulatum* and *M. grossum* are both recorded by Arthur Whistler primarily for their purgative value (1992). Their use in treatment of multiple ailments may attest to the importance Tahitians place on cleansing the body of

harmful agents (Whistler 1992). *Microsorum grossum* (metuapuaa) is used in treatments for adults and infants; however the manner of use differs. One healer, Rita You-Sing of Moorea, explained that for infants metuapuaa is used in cleansing baths but not made into potions to be drunk because the "poison is very strong" (Personal communication 2005).

Davallia solida is not reported to have these purgative properties, however it is often used in conjunction with *M. grossum*, and perhaps it has synergistic or enhancing effects in this combination. Rita You-Sing reported using *Davallia solida* leaves in the treatment of "Ira" ailments in infants. "Ira" and "He'a" ailments are a "number of poorly defined ailments or symptoms affecting infants" (Whistler 1992). When a newly born baby wakes in the night excited, shivering, and unable to sleep a bath is prepared. *Davallia solida* leaves are boiled in water, and the baby is bathed in this cooled tea until calmed (Personal communication 2005).

Three of the pteridophyte species present on Moorea are used only outside of French Polynesia: *Blechnum orientale, Microsorum membranifolium, and Sphenomeris chinensis*. There is no overlap between species and ailment addressed between locales.

Pteridophyte Ethnobotany: Men's Health

Male specific health concerns, listed in Appendix Table 3, are not abundantly addressed in Tahitian medicine. In Tahiti, testicular pain is the only concern addressed with pteridophyte remedies. This is perhaps a result of the fact that most healers are women and perhaps do not address male specific concerns (Whistler 1993). However, it is probably more likely the result of the fact that male specific health concerns are generally less numerous than female specific concerns. Only three ailments worldwide

are addressed with species of pteridophytes that occur on Moorea: spermatorrhea, testicular pain, and impotence. Also, most of the health issues men face can also affect women and so they would be classified as general health concerns and are discussed in the following section.

Pteridophyte Ethnobotany: General Health

Eleven different pteridophytes, see Appendix Table 4, are used in treatment the of general health concerns in Tahitian medicine. Four of these eleven are of an unspecified use. *Microsorum grossum* is used in 24 treatments; *Davallia solida* is used in 14, *Ophioglossum reticulatum* in 9*, Microsorum commutatum* in 3 and *Asplenium australasicum, Nephrolepis hirsutula, and Psilotum nudum* in one treatment each. Use of the following ferns was reported but not specified in detail: *Bolbitis lonchophora, Lycopodiella cernua, Dicranopteris linearis, and Angiopteris evecta*.

Some pteridophytes are identified as having particular properties- astringency, purgative, febrifuge, painkiller and antibacterial. These ferns might then be incorporated into a variety of treatments. These function specific pteridophytes appear in Table 5.

The use of *Microsorum grossum* in the treatment of ailments ranging from gonorrhea, to tuberculosis and fractures, as well as in a general health tonic, is surprising at first glance. Whistler cites *M. grossum (*and *Ophioglossum reticulatum* for that matter) for its possible purgative properties, and this would explain its use as a panacea. The cause of many ailments is considered by Tahitians to be the contamination of the body by physical or spiritual agents (Whistler1992). Thus the use of a purgative, which cleanses the body, would indeed be quite important in any healing process.

In other medicinal systems that utilize ferns present on Moorea, *Microsorum grossum* does not dominate the pharmacopoeia, appearing in just 15 treatments. The ferns that grow on Moorea, including *M. grossum*, are used in the treatment of general health concerns in many other parts of the world ranging from India, to China, to Meghalaya and Fiji. Forty-seven species in 24 genera, though unused in Tahitian medicine, are used elsewhere.

Similarities in the use of a pteridophyte species or genera between locales and cultures may support the presence of specific active compounds in these plants, which may be useful for scientists interested in finding cures for specific ailments. Here some patterns can be seen in the remedies to several complaints. For example, in the treatment of headaches, *Angiopteris evecta* is used in both Yap and Meghalaya (Defilipps et al 1988, Gogoi 2002). Also in the treatment of headache, *Microsorum grossum* is used in Moorea and Palau (Personal communication 2005, Defilipps et al 1988). In the treatment of cough, *Microsorum grossum* is used in both Tahiti and Rotuma (Grepin and Grepin 1984, McClatchey 1993). And, in the treatment of asthma *Davallia solida* is used in two places: Tahiti and Fiji (Grepin and Grepin 1984, Cambie and Ash 1994).

For boils and blisters as well as in the treatment of fractures and sprains, *M. grossum* is used in Tahiti and *M. membranifolium*, is used in Fiji (Petard 1972, Cambie and Ash 1994). For badly bleeding wounds *M. grossum* is used in Tahiti and Rotuma (Grepin and Grepin 1984, McClatchey 1993).

The small number of overlaps (only six) between medicinal plant and ailment treated in different locales may be surprising from a purely biological perspective. This could suggest that the plants do not actually have specific activity and thus are

interchanged. However, it is also probably a result of differences in availability of plant resources, and the traditional and religious components of medicine that differ greatly between locales. Collection of medical ethnobotanical information from different cultures could illuminate more fully these patterns in plant use, and help to focus scientific research.

It would be inefficient to analyze plants at random for their medicinal properties. Working in concert with traditional healers can help scientists be more efficient, and development of medicines from isolated compounds, so long as the relationship between healer informant and scientist is a cooperative and not an exploitative one, can be beneficial for all.

Bioactivity of Pteridophyte Genera present on Moorea

Species in seventeen of the genera present on Moorea have exhibited medicinal bioactivity in experiments (see Table 6 for details). Nine species of *Selaginella* represented here have shown bioactivity, however, no studies have been performed on the one *Selaginella* species, *Selaginella banskii*, which can be found on Moorea. Four of the nine tested have cytotoxic activity, while the other exhibit antiviral, anti-inflammatory, antifungal, antimicrobial, and antioxidant properties (Silva et al 1995, Sun et al 1997, Lin et al 2000, Lee et al 1999, Woo et al 2005, Chen et l 2005, Ma et al 2003). Two *Selaginella* species show an inhibitory effect on muscle contraction (Rojas et al 1999, Perez et al 1994).

Six species of *Pteris* have been tested for bioactivity thus far, but the two *Pteris* species that live on Moorea have not been tested. Two of the six tested have shown

cytotoxic activity. *Pteris semipinnata* has demonstrated anti-tumor activity in two separate investigations (Li et al 1998, Li et al 1999). The other *Pteris* species have anti-mutagenic, immunomodulatory, and neuronal activity (Wu et al 2005, Lee and Lin 1988, Goldberg and Cooper, 1975).

Pteris vittata has carcinogenic activity, (Siman et al 2000) and provides an example of a secondary compound that is actually harmful to animals. Medicinal compounds often have the potential to be harmful, thus it is not surprising that a genus would have both dangerous and medicinal plants. *Christella* ferns, by this reasoning deserve some attention as well because of the tested carcinogenic activity of one species, *Christella dentata* (Somvanshi and Sharma, 2005). Perhaps other species in this genus have medicinal properties (at least at some dosages) instead of harmful effects.

Lycopodium species have shown antiacetylcholinesterase activity in two separate experiments (Hirasawa et al 2006, Zhang et al 2002). *Lycopodiella cernua*, the single lycophyte present on Moorea, is antivirally active and has been patented as a treatment for Hayfever (Zhang et al 2002, Cambie and Ash 1994).

Out of all the species present on Moorea, only eight have been tested for bioactivity in published studies. An additional six (*A. australasicum, A. plantagineum, L. reticulatum, B. lonchophora*, *M. commutatum,* and *L. cernua*) exhibited cytotoxic activity in a brine shrimp lethality assay, and one (*Microsorum grossum*) exhibited antifungal properties in experiments conducted at the Gump Research Station on Moorea. Differences between cytotoxicity of root and leaf extracts and ethanol and water extracts were found in the cytotoxicity experiments suggesting a diversity of compounds within the pteridophytes (Baltrushes 2005). It is interesting to note that, other than in the

unpublished data mentioned, *Microsorum grossum*, the most well known medicinal fern in Tahiti, has not been tested for bioactivity.

Cancer treatments are an area of much scientific and medical interest. Perhaps it is no surprise that the genera that have been tested the most for bioactivity are those where cytotoxicity has been found in some of the species. With simple bioassays, such as the brine shrimp lethality assay, cytotoxicity is simple to assess in the field and can be an efficient screening tool for possibly useful plant products. These field assays can then be followed by assays using human cancer cells for more refined results. Seven of the species represented here, in three genera, exhibited cytotoxicity. *Selaginella*, as mentioned before has many cytotoxic species and each species with such activity contained biflavonoids (Silva et al 1995, Chen et al 2005, Woo et al 2005, Sun et al 1997). *Pityrogramma calomelanos*, a Moorean, fern, is cytotoxic and contains flavonoids (Star and Mabry 1971, Sukumaran and Kuttan 1991). *Peris semipinnata* and *Pteris multifada* are both cytotoxic, but they contain diterpenes (Li et al 1998, Li et al 1999). These plants have different active compounds but show similar effects. Analysis of the chemical constituents of plants is thus an important tool for identifying useful plants, but without assays it is not sufficient to indicate medicinal usefulness.

Phytochemistry of Pteridophyte Genera Present on Moorea, French Polynesia

The plants for which data have been collected can be split roughly into four different categories: those containing alkaloids, terpenoids, flavonoids, and other compounds. Out of the species for which chemical analyses have been performed, ten contain alkaloids, seven of which contain lycopodium alkaloids (see Table 6 for details).

Alkaloids are a diverse group of compounds and they are known to have a variety of marked effects on animals. Alkaloids often act on the nervous system as stimulators, and sometimes as poisons. Cocaine (which exhibits an anesthetic effect), atropine (which effects motor nerves), and curare (which has been used by South American natives to cause paralysis of prey), are all alkaloids (Kretovich 1966). Certain lycopodium alkaloids, which occur naturally in *Lycopodium* and other pteridophytes, have been investigated for their medicinal properties. Alpha-onocerin and lycoperine A, for example, exhibit acetylcholinesterase inhibition activity (Zhang et al 2002, Hirasawa et al 2003). Huperzine A, a lycopodium alkaloid, isolated from *Huperzia* species among others, has been shown to enhance memory in animals and is also being investigated for treatment of Alzheimer's disease (Ma and Gang 2004).

Terpenoids are the main component of many plant essential oils. This group is based on a single unit, isoprene, and thus monoterpenoid, diterpenoids, and triterpenoids, all differ in the number of isoprene units (Kretovich 1966). Terpenoids are also a very diverse group and the 40 pteridophyte species presented here contain: triterpenoids (hopane triterpenoids, epoxytriterpenoid, and serratene triterpenoid), diterpenoids, hemiterpene glycosides, and clerodane diterpene glycosides. Terpenoids have also been the subject of much study, and many are medicinally significant for a wide range of treatments. For example, triterpenoids isolated from *Erica andevalensis* are cytotoxic against human cancer cell lines (Martin-Cordero et al 2001). Also, terpenoids from *Calendula officinalis* flowers exhibit strong anti-inflammatory activity (Della Loggia 1994). Terpenoids are a very promising class of compounds, and additional studies will only add to the useful knowledge already collected.

Flavonoids are a third class of compound represented in these pteridophytes; 25 of the 48 species presented here contain flavonoids. Flavonoids, like alkaloids and terpenoids, are a diverse group. Only a fraction of flavonoid subdivisions are represented in these pteridophytes: biflavonoids, homoflavonoids, flavone glycosides, and flavonol glycosides. Many flavonoids have medicinal properties. Amentoflavone and ginkgetin, flavonoids found in *Selaginella*, exhibit neuroprotective activity against cytotoxic stressors. This property suggests their possible use in treatment of neurodegenerative diseases such as stroke and Alzheimer's (Kang et al 2005). Another flavonoid, mangiferin (found in *Trichomanes reniforme*), shows antiviral and anti-tumor effects in mice. Mangiferin enhances the immune system's natural ability to kill cancer cells and also shows inhibitory effect on HIV (Guha et al 1996).

The final category of plants is comprised of ferns from which compounds other than terpenoids, flavonoids, or alkaloids have been isolated thus far. There are only three species that fit into this category. From these plants benzophenones, ent-pimarene type glycosides, and lactone glycosides are the compounds identified. Perhaps the most interesting is the benzophenone that has been isolated in *Davallia solida* (Rancon et al 2001). Benzophenones bind to P-glycoproteins, which are efflux transporters in the body. Thus benzophenones are involved in the P-glycoprotein removal of harmful substances from the body (Thews et al 2006). *Davallia solida*, thus, may act in the detoxification function of the body.

The compounds present in the genera of pteridophytes on Moorea are numerous and varied. However, chemical composition data exists for only 19 of the 53 genera present, and only 9 of the 83 species of pteridophytes on Moorea have been analyzed.

Surely it is inefficient to do chemical analyses of every plant, so collecting traditional knowledge can help direct efforts. Quick and inexpensive bioassays can be used on suggested species and their close relatives. Chemical analysis can then be used after possibly useful plants have been identified.

CONCLUSION

The search for novel and bioactive compounds in plants is a promising endeavor. When 60% of the world's population relies on plants for their medical care, and with a booming world population, there is no doubt that these plants are effective and need to be used more efficiently (Harvey 2000). There are many approaches to such investigations and perhaps the most efficient is an ethnobotanical and ethnopharmacological one. Collecting and using traditional knowledge can curtail time-consuming and often fruitless phytochemical analyses and bioassays. Traditional knowledge will not be useful for identifying all possibly potent plant products because some conditions such as heart disease are complex and somewhat opaque to non-western systems. However, as nicely summarized by Cox (1994):

> "ethnopharmacological information can be used to provide three levels of resolution in the search for new drugs: (1) as a general indicator of non-specific bioactivity suitable for a panel of broad screens; (2) as an indicator of specific bioactivity suitable for particular high-resolution bioassays; (3) as an indicator of pharmacological activity for which mechanism-based bioassays have yet to be developed."

Presented here is all the available information regarding the ethnobotany, bioactivity, and phytochemistry of the pteridophyte genera present on Moorea, French Polynesia. It is interesting to note that, while most of the species present on Moorea are pantropical, there is only a small overlap in medicinal use. The different cultures that live among these pteridophyte species do not use them in similar ways, for the most part. This could be the result of multiple factors. Perhaps traditional medicinal knowledge of certain pteridophytes has been lost with the marginalizing of traditional medicine practice. Thus the pharmacopoeia has shrunk over the years. On the other hand, perhaps the differences are a result of an incomplete exploration of the pharmacopoeia in each locale. Perhaps, given more time and need for new medicine, different traditional pharmacopeias would become more and more similar as healers experimented more. Once a plant is found to be useful to treat dangerous ailments, a healer is not compelled to continue searching. However, with new diseases bombarding these traditionally isolated communities there will be a growing need for innovation in traditional medicine.

Future research in the medical ethnobotany and bioactivity of these pteridophytes appears promising, especially with respect to *Christella dentata*, and *Selaginella banskii* both of which have shown interesting bioactivity results. Using this reference, scientists and students can be more efficient and successful in project design and implementation. However, it is important, above all, that the scientific community reciprocates the cooperation sought from traditional healers in the search for bioactivity. Exploitation of traditional knowledge is far too easy and scientists must be kept aware of the potential uses of their apparently unbiased research. An integrative approach to medicinal research must be adopted and maintained. Shaman Pharmaceuticals, a drug company exploring

natural resources through medical ethnobotany coupled with scientific research, has set a good example by emphasizing the necessity for having agreements with the countries and people from whom knowledge is sought before commencing research. This company strives to preserve the "biocultural" diversity of the communities they cooperate with by training local scientists, providing immediate assistance to the communities (improving infrastructure, providing health education etc.), and by helping to preserve the biological resources that they study (King et al 1996). Moorean healers have expressed an interest in being part of this coalition, and they enter empowered by local Non-Governmental Organizations such as "Te Pu 'Atiti'a," an organization devoted to the preservation of Moorean traditional knowledge and the natural environment. However, despite this, there was still some reluctance to share information about recipes and treatments (Baltrushes 2005). A forum must be built where knowledge is shared safely and fairly for the mutual benefit of all people using Tahitian Medicine and for those studying it.

APPENDIX

Table 1. Medicinal uses of the pteridophytes present on Moorea, French Polynesia in the maintenance of women's health.

Ailment	Pteridophyte Treatment used in Tahiti	Pteridophytes used in Treatments in other locales
Sterility	*Microsorum grossum* (Petard 1972)	*Dicranopteris linearis*-India (Vasudeva 1999)
Menstrual Disorders:		*Lygodium reticulatum* and *Nephrolepis exaltata*- Fiji (Cambie and Ash 1994) *Tectaria circutaria* – India (Dhiman 1998)
Amenorrhea	*Microsorum grossum* rhizomes (Petard 1972)	
Dysmennorrhea	*Microsorum commutatum* (Petard 1972) *Microsorum grossum, Davallia solida* (Grepin and Grepin 1984)	*Lygodium flexuosum*- India (Dhiman 1998)
Pregnancy-promote healthy pregnancy	*Microsorum grossum, Davallia solida* (Petard 1972)	*Acrostichum aureum* –Fiji (Cambie and Ash 1994)
Birth-aid in parturition		*Pteris tripartite, Nephrolepis exaltata*- Fiji (Cambie and Ash 1994)
Post-Partum care/strengthening		*Microsorum grossum* and *Microsorum membranifolium* –Fiji (Cambie and Ash 1994)
Uterine hemorrhage	*Davallia solida* (Petard 1972, Grepin and Grepin1984) *Microsorum grossum* (Grepin and Grepin 1984) *Ophioglossum reticulatum* (Petard 1972)	
Contraception		*Asplenium nidus* – Vanuatu (Bourdy et. al 1996) *Nephrolepis cordifolia, Adiantum lunulatum*- India (sterility) (Dhiman 1998) *Lygodium reticulatum* –Fiji (Cambie and Ash 1994)
Leucorrhea	*Ophioglossum reticulatum* or *Microsoum grossum, Davallia solida* (Petard 1972, Grepin and Grepin 1984)	
Gonorrhea	*Microsorum grossum* (Petard 1972)	

Table 2. Medicinal uses of the pteridophytes present on Moorea, French Polynesia in the maintenance of infant and children's health. Notes: Information collected from interviews conducted on Moorea in the fall of 2005 appears listed by specialists' names. Healers interviewed: You-Sing= Rita You-Sing.

Ailment	Pteridophyte Treatment used in Tahiti	Pteridophyte treatments from other locales
Boils: Given to nursing mother to cure boils in infants, given to older children		*Blechnum orientale*- India (Dhiman 1998)
General tonic for invigoration		*Blechnum orientale*-Yap (Defillips et al 1988)
Cleansing bath for newborns	*Davallia solida* (You-Sing 2005)	
Child's purgative	*Ophioglossum reticulatum* (Whistler 1992) *Microsorum grossum* (Petard 1972)	
Septic umbilical cord	*Ophioglossum reticulatum* (Whistler 1992)	
"Ira" and "he'a" ailments	*Ophioglossum reticulatum* (Whistler 1992)	
Child's influenza		*Microsorum membranifolium*-Fiji (Cambie and Ash 1994)
"Tranquilizer"		*Sphenomeris chinensis*- Sarawak (Christensen 1997)

Table 3. Medicinal uses of the pteridophytes present on Moorea, French Polynesia in the maintenance of men's health.

Ailment	Pteridophyte Treatments used in Tahiti	Pteridophyte Treatments used in other locales
Spermatorrhea		*Lygodium flexuosum* –India (Dhiman 1998)
Impotence		*Blechnum orientale*-India (Dhiman 1998) *Lygodium reticulatum* –Fiji (Cambie and Ash 1994)
Testicular pain	*Microsorum grossum* (Grepin and Grepin 1984)	

Table 4. Medicinal uses of the pteridophytes present on Moorea, French Polynesia in the maintenance of general health. Notes: Information collected from interviews conducted on Moorea in the fall of 2005 appears listed by specialists' names. Healers interviewed: Lucie=Mama Lucie, You-Sing= Rita You-Sing. Elders interviewed=Papa Mape, Papa Matarau, Papa Mehai.

Effected system	Ailment/use	Pteridophyte Treatments used in Tahiti	Pteridophyte Treatments used in other locales
Nervous System	Headache/ migraine	*Asplenium australasicum*- Moorea (Elders, Lucie, 2005) *Asplenium australasicum* -(Petard 1986) *Ophioglossum reticulatum* (Whistler 1992) *Microsorum grossum*- Moorea (Lucie, Elders 2005)	*Angiopteris evecta, Lygodium flexuosum*–Meghalaya (Gogoi 2002) *Angiopteris evecta* - Yap (Defilipps et al 1988) *Ophioglossum reticulatum*- India (Vasudeva 1999) *Microsorum grossum* –Palau (Defilipps et al 1988)
	Epilepsy/ seizures		*Diplazium cochleata*-India (Dhiman 1998) *Microsorum grossum* –Rotuma (McClatchey 1993)
Respiratory	Cough		*Marsilea minuta* –India (Dhiman 1998, Vasudeva 1999) *Asplenium caudatum*- India (Vasudeva 1999) and Meghalaya (Gogoi 2002) *Asplenium lunulatum* –India (Reddy et al 2001) *Microsorum grossum* –Rotuma (McClatchey 1993)
	Sinus pains		*Acrostichum aureum* –Fiji (Cambie and Ash 1994)
	Expectorant		*Asplenium adiantum-nigrum Linn., Lygodium flexuosum, Lygodium japonicum, Adiantum venustum, Adiantum capillus-veneris*- India (Vasudeva 1999)
	Sore throat		*Asplenium polyodon* -Fiji (Cambie and Ash 1994) *Davallia solida*-Yap (Defilipps 1988) *Acrostichum aureum* -Fiji (Cambie and Ash 1994)
	Asthma		*Davallia solida* and *Dicranopteris linearis*- Fiji (Cambie and Ash 1994)
	Breathing disorder		*Microsorum grossum*–Fiji (Cambie and Ash 1994)
	Shortness of		*Microsorum mebranifolium* –Fiji

Effected system	Ailment/use	Pteridophyte Treatments used in Tahiti	Pteridophyte Treatments used in other locales
	breath		(Cambie and Ash 1994)
Gastrointestinal System	General		*Blechnum spicant* –India (Vasudeva 1999)
	Vomiting	*Microsorum grossum* (Petard 1972)	
	Emetic		*Adiantum venustum* (Vasudeva 1990)
	Stomachache		*Microsorum membranifolium, Microsorum grossum* - Fiji (Cambie and Ash 1994)
	Indigestion		*Lygodium reticulatum, Dicranopteris linearis* - Fiji (Cambie and Ash 1994) *Ophioglossum pendulum* –Yap (Defilipps 1988)
	Diarrhea		*Nephrolepis hirsutula* – Fiji (Cambie and Ash 1994) *Hymenophyllum denticulatum* – Sarawak (Christensen 1997) *Blechnum spicant* –India (Vasudeva 1999)
	Hemorrhoids (piles)		*Lygodium reticulatum, Dicranopteris linearis* –Fiji (Cambie and Ash 1994) *Adiantum venustum, Lygodium flexuosum* –India (Vasudeva 1999)
	Constipation (laxative, purgative)	*Microsorum grossum* (Petard 1972) *Davallia solida* (Whistler 1992)	*Acrostichum aureum, Psilotum nudum*- Fiji (Cambie and Ash 1994) *Asplenium adiantum-nigrum* –India (Vasudeva)
	Heartburn	*Microsorum grossum* (Petard 1972)	
	Loss of appetite		*Microsorum grossum* –Rotuma (McClatchey 1993)
	Enteritis		*Sphenomeris chinensis* – India (Vasudeva 1999)
	Gastric ulcers		*Dicranopteris linearis* – Fiji (Cambie and Ash 1994)
Renal System	General disorder		*Nephrolepis cordifolia* – India (Dhiman 1998)
	Diuretic		*Asplenium adiantum-nigrum, Diplazium dilatatum, Adiantum capillus-veneris, Adiantum venustum* -India (Vasudeva 1999) *Selaginella bryopteris* –India (Dhiman 1998)
Urinary system			
	Bed-wetting		*Microsorum grossum, Angiopteris evecta* –Yap/Palau (Defilipps 1988)
Liver System	General disorder		*Nephrolepis cordifolia* –India (Dhiman 1998)

Effected system	Ailment/use	Pteridophyte Treatments used in Tahiti	Pteridophyte Treatments used in other locales
	Jaundice		*Lygodium flexuosum* –India (Dhiman 1998) *Asplenium adiantum-negrum* (Vasudeva 1999)
	Liver cancer	*Microsorum grossum* (Petard 1972)	
Skin	General disorder		*Lygodium flexuosum* –India (Dhiman 1998) *Microsorum grossum* –Rotuma (McClatchey 1993) *Nephrolepis cordifolia* –India (Dhiman 1998)
	Blisters/ Boils/ Abscesses/ Sores	*Microsorum grossum* (Petard 1972)	*Lygodium reticulatum* –Fiji (Cambie and Ash 1994) *Microsorum membranifolium, Angiopteris evecta* –Fiji (Cambie and Ash 1994) *Nephrolepis biserrata* –Sarawak (Christensen 1997) *Blechnum orientale* –Sarawak (Christensen 1997) and –Malaysia (Fasihuddin et al 2003)
	Wounds-	*Microsorum grossum* (Petard 1972) *Nephrolepis hirsutula* – Moorea (Lucie, Elders)	*Christella parasitica* –Meghalaya (Gogoi 2002) *Lygodium flexuosum, Adiantum venustum* -India (Vasudeva 1999) *Acrostichum aureum* –Yap (Defilipps 1988) *Ophioglossum vulgatum* –India (Vasudeva 1999)
	Wounds- blood clotting		*Selaginella ciliaris* –Manipur (Singh 2001) *Blechnum orientale*- Meghalaya (Gogoi 2002) *Microsorum grossum* –Rotuma (McClatchey 1993)
	Abraded skin		*Lycopodiella cernua* –Fiji (Cambie and Ash 1994)
	Stings and bites		*Diplazium cochleata* – India (Dhiman 1998) *Trichomanes elegans* –Colombia (Nunez et al 2004) *Lygodium pinnatifidum* –India (Dhiman 1998) *Ophioglossum reticulatum, Asplenium nidus*-Yap/Palau (Defilipps 1988) *Microsorum grossum* –Rotuma (McClatchey 1993) *Adiantum venustum* –India (Vasudeva 1999)

Effected system	Ailment/use	Pteridophyte Treatments used in Tahiti	Pteridophyte Treatments used in other locales
	Eczema		*Lygodium flexuosum*- India (Vasudeva 1999)
Musculo-Skeletal system			
	Fractures/ Sprains	*Davallia solida, Microsorum grossum*– Moorea (Elders 2005) *Microsorum grossum* (Whistler 1992, Petard 1972)	*Microsorum membranifolium, Lygodium reticulatum* –Fiji (Cambie and Ash 1994)
	Muscle cramps		*Microsorum membranifolium* –Fiji (Cambie and Ash 1994)
	Sprain muscles		*Microsorum membranifolium, Lygodium reticulatum* –Fiji (Cambie and Ash 1994) *Lygodium flexuosum* –India (Vasudeva 1999)
	Rheumatism		*Diplazium cochleata* –India (Dhiman 1998) *Lycopodiella cernua* –Fiji (Cambie and Ash 1994) *Lygodium flexuosum* –India (Vasudeva 1999)
	Convulsions		*Dicranopteris linearis* –Fiji (Cambie and Ash 1994)
	Arthritis		*Microsorum grossum* –Fiji (Cambie and Ash 1994)
Reproductive System			
	Gonorrhea	*Microsorum grossum* (Petard 1972)	*Lygodium flexuosum* -India (Vasudeva 1999) *Selaginella bryopteris* –India (Dhiman 1998)
	Herpes		*Adiantum incisum* –India (Dhiman 1998) Lygodium japonicum –Nepal (Taylor et al 1996)
Dental			
	Dental pain		*Psilotum nudum* –Fiji (Cambie and Ash 1994) *Microlepia scaberula* –Hawaii/Fiji (McClatchey 1993)
Ocular			
	Eye disease		*Marsilea minuta* –India (Dhiman 1998) *Microsorum grossum* –Rotuma (McClatchey 1993)

Effected system	Ailment/use	Pteridophyte Treatments used in Tahiti	Pteridophyte Treatments used in other locales
Blood/Whole body infection			
	Ciguatera/ Fish poisoning		*Davallia solida* –New Caledonia (Benoit 2000) *Microsorum grossum, Microsorum membranifolium* –Fiji (Cambie and Ash 1994)
	Ptomaine poisoning		*Angiopteris evecta, Microsorum grossum* –Yap/Palau (Defilipps 1988)
	Worms (anthelmintic treatments)	*Microsorum grossum* (Petard 1972)	*Blechnum orientale, Tectaria polymorpha, Dicranopteris linearis* –India (Vasudeva 1999)
	Elephantiasis		*Acrostichum aureum* –Fiji (Cambie and Ash 1994)
	Fungoid ulcer		*Lycopodiella cernua* –Fiji (Cambie and Ash 1994)
	Leprosy		*Diplazium cochleata* –India (Dhiman 1998)
	Scabies		*Lygodium flexuosum* –India (Vasudeva 1999)
	Lice		*Asplenium nidus* –Manipur (Singh 2001)
	Blood disorder		*Huperzia serrata* –China (Zangara 2003) *Tectaria circutaria* –India (Dhiman 1998)
	Malaria		*Hymenophyllum denticulatum* – Sarawak (Christensen 1997)
	Cancer/ Sarcoma		*Angiopteris evecta* –Yap/Palau (Defilipps 1988) *Microsorum grossum* –Yap (Defilipps 1988) *Pteris polyphylla* –China (Lee 1988)

Table 5. Pteridophytes globally identified as having specific properties, which may then be used to address multiple disease conditions. Notes: Information collected from interviews conducted on Moorea in the fall of 2005 appears listed by specialists' names. Healers interviewed: Lucie=Mama Lucie, You-Sing= Rita You-Sing. Elders interviewed=Papa Mape, Papa Matarau, Papa Mehai.

Treatment	Pteridophyte Treatments used in Tahiti	Pteridophyte Treatments used in other locales
Febrifuge		*Huperzia serrata* –China (Zangara 2003) *Acrostichum aureum, Asplenium tenerum* –Fiji (Cambie and Ash 1994) *Adiantum capillus-veneris, Adiantum caudatum* –India (Vasudeva 1999) *Adiantum caudatum, Lygodium japonicum* –Meghalaya (Gogoi 2002)
Antibacterial	*Microsorum grossum* (Whistler 1992)	*Davallia solida, Lygodium reticulatum* –Fiji (Cambie and Ash 1994) *Dicranopteris linearis*-India (Vasudeva 1999)
Anti-inflammatory	*Microsorum grossum* (Whistler 1992)	*Huperzia serrata*- China (Zangara 2003) *Selaginella bryopteris* –India (Dhiman 1998)
Pain killer	*Psilotum nudum* (Whistler 1992)	*Lygodium flexuosum* –Meghalaya (Gogoi 2002) *Adiantum ceneatum* –Brazil (Bresciani et al 2003)
Chest pain		*Asplenium nidus* –Meghalaya (Gogoi 2002) *Acrostichum aureum* –Fiji (Cambie and Ash 1994) *Microlepia scaberula* –Rotuma (McClatchey 1993)
Appendicitis pain		*Dicranopteris linearis* –Fiji (Cambie and Ash 1994)
Breast pain		*Lygodium microphyllum*-Sarawak (Christensen 1997)
Astringent		*Pteris ensiformis* –Manipur (Singh 2001) *Adiantum capillus-veneris* –India (Vasudeva 1999)
General Health tonic		*Diplazium esculentum* –India (Dhiman 1998, Vasudeva 1999)

Treatment	Pteridophyte Treatments used in Tahiti	Pteridophyte Treatments used in other locales
Unspecified use	*Microsorum commutatum* – Moorea (Lucie, Elders 2005) *Bolbitis lonchophora- Moorea* (Lucie 2005) *Dicranopteris linearis- Moorea* (Lucie, Elders 2005) *Lycopodiella cernua*- Moorea (You-Sing, Lucie 2005) *Angiopteris evecta- Moorea* (Elders 2005)	*Psilotum nudum* –India (Jha et al 2003) *Microsorum punctatum* –India (Irudayaraj and Jeyanath 1999) *Nephrolepis hirsutula* –Indonesia (Jafarsidik and Sutomo 1986) *Marattia fraxinea* –Tanzania (de Boer et al 2005) *Selaginella labordei* –China (Chen et al 2005) *Selaginella pallescens* –Mexico (Rojas et al 1999) *Selaginella tamarascina* –China (Yin et al 2005)

Table 6. Phytochemistry and Tested Bioactivity of the Pteridophyte genera present on Moorea, French Polynesia.

Genus	Species	Compounds Present	Tested activity
Asplenium	*A. bulbiferum*.	Antioxidant flavonoids: kaempferol glucosides. (Cambie and Ferguson 2003)	
	A. foreziense, A. fontanum subsp. fontanum and subsp. pseudofontanum, A. obovatum subsp. obovatum var. obovatum and var. protobillotii, A. obovatum subsp. lanceolatum, and A. incisum	Flavonol glycosides: kaempferol 3-O-gentiobioside. (Iwashina et al 2000)	
	A. normale, its two varieties, var. boreale and var. shimurae, and related species, A. oligophlebium.	Flavone glycosides: apigenin 7-O-dirhamnoside and 7-O-glucosylrhamnoside, luteolin 7-O-dirhamnoside and 7-O-glucosylrhamnoside, genkwanin 4'-O-glucosylrhamnoside, and vicenin-2, genkwanin 4'-O-glycoside and 6,8-di-C-glycosylluteolin. (Iwashina et al 1990)	
	A. tenerum	Flavone-C-glycoside: Lucenin-2 (Umikalsom and Harborne 1991)	
Davallia	*D. solida*	4-O-beta-D-glucopyranosyl-2,6,4'-trihydroxybenzophenone. (Rancon et al 2001) Triterpenoids: 19alpha-hydroxyfernene and 19alpha-hydroxy-filic-30ene, cyanogenic leaves (Cambie and Ash 1994)	Inhibit the spontaneous action potentials ciguatera toxin causes, decrease excitability of myelinated axons (CTX-1B) (Benoit et al 2000)
Microlepia	*M. marginata*	Ent-pimarene glycosides: 2 beta,15(R),16-trihydroxy-ent-pimar-7-en-3-one (fumotoshidin A) and 3 alpha-alpha-L-arabinofuranosyloxy-15(R),16-dihydroxy-ent-pimar+++-7-ene (fumotoshidin arabinoside) (Wada et al 1994)	
Diplazium	*D. subsinuatum*	Hopane-triterpene, lactone glycosides (Inatomi et al 2000)	

Genus	Species	Compounds Present	Tested activity
Dicranopteris	*D. linearis*	Clerodane diterpene glycoside: (6S,13S)-6-[6-O-acetyl-beta-D-glucopyranosyl-(1-->4)-alpha-L-rhamnopy - ranosyloxy]-13-[alpha-L-rhamnopyranosyl-(1-->4)-beta-D-fucopyra nosyloxy]-cleroda-3,14-diene (Raja et al 1995) Flavonoids: afzelin, quercitrin, isoquercitrin, astragarin, isoquercitrin, rutin, kaempferol 3-O-(4-O-p-coumaroyl-3-O-alpha-L-rhamnopyranosyl)-alpha-L-rhamn opy ranosyl- (1-->6)-beta-D-glucopyranoside (Raja et al 1995) Triterpenoids: (11)-fernene other: Beta-stosterol, heptacosane, noncosane, 10-nonacosanone, 10-noncosanol (Cambie and Ash 1994)	
	D. pedata	Clerodane diterpene glycosides: (6S,13S)-6-[6-O-acetyl-beta-D-glucopyranosyl-(1-->4)-alpha-L-rhamnopy - ranosyloxy]-13-[alpha-L-rhamnopyranosyl-(1-->4)-beta-D-fucopyra nosyloxy]-cleroda-3,14-diene Flavonoids: afzelin, quercitrin (Raja et al 1995)	
Hymenophyllum	*H. barbatum*	Hemiterpene glycosides: hymenosides A-J (Toyota et al 2002)	
Trichomanes	*T. elegans*		Neutralizing the defibrinating effect of snake (*Bothrops asper*) venom in Colombia (Nunez et al 2004)

Genus	Species	Compounds Present	Tested activity
	T. reniforme	Clerodane diterpene Glycosides: 3,4-dihydroxyphenethyl alcohol 4-O-caffeoyl-beta-D-allopyranoside, (6S,13S)-13-beta-D-fucopyranosyloxy-6-(beta-D-fucopyranosyl -(1-->2)-[beta-D-fucopyranosyl-(1-->4)-alpha-L-rhamnopyranosyloxy]) -cleroda-3,14-diene, (6S,13S)-13-beta-D-fucopyranosyloxy-6-(beta-D-quinovopyranosyl -(1-->2)-[beta-D-fucopyranosyl-(1-->4)-alpha-L-rhamnopyranosyloxy])-cleroda-3,14-diene, (6S,13S)-13-alpha-L-arabinopyranosyloxy-6-(beta-D-fucopyranosyl-(1 -->2)-[beta-D-fucopyranosyl-(1-->4)-alpha-L-rhamnopyranosyloxy])-cleroda-3,14-diene and (6S,13S)-13-alpha-L-arabinopyranosyloxy-6-(beta-D-quinovopyrano syl-(1-->2)-[beta-D-fucopyranosyl-(1-->4)-alpha-L-rhamnopy ranosyloxy])-cleroda-3,14-diene Flavonoid: mangiferin, 6'-O-acetylmangiferin (Wada et al 1995)	
Sphenomeris	*S. chinensis*		Antibacterial activity against Bacillis cereus and Rhizoctonia solani (Sengupta et al 2002)
Huperzia	*H. selago*	Lycopodium Alkaloids: huperzine A, Selagoline, serratidine (Staerk et al 2004)	
	H. saururus	Lycopodium Alkaloids: sauroxine, 6-hydroxylycopodine, N-acetyllycodine, lycopodine, lycodine, N-methyllycodine, and clavolonine (Ortega et al 2004)	
	H. miyoshiana	Lycopodium alkaloids: miyoshianines A and B, lycopodine, lycodoline, 12-epilycodoline, clavolonine, and flabelliformine (Tong et al 2003)	

Genus	Species	Compounds Present	Tested activity
Huperzia	*H. serrata*	Alkaloids: Huperzine A and B (Wang et al 2006) Huperzine R (Tan et al 2002), 8 beta-hydroxy phlegmariurine B (Yuan and Zhao 2003) Serratene-type triterpenoids: 21alpha-hydroxyserrat-14-en-3beta-yl p-dihydrocoumarate, 21alpha-hydroxyserrat-14-en-3beta-yl dihydrocaffeate, 21alpha-hydroxyserrat-14-en-3beta-yl propanedioic acid monoester, 3alpha,21alpha-dihydroxyserrat-14-en-24-oic acid, 16-oxo-3alpha,21beta-dihydroxyserrat-14-en-24-al, 16-oxo-3alpha,21beta-dihydroxyserrat-14-en-24-oic acid , and 16-oxo-21beta-hydroxyserrat-14-en-3alpha-yl acetate (Zhou et al 2003) Epoxytriterpenoids: 14 beta,15 beta-epoxy-3 beta-hydroxyserratan-21 beta-ol, 14 beta,15 beta-epoxy-3 beta-hydroxyserratan-21alpha-ol, and 14 beta,15 beta-epoxy-3 beta-hydroxyserratan-21alpha-ol-3 beta-O-acetate (Zhou et al 2003)	Reversible inhibitor of Acetylycholinesterase , Neuroprotective and possible treatment for Alzheimer's, improved "cognitive function and the quality of life" (Zangara 2003)
Lycopodiella	*L. phlegmaria*	Serratane-type triterpene: lycophlegmarin (Shi et al 2005)	
	L. hamiltonii	Lycopodium alkaloid: lycoperine A (Hirasawa et al 2006)	Acetylcholinesterase inhibitor (Hirasawa et al 2006)
	L. inundatum	Lycopodium alkaloids: lycopodatines A, B, and C (Morita et al 2005)	
	L. sieboldii	Lycopodium Alkaloid: Sieboldine A (Hirasawa et al 2003)	

Genus	Species	Compounds Present	Tested activity
Lycopodiella	*L. cernua*	Lycopodium alkaloids: cernuine, lycocernuine, dihydroxydeoxycernuine, lycopodine, nicotine, flavone C-glycosides, phenolic acids (Cambie and Ash 1994) Serratene triterpenes: 3beta,14alpha,15alpha,21beta,29-pentahydroxyserratane-24-oic acid (lycernuic acid C, 1), 3beta,14alpha,15alpha,21beta-tetrahydroxyserratane-24-oic acid (lycernuic acid D, 2), 3beta,14beta,21beta-trihydroxyserratane-24-oic acid (lycernuic acid E, 3), 3beta,21beta,29-trihydroxy-16-oxoserrat-14-en-24-methyl ester (lycernuic ketone A, 4), 3alpha,21beta,29-trihydroxy-16-oxoserrat-14-en-24-methyl ester (lycernuic ketone B, 5), 3alpha,21beta,24-trihydroxyserrat-14-en-16-one (lycernuic ketone C, 6), 3beta,21beta-dihydroxyserrat-14-en-24-oic acid (lycernuic acid A, 7), 3beta,21beta,29-trihydroxyserrat-14-en-24-oic acid (lycernuic acid B, 8), serrat-14-en-3beta,21beta-diol (9), and serrat-14-en-3beta,21alpha-diol (10) apigenin-4'-O-(2' ',6' '-di-O-p-coumaroyl)-beta-D-glucopyranoside (11). (Zhang et al 2002)	Extract patented for Hayfever treatment (Cambie and Ashe 1994) inhibitory effects against C. albicans secreted aspartic proteases (SAP) (Zhang et al 2002)
Angiopteris	*A. evecta*	di-C-glycosylflavones: violanthin and isoviolanthin (Cambie and Ash 1994)	Treat hyperglycemic effects of diabetes—found to have a hypoglycemic effect on mice (Nguyen 2005)
Marattia	*M. fraxinea*		Anti-fungal/ anti-bacterial activity,(de Boer et al 2005)
Marsilea	*M. minuta*		Reduce cholesterol in gerbils (Gupta et al 2000)
Nephrolepis	*N. acuminata*		Anti-bacterial activity (Jimenez et al 1979)

Genus	Species	Compounds Present	Tested activity
Ophioglossum	*O. petiolatum/ O. reticulatum*	Homoflavonoids: ophioglonin (1), ophioglonin 7-O-beta-D-glucopyranoside (2), ophioglonol (3), ophioglonol prenyl ether (4), ophioglonol 4'-O-beta-D-glucopyranoside (5), and isoophioglonin 7-O-beta-D-glucopyranoside (6), quercetin, luteolin, kaempferol, 3,5,7,3',4'-pentahydroxy-8-prenylflavone, and quercetin 3-O-methyl ether (Lin et al 2005)	
Microsorum	*M. grossum*	Triterpenoids: (22(29)-hopene, 17(21)-hopene, 13(18)-hopene, 9(11)-fernene, 8-fernene, 7-fernene), sterols (Cambie and Ash 1994)	
Pyrrosia	*P. gralla*	Flavonoids: stigmasterol(I), ursolic acid (II), mangiferin(III) (Markham and Andersen 1990)	
	P. lingua		Anti-viral activity against Herpes simplex virus (Zheng 1990)
	P. serpens	Flavonoids: naringenin, neohesperidosides(4) flavonol glycoside, (Markham and Andersen 1990)	
Psilotum	*P. nudum*	Flavonoids: quercetin, kaempferol, amentoflavone, hinokiflavone, vicenin-2 psilotin, 3'-hydroxypsilotin (Cambie and Ash 1994)	
Acrostichum	*A. aureum*	beta-sitosterol, alkaloid, flavonoids, Phenolics (Cambie and Ash 1994) catechins, saponins, tannins (Jesudass et al 2003)	Anti-implantation activity in rats. (Prakash et al 1985) Antimicrobial activity (Cambie and Ash 1994)
Adiantum	*A. ceneatum*	Triterpene: filicene (1) and filicenal (2) (Bresciani et al 2003)	Showed analgesic activity in mice (Bresciani et al 2003)
	A. capillus-veneris	Hopane triterpenoids: 4alpha-hydroxyfilican-3-one and fern-9(11)-en-12beta-ol, and olean-18-en-3-one and olean-12-en-3-one (Nakane et al 2002) beta-sito sterol, stigmasterol and capesterol (Marino et al 1989)	

Genus	Species	Compounds Present	Tested activity
	A. lunuactum	Hopane triterpenoid: 6 alpha-acetoxy-16 beta,22-dihydroxy-3-ketoisohopane, along with the known 3beta,6 alpha,16 beta,22-tetrahydroxyisohopane (mollugogenol A) (Brahmachari and Chatteriee 2002)	
Adiantum	*A. caudatum*	Triterpenoids: 8alpha-hydroxyfernan-25,7beta-olide, 3alpha-hydroxy-4alpha-methoxyfilicane and 19alpha-hydroxyferna-7,9(11)-diene (Tsuzuki et al 2001)	
	A. lunulatum	Triterpenoid: 22,29xi-epoxy-30-norhopane-13beta-ol (1) viz., fern-9(11)-en-6alpha-ol. fern-9(11)-ene, fern-9(11)-en-25-oic acid, fern-9(11)-en-28-ol, filicenol-B, adiantone and oxidation product of fern-9(11)-en-6alpha-ol obtained as 6-oxofern-9(11)-ene (Reddy et al 2001)	Antibacterial activity against S. typhi (gram pos) and P. aeruginosa(gram negative) (Reddy et al 2001)
	A. venustum	Lanostane triterpenic ether: lanost-20(22)-en-3,19-ether, named adiantulanostene ether (Chopra et al 2000) Triterpenoid: 30-normethyl lupane-20-one, 30-normethyl olean-3-one-30 beta-ol and lanost-20(22)-ene-30-ol (Alam et al 2000)	
Pityrogramma	*P. calomelanos*	Flavonoid: 2'6' dihydroxy- 4'4-dimethoxy dihydrochalcone (Sukumaran and Kuttan 1991) 2',6'-dihydroxy-4'-methoxydihydrochalcone (Star and Mabry 1971)	Cytotoxic activity Dalton's lymphoma ascites tumour cells and Ehrlich ascites tumour cells (Sukumaran and Kuttan 1991)
	P. tartarea	Flavonoids: 2',6'-Dihydroxy-4,4'-dimethoxydihydrochalcone, kaempferol 7-methyl ether (rhamnocitrin) and apigenin 7-methyl ether (genkwanin) (Star and Mabry 1971)	
Pteris	*P. ensiformis Burm.*		Immunomodulatory: attenuates inflammatory mediator synthesis of activated macrophages (Wu et al 2005)

Genus	Species	Compounds Present	Tested activity
	P. semipinnata	Diterpenoids: ent-11 alpha-hydroxy-15-oxo-kaur-16-en-19-olic acid (5F) and ent-11 alpha-hydroxy-15-oxo-kaur-16(R) methyl-19-olic acid (4F) (37) the alpha, beta-methylene cyclopentanone moiety, and hydroxy group number and location determine the relative cytotoxicity of these compounds (Li et al 1998)	Cytotoxicity against human tumor cell lines (Li et al 1998, Li et al 1999)
	P. multifida	Diterpene: entkaurane-2 beta, 16 alpha-diol and ent-kaur-16-ene-2 beta, 15 alpha-diol (Woerdenbag et al 1996)	Moderate cytotoxicity to Ehrlich ascites tumour cells (Woerdenbag et al 1996)
	P. vittata		Extract of spores damages DNA-carcinogen (Siman et al 2000)
Pteris	*P. cretica*	Flavone glycoside: Luteolin 8-C-rhamnoside-7-O-rhamnoside (Imperato 1994)	
	P. polyphylla		Moderate antimutagenic activity against benzo[a]pyrene (Lee and Lin 1998)
	P. aquiline		Decreased the maximum rate of rise of the action potential and depolarized the resting potential (Goldberg and Cooper 1975)
Lygodium	*L. reticulatum*		Anti-microbial activity (Cambie and Ash 1994)
	L. japonicum		Anti-androgenic activity (Matsuda et al 2002) antiviral activity against Sindbis virus –no activity against Herpes (Taylor et al 1996)

Genus	Species	Compounds Present	Tested activity
Selaginella	*S. delicatula*	Biflavonoids: robustaflavone 7,4',4'"-trimethyl ether, robustaflavone 4',4'"-dimethyl ether, 2,3-dihydroamentoflavone 7,4',7"-trimethyl ether, 2,3-dihydroamentoflavone 7,4'-dimethyl ether, and 2",3"-dihydroisocryptomerin 7-methyl ether (Chen, Duh, Chen 2005) Biflavonoids: 3,5-di-O-caffeoylquinic acid, 3, 4-di-O-caffeoylquinic acid, and 4,5-di-O-caffeoylquinic acid Lin et al 2000)	Cytotoxicity against Raji and Calu-1 tumor cell lines. (Lin et al 2000) Some cytotoxic activity (Chen, Duh, Chen 2005)
	S. tamarascina	Biflavonoid: Amentoflavone (Woo et al 2005)	Tumoricidal activity against leukemia cell lines, and reduction in tumor growth in epithelial cell tumors (Lee et al 1999) Amentoflavone-anti-fungal and anti-inflammatory activity, inhibits production of NO (Woo et al 2005) vasorelaxant activity found (Yin et al 2005) Treatment of Alloxan induced diabetes-increase serum insulin, lower blood sugar (Miao et al 1996)
	S. labordei		Antioxidant activity (Chen, Plumb et al 2005)
Selaginella	*S. uncinata*	Chromone glycosides: 5-hydroxy-2,6,8-trimethylchromone 7-O-beta-D-glucopyranoside (uncinoside A) and 5-acetoxyl-2,6,8-trimethylchromone 7-O-beta-D-glucopyranoside (uncinoside B) (Ma et al 2003)	Antiviral activity against respiratory syncytial virus (RSV), and moderate antiviral activities against parainfluenza type 3 virus (PIV 3) (Ma et al 2003)
	S. pallescens Spring.		Spasmolytic activity (inhibit spontaneous contractions of ileum), antimicrobial activity- (Rojas et al 1999)
	S. moellendorffii	Biflavonoid: ginkgetin (1) (Sun et al 1997)	Moderate inhibition of human ovarian adenocarcinoma (Sun et al 1997)

Genus	Species	Compounds Present	Tested activity
	S. willdenowii	Biflavonoids: 4',7"-di-O-methylamentoflavone, isocryptomerin and 7"-O-methylrobustaflavone (Silva et al 1995)	Cytotoxicity against human cancer cell lines (Silva et al 1995)
	S. lepidophyla	3-methylenhydroxy-5-methoxy-2,4-dihydroxy tetrahydrofurane (Perez et al 1994)	Inhibit rat uterus contractions (Perez et al 1994)
	S. doederleinii H.		Moderate anti-mutagenic activity (Lee and Lin 1988)
Christella	*C. dentate*		Induce urocystica and adenoma in the urothelium of guinea pig carcinogenic (Somvanshi and Sharma 2005)

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