An ethnobotanical survey of medicinal plants used in the East Sepik province of Papua New Guinea

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Abstract

Background: Rapid modernization in the East Sepik (ES) Province of Papua New Guinea (PNG) is resulting in a decrease in individuals knowledgeable in medicinal plant use. Here we report a synthesis and comparison of traditional medicinal plant use from four ethnically distinct locations in the ES Province and furthermore compare them to two other previous reports of traditional plant use from different provinces of PNG.

Methods: This manuscript is based on an annotated combination of four Traditional Medicines (TM) survey reports generated by University of Papua New Guinea (UPNG) trainees. The surveys utilized a questionnaire titled “Information sheet on traditional herbal preparations and medicinal plants of PNG”, administered in the context of the TM survey project which is supported by WHO, US NIH and PNG governmental health care initiatives and funding. Regional and transregional comparison of medicinal plant utilization was facilitated by using existing plant databases: the UPNG TM Database and the PNG Plant Database (PNG Plants) using Bayesian statistical analysis.

Results: Medicinal plant use between four distinct dialect study areas in the ES Province of PNG showed that only a small fraction of plants had shared use in each area, however usually utilizing different plant parts, being prepared differently and to treat different medical conditions. Several instances of previously unreported medicinal plants could be located. Medicinally under- and over-utilized plants were found both in the regional reports and in a transregional analysis, thus showing that these medicinal utilization frequencies differ between provinces.

Conclusions: Documentation of consistent plant use argues for efficacy and is particularly important since established and effective herbal medicinal interventions are sorely needed in the rural areas of PNG, and unfortunately clinical validation for the same is often lacking. Despite the existence of a large corpus of medical annotation of plants for PNG, previously unknown medical uses of plants can be uncovered. Furthermore, comparisons of medicinal plant utilization is possible if databases are reformatted for consistencies that allow comparisons. A concerted effort in building easily comparable databases could dramatically facilitate ethnopharmacological analysis of the existing plant diversity.

Keywords: Papua New Guinea, East Sepik, Medicinal plants, Bougainville, Eastern highlands, Quantitative ethnopharmacology

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Background

Papua New Guinea (PNG) is a largely rural country characterized by at least 800 ethnic traditions dispersed over 462,840 km² [1, 2]. Most of the population resides in small villages, situated in diverse environs that range from montane rainforest to lowland river deltas and small tropical islands. Settled 49,000–44,000 years ago (Ivane Valley in the PNG Highlands) [3], PNG is blessed with extraordinary biological diversity and a rich but fragmented cultural tapestry of customs, art, spiritual beliefs and medicinal knowledge.

The East Sepik Province is situated in the northwest of the country bordered by the West Sepik Province (West), Madang Province (East), the Bismark Sea (North) and Enga Province (South). East Sepik (43,426 km²) is characterized by mountainous terrain to the south and west and the costal floodplain of the Sepik river, which flows west to east through the province [4]. The approximately 350,000 inhabitants have to rely on 37 health centers for provisioning health care and heavily suplement western medicines with traditional medicines (TM) [4, 5]. The 10 % mortality rate for children under 5 years reflects the difficulty of providing adequate health care in the East Sepik Province. In an effort to supplement health care with effective traditional medicines the University of Papua New Guinea (UPNG), endorsed by the PNG government, struck a collaboration with the WHO to develop reliable traditional medicines (TM) and safe practices (outlined in the 2001–2010 PNG National Health Plan [6]). Part of this project includes traditional medicine surveys performed by UPNG students working in their kinship (“wantok”) communities. The data are then recorded in a proprietary database maintained at UPNG [7]. This database serves as central repository for PNG traditional medicine practices, preserving cultural traditions from many diverse communities.

Methods

The TM surveys are performed by UPNG students who are instructed on plant identification, preservation, herbal medicine use, and trained on how to administer the survey instrument entitled “Information sheet on traditional herbal preparations and medicinal plants of Papua New Guinea.” The survey questionnaire is the basis for semi-structured face-to-face interviews with healers, herbalists, birth attendants, and bone setters. Field vouchers of medicinal plants (twigs with leaves, fruits, flowers, nuts, etc.) are harvested under guidance of the healer and dried and compressed in newspapers. Photographs, descriptions and the pressed plant samples are assigned a voucher number and deposited with the UPNG Herbarium for later identification and reference [8].

The data concerning plant use are written up under supervision into student authored reports and the plant information is entered into the UPNG Traditional Medicines Database, which contains the combined data from reports generated by a decade’s work in this endeavor. It is the student reports that provide the base information for this current report.

Four student reports from the East Sepik Province representing four distinct language dialect communities have been compiled here: “Traditional Medicinal Plants and Practices in the Waskuk Hills Area of Ambunti District in East Sepik (2005)” by Dickson Andrew Kehop; “Traditional Medicine Practices in Niungweko and Kunjingini (MUL) Area of Wosera-Gawi District in East Sepik (2006)” by Boniface Kinminja; “Ethnobotanical Survey of Traditional Medicine in East Yangoru, East Sepik Province, Papua New Guinea” (2004) by Graham Wavimbukie; and “Traditional Medicinal Plants and Practices in Kairiru Island East Sepik Province Papua New Guinea (2004) by Malcolm Sabak The first three reports (DK, BK and GW, respectively) are inland above the Sepik floodplain at elevations ranging from 150 to 300 m. The report from Kairiru Island is referred to as MS. The specific village communities interviewed included: Bangus and Mariawai villages (DK), Niungweko and Mul (Kunjingini 1) villages (BK); Marambanja, Saina, Ambukanja, Parina, Jawia, Mandien, Bukiendoun, Sausenduon, Hangrerak and Kiarivu villages (GW) and Rumlal, Shagur and Bou villages (MS).

A compilation of references for medicinal plants described from Papua New Guinea is currently in progress (50 references) in our lab. These references were used to determine if plants collected in the current East Sepik survey work have been previously reported for medicinal use. Comparison of this East Sepik medicinal plant report to our previous reports from Bougainville [8] and the Eastern Highlands [9] was accomplished after editing the previous two reports to match the current format, including codes for conditions treated.

Overall flora distribution data for PNG was obtained for the provinces of East Sepik, Eastern Highlands, and the autonomous region of Bougainville from the PNG Plants Database [10]. The data was imported into Microsoft Excel®, formatted and edited as necessary, then processed with standard Unix (Linux) utilities to produce a formatted list containing the plant family, genus and species (if known). Duplicated instances of plants in the list were removed. The family names were split off, sorted and processed using a Python script on a Raspberry Pi Model B (http://www.raspberrypi.org) to quantify the number of instances of each plant family cited in the list. In general, when multiple names for the same species were found, we attempted to match plant family names to the PNG Plant Database versions to allow for quantitative comparison. Statistical analysis was carried out exactly as previously described by Weckerle et al. [11] using the
“beta.inv” function provided in Microsoft Excel™ to calculate the 95% inferior and superior credible intervals for the data. Comparison of the currently reported East Sepik medical plants to the Traditional Medicines Plant Database maintained at UPNG was carried out similarly. Discrepancies in plant family names were resolved as described above, the family names were adapted to the family names in the UPNG Traditional Medicines Database; resulting in a slightly different number of plant families for the traditional plant uses reported.

Plant families which are considered overused have an inferior credible interval that lies above the superior credible interval for the regional total data. Plant families that are considered underused have a superior credible interval below the inferior credible interval of the regional total data set distribution.

Results and discussion

East Sepik reports

The combined student reports contained 299 entries (including unidentified plants \( n = 6 \)) from the East Sepik province of PNG. The reports collated 205 plants, of which 139 were identified to species and 66 to genus, from a total of 71 families. Three reports were from areas of estimated 150 m to 300 m elevation (DK, BK and GW voucher numbers), DK from Waskuk Hills in the center of Sepik province, and BK and GW from elevated areas of the province north of the Sepik river plain and southwest of the capital Wewak. One report (MS voucher numbers) came from an island (Kairiru Island) situated close to the coast of East Sepik. The combined dataset is presented in Table 1 for all four areas of the East Sepik province under consideration.

Shared and unique plants

We found a number of plants were reported as used in common amongst these areas. Many plants had many overlaps in use, preparation, and disease (Table 1). However, among the plants identified to species level, only four species were reported in every survey: Alstonia scholaris (L.) R.Br., Cassia alata L., Passiflora foetida L., and Zingiber officianale Roscoe. The number of plants unique to one or another of the four reports was surprisingly large in comparison to the previous reports [8, 9]. A total of 80 genera, of which 29 are identified to genus level and 51 to species level (see Table 2), were not shared between any of the four study areas.

Plant parts utilization, preparation, administration and diseases treated

In general the areas studied were similar in the relative utilization of plant parts (Fig. 1) with leaves predominating followed by bark and sap as next most common (with the exception of GW where roots were more commonly utilized than sap). The MS sample set reported a large number of young shoots/young roots stipulated for use in comparison to the other reports, where “young” was not specifically stipulated. The DK and GW reports only cited use of shoots. Only DK reported the medicinal use of nuts.

The method of preparation (Fig. 2) shows a similar pattern amongst the reports: use of succus (expressed juice) was most commonly reported, followed by decoction and direct application of the raw plant material. Usually direct application meant placing the material on a wound or skin ailment after minimal handling. Similarly all reports contain inhalation of smoke or vapor, heat treatment and cooking prior to utilization. DK reported a much higher frequency of cooking the material than the other areas. Boiling as a method of preparation was only mentioned in the MS and GW reports, while mastication (chewing) was reported in all except MS. Typically heating implies later consumption or preparation of steam for inhalation, however, in the GW report heating is a method to prepare the plant material prior to topical application (labelled HR—Heated-Rubbed). Another mode of preparation was mastication and spitting on the affected area. This was relatively common in the MS report and mentioned in the DK report, but not noted in the the other two areas. Only from the DK report is the reverse utilization of the plants reported, where in one instance Homalium foeti-dum (Roxb.) Benth. was utilized in a reverse-from-expected manner. In this case, the blood of the patient was placed under the bark of the tree with the expected result being a lessening of knee pain and strengthening of bones as the tree grew. This clearly implies a spiritual/magical connection of plant and patient.

The routes of administration for plant based medicines reported by DK, BK and MS were about evenly divided between oral or topical routes (Fig. 3). The exception was the administration practices reported by GW where oral consumption outpaced topical application (3:2 ratio). Inhalation was reported only once for the DK and BK areas, and more frequently in the BW and MS areas. The lone outlier for route of administration was from the DK report in which patient material (blood) was transferred to the plant (as described above).

Ailments treated (Fig. 4) with plant based medicines were categorized into 28 groups, sorted according to the target site, in order to to minimize possibly uncertain medical judgements or clinical misdiagnoses. Many described symptoms can likely accurately be ascribed to their appropriate causative diseases, but in the absence of independent clinical confirmation the decision was made to present the data in as unbiased a way as possible. Therefore, the category of “SKIN” contains both
Table 1: Plants reported as medicinally used in 4 study areas in East Sepik Province

| Voucher   | Plant ID/References | Family           | Local Name | Ailment                                | Ailment Code | Part Code | Prep Code | Route Code |
|-----------|---------------------|------------------|------------|----------------------------------------|--------------|-----------|-----------|------------|
| MS 02/04  | Abellmoschus manihot (L) Medik [32–39] | Malvaceae        | Wasiat     | Uterine contraction                    | REP          | L         | D         | O          |
| GW 05/04  | Acalypha grandis Benth [33, 40]          | Euphorbiaceae    | Unknown    | Antidote to poisoning (Chemical or acid) | POIS         | L         | S         | O          |
| DK 16/05  | Acalypha sp. [7, 33–35, 39–49]          | Euphorbiaceae    | Mikirme    | Malaria                               | MAL          | L         | D         | O          |
| GW 88/04  | Acalypha sp. [7, 33–35, 39–49]          | Euphorbiaceae    | Winghongong | Cough, shortness of breath             | RESP         | Sap       | S         | O          |
| BK 05/06  | Acalypha wilkesiana Müll. Arg [42, 44, 45, 47–49] | Euphorbiaceae    | Polembiere  | Cough, shortness of Breath             | RESP         | L         | D         | O          |
| DK 38/05  | Ageratum conyzoides (L) L [8]           | Asteraceae       | Mungrimb   | Sore                                   | SKIN         | L         | R         | T          |
| GW 56/04  | Aglaia sp. [33, 50, 51]                 | Meliaceae        | Waniembi   | Fevers, malaria                        | FEV/MAL      | L         | B         | I          |
| GW 09/04  | Albizia procera (Roxb.) Benth [34]      | Fabaceae         | He`re      | Malaria, pneumonia, asthma             | MAL/RESP     | B         | S         | I & O      |
| BK 05/06  | Albizia saman (Jacq.) Merr [34, 52]     | Mimosaceae       | Lundumi    | Induce sleep                           | PSYCH        | L         | D         | T          |
| DK 08/05  | Allioptius cobbe (L) Rauesch [8, 42, 51, 53] | Sapindaceae    | Haim       | Scabies                               | SKIN         | B         | C         | O          |
| GW 50/04  | Allioptius cobe (L) Rauesch [8, 42, 51, 53] | Sapindaceae    | Wah        | Skin pox, cough                        | SKIN/RESP    | L         | D         | T          |
| DK 37/05  | Alocasia cucullata (Lour.) G. Don       | Araceae          | Waken      | Boil                                   | SKIN         | Root      | R         | T          |
| MS 07/04  | Alocasia sp. [8, 33–35, 43, 50, 51]     | Araceae          | Waiyat     | Abortion                              | REP          | L         | S         | O          |
| GW 27/04  | Alpinonius incana (Roxb.) Teijsm. & Binn. ex Kurz [33–35, 43, 54] | Rhamnaceae  | Hushu      | Scabies                               | SKIN         | B         | S         | T          |
| GW 24/04  | Alpinia sp. [8, 9, 33, 42, 43, 55–57]   | Zingiberaceae    | Wambeleke  | Cancer (mouth), hypertension           | CANC/CV      | R         | D         | O          |
| MS 03/04  | Alpinia sp. [8, 9, 33, 42, 43, 55–57]   | Zingiberaceae    | Kasai      | Cough                                 | RESP         | yShoot    | S         | O          |
| MS 41/04  | Alpinia sp. [8, 9, 33, 42, 43, 55–57]   | Zingiberaceae    | Sinup      | Fever, headache, body ache            | FEV/HEAD/PAIN/SWELL | yShoot | S         | O          |
| MS 68/04  | Alpinia sp. [8, 9, 33, 42, 43, 55–57]   | Zingiberaceae    | Kasai      | Antidepressant                        | PSYCH        | L & yShoot | S         | O          |
| BK 02/06  | Alstonia scholaris (L) R.Br [7–9, 34, 39, 40, 42, 43, 46–49, 51–53, 57–64] | Apocynaceae    | Kam-bh     | Malaria, diarrhoea, asthma, sores      | MAL/GAST/RESP/SKIN | L | Sap      | Sap | D | D | S | O |
| DK 25/05  | Alstonia scholaris (L) R.Br [7–9, 34, 39, 40, 42, 43, 46–49, 51–53, 57–64] | Apocynaceae    | Chimb      | Scabies                               | SKIN         | B         | C         | O          |
| GW 16/04  | Alstonia scholaris (L) R.Br [7–9, 34, 39, 40, 42, 43, 46–49, 51–53, 57–64] | Apocynaceae    | Hemba      | Fever, malaria, cough, diarhhea        | FEV/MAL/RESP/GAST | Sap    | S         | O          |
| MS 04/04  | Alstonia scholaris (L) R.Br [7–9, 34, 39, 40, 42, 43, 46–49, 51–53, 57–64] | Apocynaceae    | Kaisabok   | Fever, headache                        | FEV/HEAD      | B         | D         | O          |
| BK 03/06  | Ammonium aculeatum Roxb [39, 42, 53, 58, 65] | Zingiberaceae   | Takkwa hamba | Asthma, scabies                      | RESP/SKIN    | Stem      | C         | O & T      |
| DK 19/05  | Ammonium aculeatum Roxb [39, 42, 53, 58, 65] | Zingiberaceae   | Guinj Nikir | Fever                                | FEV          | Whole     | V         | I          |
| DK 53/05  | Angiopteris evecta (G. Forst.) Hoffm [8, 56] | Marattiaceae   | Yarchapa   | Shortness of breath                    | RESP         | Shoot & Root | 3 | O          |
| MS 01/04  | Archidendron sp. [8, 66]                | Fabaceae        | Niar       | Diarrhoea, asthma, fever, headache    | HEAD/FEV/GAST | B         | D         | O          |
Table 1  Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued)

| Code   | Species                              | Family     | Uses                                      | Parts      | Shoot | Root | Nut | R | T | O |
|--------|--------------------------------------|------------|-------------------------------------------|------------|-------|------|-----|---|---|---|
| DK 02/05 | *Areca catechu* L [8, 34, 37, 39, 42, 43, 51, 67, 68] | Arecales   | Abdominal ache, whitespots               | Nut        |       |      |     |   |   |   |
| MS 10/04 | *Aristolochia sp.* [8, 9, 34, 43, 48, 56, 59, 61, 63] | Aristolochiaceae | Epigastric pain          | GAST       |       |     |     |   |   |   |
| MS 73/04 | *Aristolochia sp.* [8, 9, 34, 43, 48, 56, 59, 61, 63] | Aristolochiaceae | Blocked nose, flu, cough | RESP       |       |     |     |   |   |   |
| MS 23/04 | *Artocarpus altilis* (PARKINSON ex F.A. ZORN) Fosberg [8, 34, 43, 50, 61] | Moraceae   | Hemorrhage                             | WOUND      |       |     |     |   |   |   |
| GW 79/04 | *Aristolochia sp.* [8, 9, 34, 43, 48, 56, 59, 61, 63] | Aristolochiaceae | Epigastric pain          | GAST       |       |     |     |   |   |   |
| DK 21/05 | *Aristolochia sp.* [8, 9, 34, 43, 48, 56, 59, 61, 63] | Aristolochiaceae | Blocked nose, flu, cough | RESP       |       |     |     |   |   |   |
| BK 039/06 | *Averrhoa carambola* L. Oxalidaceae | Oxalidaceae | Aasthma, sore, fresh cut, wound | Fruit      |       |     |     |   |   |   |
| BK 010/06 | *Averrhoa carambola* L. Oxalidaceae | Oxalidaceae | Cough                                  | Fruit      |       |     |     |   |   |   |
| MS 27/04 | *Barringtonia asiatica* (L.) Kurz [38, 39, 42, 43, 50, 53] | Lecythidaceae | Antipsychotic                        | PSYCH      |       |     |     |   |   |   |
| GW 21/04 | *Bryophyllum pinnatum* (Lam.) Oken [7, 42, 51, 67] | Crassulaceae | Ulcer                                  | SKIN       |       |     |     |   |   |   |
| MS 20/04 | *Calamus sp.* [8, 33, 35, 43, 53, 57] | Arecaceae   | Fever, headache, malaria, cough, malnutrition | FEV/HEAD/MAL/NUT | Sap   |     |     |   |   |   |
| BK 051/06 | *Calamus sp.* [8, 33, 35, 43, 53, 70] | Arecaceae   | Dehydration                           | NUT        | Sap   |     |     |   |   |   |
| GW 92/04 | *Calamus sp.* [8, 33, 35, 43, 53, 64] | Arecaceae   | General cleansing                     | MAINT      | Sap   |     |     |   |   |   |
| MS 85/04 | *Callicarpa langifolia* Lam. [34, 51] | Verbenaceae | Sore in baby’s mouth                  | CHILD      | B     | MS  |     |   |   |   |
| BK 40/04 | *Bidens pilosa* L. Asteraceae | Asteraceae   | Eye infections, bleeding           | INF/WOUND  | Root  |     |     |   |   |   |
| MS 12/04 | *Calotropis gigantea* (L.) (L.) Dryand [34, 51] | Apocynaceae | Fever, headache                        | FEV/HEAD   | L     | V    | I   |   |   |   |
| BK 56/05 | *Campnosperma brevipetiolatum* Volkens [71] | Anacardiaceae | Ulcer                                 | SKIN       | Sap   |     |     |   |   |   |
| BK 10/06 | *Campnosperma sp.* | Anacardiaceae | Sore, scabies, fresh cut, wound, hair and skin | WOUND/SKIN | B     | S    | T   |   |   |   |
Table 1 Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued)

| MS 39/04 | Canarium sp. [34, 42, 43, 50, 57, 70] | Burseraceae | Klakul | Emetic | GAST | B | S | O |
| MS 64/04 | Canarium sp. [34, 42, 43, 50, 57, 70] | Burseraceae | Yamuok | Ulcer | SKIN | Sap | S | T |
| DK 15/05 | Capsicum annuum L. | Solanaceae | Seraimbsik | Malaria | MAL | Fruit & Seed | C | O |
| DK 34/05 | Carica papaya L [42, 43, 46, 47, 59, 64, 68] | Caricaceae | Pous | Malaria | MAL | Root | D | O |
| DK 26/05 | Caryota mitis Lour. | Arecaceae | Tosh | Shortness of Breath | RESP | Succus | S | O |
| MS 69/04 | Caryota rumphiana Mart. [39, 53] | Arecaceae | Yamoun | Toothache | DENT | yShoot | M | O |
| BK 028/06 | Cassia alata L. | Fabaceae | Yundilipgi | Grille and white spot | SKIN | L & Seed | S | T |
| BK 008/06 | Christia sp. | Fabaceae | Banjip | Diarrhoea, scabies, sores on the head like scabies | GAST/SKIN | L | D | R | O | T |
| MS 50/04 | Chrysopogon aciculatus (Retz). Trin. | Poaceae | Knarbru | Swollen bodies, legs, arms | SWELL | Whole | D | T |
| DK 54/05 | Cinnaemonum sp. | Lauraceae | Metamboi | Headache | HEAD | B | MS | T |
| GW 59/04 | Cissus sp. [33, 34, 43, 53, 59, 62] | Vitaceae | Lenghasa | Stomach ache, diarrhoea | GAST | Sap | S | O |
| BK 049/06 | Clematis sp. [8, 33, 34, 37, 39, 42, 43, 51, 53, 59, 65–67, 69] | Ranunculaceae | Gwawingga | Nasal congestion, running nose | RESP | L | V | I |
| GW 87/04 | Clerodendrum sp. [8, 37, 38, 62] | Ochnaceae | Hambaihile | Snake bite | BITE | Sap | S | O |
| GW 91/04 | Clitoria ternatea L. | Fabaceae | Pohuk | Determine female sex for baby, infertility | REP | Fruit | C | O |
| MS 78/04 | Cocos nucifera L. [7, 8, 34, 37–39, 43, 56, 59, 61, 67, 68] | Arecaceae | Niumour | Bleeding from cuts | WOUND | Fruit | H | T |
| Ref. | Name and Genus | Author | Action | Part Used | Organs | Comment |
|------|----------------|--------|--------|----------|--------|---------|
| BK 047/06 | Codiaeum variegatum (L.) Rumph. ex A. Juss. | [8, 34, 35, 39, 42, 43, 48, 56, 58, 61, 62, 66, 73] | | | | |
| MS 37/04 | Codiaeum variegatum (L.) Rumph. ex A. Juss. | [8, 34, 35, 39, 42, 43, 48, 56, 58, 61, 62, 66, 73] | | | | |
| DK 12/05 | Cordyline fruticosa (L.) A. Chev. | [37, 38, 45, 56, 59–61] | | | | |
| GW 86/04 | Cordyline fruticosa (L.) A. Chev. | [37, 38, 45, 56, 59–61] | | | | |
| MS 67/04 | Cordyline fruticosa (L.) A. Chev. | [37, 38, 45, 56, 59–61] | | | | |
| BK 053/06 | Crinum asiaticum L. | [7, 8, 34, 42, 49, 51, 56, 61, 62, 67, 74] | | | | |
| GW 39/04 | Crinum asiaticum L. | [7, 8, 34, 42, 49, 51, 56, 61, 62, 67, 74] | | | | |
| MS 29/04 | Crinum asiaticum L. | [7, 8, 34, 42, 49, 51, 56, 61, 62, 67, 74] | | | | |
| MS 54/04 | Crinum asiaticum var. asiaticum | [34, 54, 61] | | | | |
| GW 75/04 | Cryptocarya sp. | [8, 33–35, 43, 50, 53, 55, 65] | | | | |
| BK 035/06 | Cryptocarya sp. | [8, 33–35, 43, 50, 53, 55, 65] | | | | |
| BK 029/06 | Curcuma longa L. | [34, 42, 45] | | | | |
| GW 35/04 | Curcuma sp. | [34, 35, 40, 42–45, 62] | | | | |
| GW 38/04 | Curcuma sp. | [34, 35, 40, 42–45, 62] | | | | |
| MS 84/04 | Cycas circinalis L. | [34, 35, 38, 42, 43, 46, 47, 51, 73] | | | | |
| BK 002/06 | Cynanchus sp. | [8, 34, 39, 42, 43, 46, 51, 63, 72, 73] | | | | |
| BK 06/05 | Cymbopogon citratus (DC) Stapf. | [42, 56, 66] | | | | |
| GW 53/04 | Cymbopogon citratus (DC) Stapf. | [42, 56, 66] | | | | |
| MS 70/04 | Davallia sp. | [8, 34] | | | | |
| DK 35/05 | Dendrocline cordata (Warb. ex H.J.P. Winkl.) Chew | [51] | | | | |
| MS 33/04 | Dendrocline latifolia (Gaudich.) Chew | [64] | | | | |
| GW 101/04 | Desmodium sp. | [7, 9, 33–35, 37, 43, 48, 60, 66, 68, 70, 72, 75, 76] | | | | |
| MS 81/04 | Dillenia sp. | [39, 50, 58, 60, 65, 77] | | | | |
| DK 59/05 | Dioscorea bulbifera L. | [33, 42] | | | | |

**Table 1**: Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued)
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| Code  | Species                                | Family            | Part Used       | Disease                        | Species Combinations |
|-------|----------------------------------------|-------------------|-----------------|--------------------------------|----------------------|
| GW 63/04 | Dioscorea sp.                         | Dioscoreaceae    | Harehare        | Headache, migraine              | HEAD L HR T          |
| BK 013/06 | Donax canniformis (G. Forst.) Schum    | Marantaceae      | Gani            | Ear ache                        | PAIN yL R T          |
| DK 23/05 | Donax canniformis (G. Forst.) Schum    | Marantaceae      | Guarimb          | Ear infection                   | INF L R T            |
| GW 78/04 | Dracaena angustifolia (Medik.) Roxb     | Asparagaceae     | Hembesaihe      | Fever, headache, stomach complaints | FEVER/HEAD/GAST Root S T |
| GW 25/04 | Dysoxylum sp.                         | Meliaceae        | Sengiwiama      | Sores, ulcers                   | SKIN B R T           |
| GW 68/04 | Dysoxylum sp.                         | Meliaceae        | Huambuka        | Malaria, cough                  | MAL/RESP L D O       |
| GW 100/04 | Elaeocarpus sphaericus Schum (39, 53)  | Elaeocarpaceae   | Nangila         | Malaria, cough, pneumonia, shortness of breath | MAL/RESP B D O       |
| MS 25/04 | Elaeocarpus sphaericus Schum (39, 53)  | Elaeocarpaceae   | Kaiboun          | Asthma                          | RESP B S O           |
| BK 043/06 | Elatostema sp                | Urticaceae       | Kkas-bhirs      | Scabies                         | SKIN Whole D T       |
| MS 59/04 | Elatostema sp                | Urticaceae       | Moin kukuri     | Fever, headache, joint pain, fertility | FEVER/HEAD/PAIN/REP Whole M O |
| GW 28/04 | Endospermum formicarium Becc        | Euphorbiaceae    | Bundua          | Fever, asthma                   | FEVER/RESP B S O     |
| DK 40/05 | Endospermum labios Schodde         | Euphorbiaceae    | Paruang         | Scabies                         | SKIN Seed & Flower C O |
| MS 89/04 | Endospermum medullosum L.S.Sm.      | Euphorbiaceae    | Karak           | Fever, body pain, unconscious   | FEV/PAIN/PSYCH L B I |
| GW 47/04 | Epipremnum pinnatum (L.) Engl      | Araceae          | Kumbui-bhi      | Fever                           | FEV B S O            |
| BK 009/06 | Epipremnum sp.                   | Araceae          | Kunga           | Dysentery (excreting of blood), vomiting of blood | GAST Root M | C O |
| MS 12/04 | Epipremnum sp.                   | Araceae          | Kkajial         | Headache, swollen bodies, fever, cold | HEAD/SWELL/FEV/RESP Sap S O |
| GW 18/04 | Erythrina memillana Krukooff      | Fabaceae         | Kwai            | Diarrhoea, shortness of breath, cough | GAST/RESP L & B D O |
| MS 42/04 | Erythrina memillana Krukooff      | Fabaceae         | Pear            | Contraceptive                    | REP B B O            |
| MS 52/04 | Euodia hortensis J.R. Forst. & G. Forst. | Rutaceae        | Ghin            | Unconsciousness                  | PSYCH L V I          |
| MS 66/04 | Euodia sp.                        | Rutaceae         | Muth            | Fertility, emetic                | REP/GAST B S O       |
| BK 025/06 | Euphorbia heterophylla L. [51]     | Euphorbiaceae    | Wilai           | For treating diarrhoea           | GAST Sap S O         |
| BK 023/06 | Euphorbia hirta L [9, 34, 39, 46, 50, 51, 56, 57, 67] | Euphorbiaceae | Unknown         | Sore                             | SKIN L S T           |
| GW 17/04 | Euphorbia hirta L [9, 34, 39, 46, 50, 51, 56, 57, 67] | Euphorbiaceae | Seplein Nai     | Shortness of breath, asthma, pneumonia | RESP Whole D O       |
| DK 03/05 | Euphorbia plumerioides Teijsm. ex Hassk. [33, 34, 36, 43, 51, 53, 60, 69] | Euphorbiaceae | Mimi/Pombi      | Poisoning                        | POIS Sap S O         |
| MS 47/04 | Euphorbia sp.                      | Euphorbiaceae    | Sungwia         | Emetic                          | GAST Sap S O         |
Table 1 Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued)

| Code  | Species/Botanical Name | Family | Part Used | Preparation | Part | Treatment | Organism |
|-------|------------------------|--------|-----------|-------------|------|-----------|----------|
| GW 44/04 | Euphorbia sp. [9, 34–36, 41–44, 50, 53, 54, 57–59, 67, 74, 78] | Euphorbiaceae | Wale | Emetic | GAST | Sap | S O |
| GW 80/04 | Euphorbia sp. [9, 34–36, 41–44, 50, 53, 54, 57–59, 67, 74, 78] | Euphorbiaceae | Tuth | Emetic | GAST | Sap | S O |
| MS 59/04 | Euphorbia tithymaloides (L.) [51, 56] | Euphorbiaceae | Mual nias | Epigastric pain | GAST | Sap | S O |
| BK 046/06 | Ficus adersperma Miq [8, 33–35, 53] | Moraceae | Belloki | Cut | WOUND | yL | S T |
| DK 41/05 | Ficus pungens Reinw. ex Blume [9, 33, 34, 42, 43, 53, 59, 60, 63] | Moraceae | Kuar | Shortness of breath | RESP | Succus | S O |
| MS 40/04 | Ficus septica Burm.f. [34, 37–40, 42, 43, 48, 49, 51, 57–59, 61, 62, 66, 67, 78] | Moraceae | Poipuk | Diarrhoea | GAST | Sap & yShoot | S O |
| DK 58/05 | Ficus sp. [7–9, 33–40, 42–45, 47–49, 51–59, 61–63, 66–69, 74, 75, 77, 78] | Moraceae | Tuohoepolehe | Malnutrition | NUT | Sap | C O |
| GW 58/04 | Ficus sp. [7–9, 33–40, 42–45, 47–49, 51–59, 61–63, 66–69, 74, 75, 77, 78] | Moraceae | Manjemieri | Nutrient supplement for babies | NUT | Sap | S O |
| GW 74/04 | Ficus sp. [7–9, 33–40, 42–45, 47–49, 51–59, 61–63, 66–69, 74, 75, 77, 78] | Moraceae | Wavihsa/ Horikieng | Broken bones | BONE | Root | M T |
| GW 89/04 | Ficus sp. [7–9, 33–40, 42–45, 47–49, 51–59, 61–63, 66–69, 74, 75, 77, 78] | Moraceae | Chiplapul | Abortion | REP | B R T |
| MS 17/04 | Ficus sp. [7–9, 33–40, 42–45, 47–49, 51–59, 61–63, 66–69, 74, 75, 77, 78] | Moraceae | Bukabok | Fracture | BONE | B R T |
| MS 31/04 | Ficus sp. [7–9, 33–40, 42–45, 47–49, 51–59, 61–63, 66–69, 74, 75, 77, 78] | Moraceae | Moul koni | Ulcer | SKIN | Sap | S T |
| MS 88/04 | Ficus sp. [7–9, 33–40, 42–45, 47–49, 51–59, 61–63, 66–69, 74, 75, 77, 78] | Moraceae | Aiyau | Toothache | DENT | yRoot | M O |
| MS 75/04 | Ficus wassa Roxb [33, 34, 39, 40, 42, 47, 68, 75] | Moraceae | Kikquai | Contraceptive | REP | Root | M O |
| BK 060/06 | Gnetum gnemon L [8, 34] | Gnetaceae | Yit | Removal of wood or stick in skin | WOUND | yL | S T |
| DK 14/05 | Gnetum gnemon L [8, 34] | Gnetaceae | Mogsa | Removal of nails/ splints lodged in the body | WOUND | Sap | S T |
| MS 18/04 | Gnetum gnemon L [8, 34] | Gnetaceae | Popoyiri | Eye disease | OCC | Sap | S T |
| GW 45/04 | Gnetum gnemonoides Brongn. | Gnetaceae | Biek | Fever, headache (malaria) | FEV/MAL | B D | O |
| MS 14/04 | Graftophyllum sp. [7–9, 33, 35, 36, 39, 41, 66, 67] | Acanthaceae | Intalhiat | Fever, headache, joint pain, cold | FEV/HEAD/PAIN/RESP | L D | O & I & T |
| GW 11/04 | Gymnostoma papuanum (S. Moore) L.A.S. Johnson [33, 35, 43] | Casuarinaceae | Mania | Shortness of breath, asthma | RESP | B D | O |
| GW 70/04 | Hemigraphis reptans (G. Forst.) T. Anderson ex Hemsl. | Acanthaceae | Mijika | Centipede bite | BITE | Whole | HR T |
| BK 018/06 | Hibiscus rosa-sinensis L [37, 56, 59] | Malvaceae | Mawe | Sore eye | OCC | Flower | R T |
Table 1 Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued)

| Plant Name | Family | Common Uses | Body Systems | Study Area |
|------------|--------|-------------|--------------|------------|
| Hibiscus rosa-sinensis | Malvaceae | Kupawaruk | Menstrual cramps | REP L S O |
| Homalanthus sp. | Euphorbiaceae | War moap | Scabies | SKIN Stem D T |
| Salicaceae | Mes | Knee ache | PAIN B MAG P_to_Plant |
| Areceae | Yawah | Shortness of breath | RESP Stem S O |
| Homalium foetidum (Roxb.) Benth | Salicaceae | Wun | Boil | SKIN Stem C T |
| Viburnum sp. | Euphorbiaceae | War moap | Fractured bones | BONE B HR T |
| Intsia bijuga (Colebr.) Kuntze | Fabaceae | Stem | D T |
| Ipomoea sp. | Convolvulaceae | Firac | Distended stomach, pigbel | RESP Stem S T |
| Ipomoea pes-caprae (L.) R. Br | Convolvulaceae | Waimabhu | Running nose, cough, asthma | Resp Stem S T |
| Ipomoea pes-caprae (L.) R. Br | Convolvulaceae | Kairo | Fever, headache, joint pain, swelling | RESP Stem S T |
| Kalanchoe pinnata (Lam.) Pers | Crassulaceae | Kupun |Knee pain/ache, back ache/pain, swollen legs, boils | PAIN/ SWELL/SKIN |
| Laportea decumana Wedd. | Urticaceae | Salat | Muscle ache, knee pain, ankle sprain | Pain L R T |
| Laportea interrupta (L.) Chew | Urticaceae | Salat (red) | Fresh cuts, wounds | WOUND |
| Leucosyke capitellata Wedd | Urticaceae | Asamambia | Insect bite | BITE |
| Larrea sp. | Euphorbiaceae | Lomi | Anti-venom | POIS |
| Larrea sp. | Euphorbiaceae | Lomi | Malaria, fevers, coughs | MAL/FEV/RESP L O B D O |
| Larrea sp. | Euphorbiaceae | Lomi | Skin infections, scabies | SKIN B S T |
| Macaranga clavata Warb. | Urticaceae | Salat | Muscle ache, knee pain, ankle sprain | Pain L R T |
| Manihot esculenta Crantz | Euphorbiaceae | Gumbbow | Fresh cuts, wounds | WOUND |
| Marattia sp. | Urticaceae | Asamambia | Insect bite | BITE |
| Marattia sp. | Urticaceae | Asamambia | Insect bite | BITE |
| Melanolepis multiglandulosa (Reinw. ex Blume) Rchb. & Zoll | Euphorbiaceae | Waru | Snake bite | BITE |
| Melastoma sp. | Rutaceae | Mutamuth | Blocked nose, flu, cough | RESP L V I |
| Meliosma acuminata (Lour.) Corner | Anacardiaceae | Huarambie/ Wamahang | Snake bite | BITE |
| Melicope triphylla (Lam.) Merr | Rutaceae | Kupun | Abortion | REP L D O |
| Code   | Species (Family) | Part | Action 1                  | Organ Systems |
|--------|-----------------|------|---------------------------|---------------|
| BK 001/06 | *Merremia peltata* (L.) Merr [8, 34, 42, 43, 56, 59, 67] | Convolvulaceae Aukut | Boil, sore or ulcer, fresh cut | SKIN/WOUND Sap | L | S | H | T |
| DK 28/05 | *Merremia peltata* (L.) Merr [8, 34, 42, 43, 56, 59, 67] | Convolvulaceae Bangpuk | Fresh cuts, wounds | WOUND Sap | S | T |
| GW 62/04 | *Merremia peltata* (L.) Merr [8, 34, 42, 43, 56, 59, 67] | Convolvulaceae Nangumareng | Determine male sex of baby | REP L D O |
| GW 43/04 | *Merremia* sp. [8, 34, 42, 43, 56, 59, 67] | Convolvulaceae Wararamang | Fever, malaria | FEV/MAL Stem S O |
| DK 30/05 | *Metroxylon sagu* Rottb [42] | Arecaceae Nok | Burns | BURN Stem R T |
| GW 96/04 | *Mikania* sp. | Asteraceae Lihasuanga | Skin infections, scabies, sores | SKIN Sap S T |
| BK 059/06 | *Mimosa pudica* L [8, 34] | Fabaceae Bambu kiya | Induce sleep | PSYCH Whole D T |
| DK 52/05 | *Mimosa pudica* L [8, 34] | Fabaceae Halihioka | Infant colic | CHILD Whole D T |
| MS 77/04 | *Mimosa pudica* L [8, 34] | Fabaceae Mistmiat | Induced sleep | PSYCH Whole D T |
| GW 20/04 | *Mimosa pudica* L [8, 34] | Rubiaceae Waramang | Eye infections, color defects | OCC Whole B I |
| BK 038/06 | *Morinda citrifolia* L [7, 8, 34, 37, 38, 42, 43, 48, 49, 56–59, 61, 68, 70, 73, 78] | Rubiaceae Simbiya | Knee ache, cough | PAIN/RESP yL | Fruit D R | H O & T |
| MS 71/04 | *Morinda citrifolia* L [7, 8, 34, 37, 38, 42, 43, 48, 49, 56–59, 61, 68, 70, 73, 78] | Rubiaceae Knuel | General body pain, boils, inflammation | PAIN/SKIN/SWELL L R T |
| GW 64/04 | *Mucuna nova-guineensis* Scheff. [8] | Fabaceae Kilemessik | Shortness of breath | RESP Root S O |
| MS 37/04 | *Mucuna* sp. [8, 9, 34, 43, 47, 50, 52, 56, 63] | Fabaceae Ombo | Anemia | BLOOD Sap S O |
| GW 51/04 | *Mucuna* sp. [8, 9, 34, 43, 47, 50, 52, 56, 63] | Fabaceae Warnayilhara | Tooth ache, loose tooth | DENT Stem M O |
| GW 66/04 | *Mucuna* sp. [8, 9, 34, 43, 47, 50, 52, 56, 63] | Fabaceae Ponnambile | Anemia | BLOOD B S O |
| GW 84/04 | *Mucuna* sp. [8, 9, 34, 43, 47, 50, 52, 56, 63] | Fabaceae Manvil | Arthritis joint pain, back ache | PAIN B S T |
| BK 033/06 | *Munuya paniculata* (L.) Jack [8, 73] | Rutaceae Sika | Cough | RESP L D O |
| DK 24/05 | *Musa acuminate* Colla [34, 37, 47, 57] | Musaceae Yup | Sore lip | PAIN Fruit C T |
| MS 44/04 | *Musa* sp. [8, 9, 32–34, 37, 42, 43, 47, 52, 54, 56, 57, 59, 61, 63, 67, 71, 72] | Musaceae Wur karasau | Wound | WOUND Sap S T |
| BK 055/06 | *Nauclea orientalis* (L.) L [34, 55, 63] | Rubiaceae Runggool | Asthma, shortness of breath | RESP B S O |
| DK 44/05 | *Nauclea orientalis* (L.) L [34, 55, 63] | Rubiaceae Kuva | Snake bite | BITE B S O |
| GW 10/04 | *Neonauclea purpurea* (Roxb.) Merr [39] | Rubiaceae Kripa | Fever, headache (malaria), pneumonia, asthma | FEV/MAL/RESP B B I & O |
| BK 061/06 | *Neonauclea* sp. | Rubiaceae Gipma | Poisonous snake bite | BITE B M O |
| DK 48/05 | *Nephrulepis hisutula* (G. Forst.) C. Presl [8] | Lomariopsidaceae Tamanguia | Uncontrollable urine | URINE L C O |
| GW 36/04 | *Nephrulepis* sp. [7, 8, 33, 34, 43] | Lomariopsidaceae Walendau | Headache, fever (malaria) | HEAD/MAL Shoot & Root S O |
| MS 48/04 | *Nicotiana* sp. [33–36, 42, 43, 47, 52, 59, 63, 66, 71, 72, 76, 77] | Solanaceae Kennings | Anticoagulant | BLOOD yL H T |
| BK 024/06 | *Nicotiana tabacum* (L.) [33, 35, 36, 42, 43, 52, 59, 63, 76, 77] | Solanaceae Sauken | Sores | SKIN L S T |
| BK 036/06 | Not Identified | Not Identified | Ukapuk | Scabies, malaria | SKIN/MAL Sap S T O |
Table 1 Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued)

| Code   | Plant Name                      | Family       | Common Name            | Use                  | Part Used | Dimension |
|--------|--------------------------------|--------------|------------------------|----------------------|-----------|-----------|
| DK 47/05 | Not identified                | Not identified | Kupnenj                | Shortness of breath | RESP      | Sucus     | S          | O         |
| DK 60/05 | Not identified                | Fabaceae     | Wulamian               | Malnutrition         | NUT       | Whole     | H          | O         |
| MS 80/04 | Not identified                | Orchidaceae  | Kraufung                | Skin disease (grille) | SKIN      | L         | H          | T         |
| DK 57/05 | Not identified                | Not identified | Sarimbiya              | Cough                | RESP      | L         | -          | O         |
| MS 22/04 | Not identified                | Not identified | Asakurkunja            | Scabies              | SKIN      | Stem & Root | D          | T         |
| MS 08/04 | Ocimum basilicum L            | Labiate      | Ruk                    | General body weakness, fever, headache, etc. | FEV/MAL/HEAD | Whole | B           | O         |
| BK 004/06 | Octomeles sumatrana Miq [43]  | Datiscaeeae  | Wani                   | Asthma, back ache, malnourished/pigbel | RESP/PAIN/NUT/GAST | B | Sap | S | O | O | O |
| GW 48/04 | Octomeles sumatrana Miq [43]  | Datiscaeeae  | Waine                  | Fever                | FEV       | B         | S          | O         |
| MS 30/04 | Pandanus dubius Spreng.       | Pandanaceae  | Viak                   | Asthma               | RESP      | Shoot & L | S          | O         |
| GW 98/04 | Pangium edule Reinw [34, 42, 43, 50, 51, 53] | Achariaceae  | Imahek                 | Enlarged spleen      | ORG       | Fruit     | R          | O         |
| MS 35/04 | Pangium edule Reinw [34, 42, 43, 50, 51, 53] | Achariaceae  | Sis                    | Lice killer          | INSECTICIDE | L | S | O | T |
| GW 65/04 | Paepluchites sp. [34, 43]     | Apocynaceae  | Pari                   | Enlarged spleen      | ORG       | Fruit     | S          | O         |
| GW 29/04 | Parsonia sp. [37, 59]         | Apocynaceae  | Tielimbika             | Fresh cuts, sores    | SKIN/WOUND | L | H | T |
| BK 032/06 | Passiflora foetida L [8, 42, 51, 56] | Passifloraceae | Bombo                  | Asthma, white spot   | RESP/SKIN | Flower & L | D | R | O | T |
| DK 46/05 | Passiflora foetida L [8, 42, 51, 56] | Passifloraceae | Apsarapuk              | Whitespots           | SKIN      | L         | R          | T         |
| GW 19/04 | Passiflora foetida L [8, 42, 51, 56] | Passifloraceae | Apduanapuk             | Strong cough         | RESP      | Shoot & L | S          | O         |
| MS 09/04 | Passiflora foetida L [8, 42, 51, 56] | Passifloraceae | Maparou                | Skin disease         | SKIN      | R         | T          |          |
| DK 55/05 | Passiflora sp. [8, 42, 51, 56] | Passifloraceae | War yasokk             | Scabies              | SKIN      | Sap       | H          | T         |
| BK 017/06 | Peperomia pellucida (L.) Kunth [7] | Piperaceae   | Koikoivara             | Pimple               | SKIN      | L         | R          | T         |
| GW 81/04 | Peperomia pellucida (L.) Kunth [7] | Piperaceae   | Lerek                  | Fever, headache, (malaria) | FEV/MAL | Whole | D | O |
| MS 58/04 | Peperomia pellucida (L.) Kunth [7] | Piperaceae   | Kinkanak               | Antidepressant       | PSYCH     | L | D | T |
| BK 014/06 | Phyllanthus armanus Schumach. & Thonn [34, 43, 49, 52, 63] | Phyllanthaceae | Ripa kwalingu          | Scabies              | SKIN      | Sucus     | S          | T         |
| MS 55/04 | Phyllanthus armanus Schumach. & Thonn [34, 43, 49, 52, 63] | Phyllanthaceae | Kambaningi            | Fever, headache, swollen bodies | FEV/HEAD/SWELL | Root | S | O |
| GW 54/04 | Phyllanthus niruri L [7, 9, 34, 42, 43, 46, 57, 59, 73] | Phyllanthaceae | Hipanchinchii          | Menorrhagia          | REP       | Whole     | D          | O         |
| MS 60/04 | Phyllanthus niruri L [7, 9, 34, 42, 43, 46, 57, 59, 73] | Phyllanthaceae | Shuk miau              | Fever                | FEV       | Whole     | D          | T         |
| GW 14/04 | Phyllanthus sp. [7, 9, 33–35, 39, 42, 43, 46, 49, 52, 57, 59, 63, 67, 73] | Phyllanthaceae | Kai veai               | Tooth infections, toothache | DENT | Root | M | T |
| GW 61/04 | Pimelodendron ambicinicum Hassk [34, 39] | Euphorbiaceae | Sombik                 | Enlarged spleen      | ORG       | Sap       | S          | O         |
| MS 15/04 | Pimelodendron ambicinicum Hassk [34, 39] | Euphorbiaceae | Kunial                 | Swollen stomach      | GAST      | B | D | T |
| BK 062/06 | Piper betle L [37–39, 42, 61, 67, 68] | Piperaceae    | Kwasse gungga         | Sores,boils         | SKIN      | L         | H          | T         |
Table 1  Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued)

| Plant Name                        | Family          | Part Used   | Use                                                                 |
|-----------------------------------|----------------|-------------|----------------------------------------------------------------------|
| Piper betle L                     | Piperaceae      | Kosh        | Abdominal ache                                                       |
| Wikaya L                         | Lamiaceae       | Lai         | Skin infections, scabies                                            |
| Premna sp.                       | Lamiaceae       | Pokware     | Scabies, grille                                                      |
| Premna sp.                       | Lamiaceae       | Wunweik     | Malaria                                                              |
| Psidium guajava L                | Myrtaceae       | Yambu       | Cough, itchy throat                                                  |
| Psidium guajava L                | Myrtaceae       | Yambosik    | Diarrhoea                                                            |
| Psychotria sp.                   | Rubiaceae       | Sisikupa    | Boil                                                                 |
| Psychotria sp.                   | Rubiaceae       | Konumbo     | Enlarged spleen                                                      |
| Pterocarpus indicus Willd.       | Fabaceae        | Markulu     | Anemia                                                               |
| Pterocarpus indicus Willd.       | Fabaceae        | Moroho      | Diarrhoea, stomach ache, anemia                                      |
| Riedelia corallina L             | Zingiberaceae   | Moukuaikai  | Menstrual cramps                                                     |
| Scaevola seneca Vahl             | Goodeniaceae    | Knanas      | Cough                                                                |
| Schismatoglottis calyptra L      | Araceae         | Maghau      | Sore                                                                 |
| Semecarpus sp.                   | Anacardiaceae   | Huaho       | Itchy skin (pruritis)                                               |

DK 22/05  Piper betle L [37–39, 42, 61, 67, 68]  Piperaceae  Kosh  Abdominal ache  GAST  Seed  MS  T
GW 49/04  Piper betle L [37–39, 42, 61, 67, 68]  Piperaceae  Guspui  Tuberculosis, centipede bite  BITE/INF  L  Fruit  H  O  T
DK 27/05  Piper mestoni F.M. Bailey.  Piperaceae  Hrunga  Fresh cuts, wounds  WOUND  L  S  T
GW 97/04  Scaevola sericea  Piperaceae  Walehrui  Memory enhancing, clear thinking  PSYCH  Root  M  O
MS 56/04  Pouteria granifolia (Donn. Sm.) I.M. Johnst.  Fabaceae  Yinaupuk  Strong headache  HEAD  Stem  R  T
GW 32/04  Pisonia longirostris (Teijjm. & Bin.)  Nyctaginaceae  Kumieie/Weworo  Tropical ulcers, peptic ulcers  SKIN/GAST  B  S  T  O
DK 45/05  Planchoninia papuana R. Knuth  Lecythidaceae  Ningia  Scabies  SKIN  B  C  O
MS 57/04  Plectranthus amboinicus (Lour.) Spreng [60, 74]  Labiatae  Wasirika  Skin disease (grille)  SKIN  L  S  T
GW 13/04  Plectranthus hereroensis Engl.  Labiatae  Sumoun  Stomach ulcers, placenta sores  GAST/REP  L  D  O
GW 15/04  Plectranthus hereroensis Engl.  Labiatae  Krau sumin  Scabies, itchy skin  SKIN  L  S  T
BK 031/06  Plectranthus vanilliflorus Willd.  Labiatae  Humbiang  Sores  SKIN  L  S  T
MS 49/04  Plectranthus scutellarioides (L.) R.Br [8, 9, 33, 42, 43, 56, 74]  Labiatae  Humbiang  Ulcer, fresh cut  SKIN/WOUND  L  S  T
MS 87/04  Plectranthus scutellarioides(L.) R.Br [8, 9, 33, 42, 43, 56, 74]  Labiatae  Trakain  Skin disease (grille)  SKIN  L  R  T
GW 30/04  Pongamia pinnata (L.) Pierre [40, 42, 43, 52, 56, 59, 63]  Fabaceae  Lai  Skin infections, scabies  SKIN  Root  S  T
GW 41/04  Pouteria sp.  Sapotaceae  Pokware  Scabies, grille  SKIN  Sap  S  T
BK 052/06  Premna serratifolia L. [39, 42, 61]  Lamiaceae  Kunggwia  Emetic  GAST  Seed  R  O
GW 42/04  Premna sp.[8, 34, 39, 42, 43, 53, 56, 63]  Lamiaceae  Nering  Ear ache  PAIN  B  S  T
MS 06/04  Premna sp.[8, 34, 39, 42, 43, 53, 56, 63]  Lamiaceae  Wurweik  Malaria  MAL  L & B  D  O
BK 050/06  Psidium guajava L [39, 40, 56, 61]  Myrtaceae  Yambu  Cough, itchy throat  RESP  Fruit  R  O
DK 17/05  Psidium guajava L [39, 40, 56, 61]  Myrtaceae  Yambosik  Diarrhoea  GAST  L  D  O
DK 49/05  Psychotria sp. [7, 9, 33–35, 37, 38, 43, 59]  Rubiaceae  Sisikupa  Boil  SKIN  L  S  T
GW 07/04  Psychotria sp. [7, 9, 33–35, 37, 38, 43, 59]  Rubiaceae  Konumbo  Enlarged spleen  ORG  Sap  S  O
BK 040/06  Pterocarpus indicus Willd. [7, 8, 34, 37, 38, 40, 42, 43, 47, 48, 56, 57, 59, 61, 67, 68]  Fabaceae  Markulu  Anemia  BLOOD  Sap  S  O
GW 03/04  Pterocarpus indicus Willd. [7, 8, 34, 37, 38, 40, 42, 43, 47, 48, 56, 57, 59, 61, 67, 68]  Fabaceae  Moroho  Diarrhoea, stomach ache, anemia  GAST/BLOOD  L & B  D  O
DK 18/05  Riedelia corallina L (K. Schum.) Valeton  Zingiberaceae  Moukuaikai  Menstrual cramps  REP  Root  D  O
MS 63/04  Scavaela seneca Vahl [39]  Goodeniaceae  Knanas  Cough  RESP  yL  S  O
MS 83/04  Schismatoglottis calyptra L (Roxb.) Zoll. & Moritz  Araceae  Maghau  Sore  SKIN  L  H  T
GW 55/04  Semecarpus sp. [8, 50, 51]  Anacardiaceae  Huaho  Itchy skin (pruritis)  SKIN  B  D  T
Table 1  Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued)

| Study area | Plant species | Family | Use | Part(s) | Gender(s) |
|------------|---------------|--------|-----|---------|-----------|
| MS 76/04   | *Sida rhombifolia* L. | Malvaceae | Contraceptive | REP | Root | M | O |
| GW 99/04   | *Smilax* sp. | Smilaceae | General cleansing | MAINT | Root & Stem | S | O |
| GW 26/04   | *Solanum torvum* Sw | Solanaceae | Joint pains, arthritis | PAIN | Root | D | O |
| GW 33/04   | *Spathiphyllum* sp. | Araceae | Strong cough, fever | RESP/FEV | Root | S | O |
| GW 95/04   | *Sphaerostephanos* sp. | Thelypteridaceae | Sores, ulcers | SKIN | L | S | T |
| MS 24/04   | *Sperostephanos unitus* (L.) Holttum | Thelypteridaceae | Sores, scabies | SKIN | B | C | O |
| GW 37/04   | *Stephania japonica* var. discolor (Blume) Forman | Menispermaceae | Fever, headache (malaria), asthma, cough | FEV/MAL/RESP | Sap | S | O |
| GW 31/04   | *Stephania* sp. | Menispermaceae | Enlarged spleen, pigbel | ORG/GAST | L | Sap | D | S | O |
| DK 09/05   | *Syzygium malaccense* (L.) Merr. & L.M. Perry | Myrtaceae | Cough with itchy throat | RESP | yL | D | O |
| BK 054/06  | *Tabernaemontana pandacaqui* Lam | Apocynaceae | Grille | SKIN | Fruit | S | T |
| MS 65/04   | *Tinospora* sp. | Menispermaceae | Cough, grille | RESP/SKIN | L | D | S | T |
| GW 76/04   | *Tinospora* sp. | Menispermaceae | Asthma, cough | RESP | L | S | O |
| BK 005/06  | *Uncaria lanosa* var. appendiculata (Benth.) Ridsdale | Rubiaceae | Fever, headache, malaria, cough, malnutrition | MAL/FEV/NUT/HEAD/RESP | Sap | S | O |
| MS 82/04   | *Uncaria lanosa* var. appendiculata (Benth.) Ridsdale | Rubiaceae | Severe fever, chronic diarrhoea with blood, loss of weight | FEV/GAST | Sap | S | O |
| DK 29/05   | *Uncaria orientalis* Guillaumin | Rubiaceae | Shortness of breath | RESP | Sap | S | O |
| GW 85/04   | *Ursi* sp. | Fabaceae | Headache, migraine | HEAD | Sap | S | O |
| GW 72/04   | *Ursi* sp. | Fabaceae | Determine baby boy | REP | Root | S | O |
| Ailment treated (Ailmentcode) as follows: | Route of Administration codes (RouteCode) as follows: | Mode of preparation codes (PrepCode) as follows: | Ailment treated (Ailmentcode) as follows: | Route of Administration codes (RouteCode) as follows: | Mode of preparation codes (PrepCode) as follows: |
|----------------------------------------|--------------------------------------------------|---------------------------------|----------------------------------------|--------------------------------------------------|---------------------------------|
| BITE = insect or snake bite; BLOOD = hematological issues including coagulation; BONE = bone related injury or disease; BURN = burns; CANC = cancer; CHILD = childhood disease; CV = Cardiovascular; DENT = dental disease; FEV = fever; GAST = gastroenterological disease; HEAD = headache; INF = infection; INSECTICIDE = delousing; MAGIC = disease of unidentified etiology (‘magical poisoning’); MAINT = health promotion, including failure to thrive; MAL = Malaria; NUT = nutritional supplement; OCC = ocular diseases; ORG = diseases thought to affect one particular organ; OTHER = unclear disease syndrome; PAIN = physical pain; POIS = envenomation or poisoning; sometimes this includes transnatural causation; PSYCH = psychiatric diseases or syndromes; REP = reproductive diseases including childbirth related issues; RESP = respiratory diseases; SKIN = dermal related diseases; often includes infectious disease; SWELL = swelling of whole body or part of the body; URINE = urinary conditions; WOUND = wound related diseases or syndromes | O = oral; T = topical; I = inhalation; P_to_Patient = patient to plant transfer of blood | B = burned (smoke generation), C = cooked; D=decoction, H = heated, HR = heated then rubbed, M = masticated, MAG = magical, MS = masticated then spit on affected area(s), R = raw, S = succus (crushed), V = vapor |
| Prevent miscarriage | O | R |
| Prevent miscarriage | O | R |
| Prevent miscarriage | O | R |

| Table 1 Plants reported as medicinally used in 4 study areas in East Sepik Province (Continued) |
|----------------------------------------|--------------------------------------------------|---------------------------------|
| GW 77/04 | Urticaceae | Purkumb |
| MS 62/04 | Urticaceae | Chipia |
| BK 012/06 | Orchidaceae | Dunauaru banguwi |
| MS 13/04 | Urticaceae | Wurarian |
| MS 86/04 | Myristicaceae | Sukuai |
| GW 73/04 | Asteraceae | Bambanghoo |
| BK 019/06 | Asteraceae | Pava |
| MS 72/04 | Asteraceae | Kiskiash |
| BK 030/06 | Zingiberaceae | Kambbei laki |
| DK 07/05 | Zingiberaceae | Nikirkusa |
| DK 39/05 | Zingiberaceae | Huaukuusa |
| MS 45/04 | Zingiberaceae | Leai |

| Mode of preparation codes (PrepCode) as follows: | Ailment treated (Ailmentcode) as follows: |
|----------------------------------------|--------------------------------------------------|
| B = burned (smoke generation), C = cooked; D=decoction, H = heated, HR = heated then rubbed, M = masticated, MAG = magical, MS = masticated then spit on affected area(s), R = raw, S = succus (crushed), V = vapor | BITE = insect or snake bite; BLOOD = hematological issues including coagulation; BONE = bone related injury or disease; BURN = burns; CANC = cancer; CHILD = childhood disease; CV = Cardiovascular; DENT = dental disease; FEV = fever; GAST = gastroenterological disease; HEAD = headache; INF = infection; INSECTICIDE = delousing; MAGIC = disease of unidentified etiology (‘magical poisoning’); MAINT = health promotion, including failure to thrive; MAL = Malaria; NUT = nutritional supplement; OCC = ocular diseases; ORG = diseases thought to affect one particular organ; OTHER = unclear disease syndrome; PAIN = physical pain; POIS = envenomation or poisoning; sometimes this includes transnatural causation; PSYCH = psychiatric diseases or syndromes; REP = reproductive diseases including childbirth related issues; RESP = respiratory diseases; SKIN = dermal related diseases; often includes infectious disease; SWELL = swelling of whole body or part of the body; URINE = urinary conditions; WOUND = wound related diseases or syndromes |
Table 2  Plants not shared between the four study areas in East Sepik Province

| BK  | DK       | GW                       | MS                       |
|-----|----------|--------------------------|--------------------------|
| Albizia saman (Jacq.) Merr. (BK 058/06) | Ageratum conyzoides (L.) L. (DK 38/05) | Albizia procera (Roxb.) Benth. (GW 09/04) | Abelmoschus manihot (L.) Medik. (MS 02/04) |
| Cascabela thevetia (L.) Lippold (BK 028/06) | Angiopteris evecta (G. Forst.) Hoffm. (DK 53/05) | Bidens pilosa L. (GW 40/04) | Artocarpus altis (Parkinson ex F.A. Zorn) Fosberg (MS 23/04) |
| Murraya paniculata (BK 003/06) | Areca catechu L. (DK 02/05) | Cerbera floribunda K. Schum. (GW 12/04) | Barringtonia asiatica (L.) Kurz (MS 27/04) |
| Premna serratifolia (BK 052/06) | Asplenium nidus L. (DK 21/05) | Clitoria ternatea L. (GW 91/04) | Callicarpa longifolia Lam. (MS 85/04) |
| Tabernaemontana pandacaqui Lam. (BK 054/06) | Bixa orellana L. (DK 11/05) | Gymnostoma papuana (S. Moore) L.A.S. Johnson (GW 11/04) | Calophyllum inophyllum L. (MS 20/04) |
| | Capsicum annuum L. (DK 15/05) | Hemigraphis reptans (G. Forst.) T. Anders. ex Hemsl. (GW 70/04) | Calotropis gigantea (L.) Dryand (MS 32/04) |
| | Carica papaya L. (DK 34/05) | Hydratele costata F.M. Bailey (GW 83/04) | Carya rumphiana Mart. (MS 69/04) |
| | Caryota mitis Lour. (DK 26/05) | Maclura cochinchinensis (Lour.) Corner (GW 46/04) | Casuanina equisetifolia L. (MS 28/04) |
| | Cheilocostus speciosus (J. König) C. Specht (DK 20/05) | Mangifera indica L. (GW 93/04) | Chrysopogon aciculatus (Retz). Trin (MS 50/04) |
| | Dendrocnide cordata (Warb. ex H.J.P. Winkl) Chew (DK 35/05) | Neonauclea purpurea (Roxb.) Merr. (GW 10/04) | Cocos nucifera L. (MS 78/04) |
| | Homalium foetidum (Roxb.) Benth. (DK 42/05) | Pisonia longirostris Teijsm. & Binn. (GW 32/04) | Dendrocnide latifolia (Gaudich.) Chew (MS 33/04) |
| | Manihot esculenta Crantz (DK 51/05) | Solanum torvum Sw. (GW 26/04) | Euphorbia tithymaloides (L.) (MS 79/04) |
| | Metroxylon sagu Rottb. (DK 30/05) | Sterculia shillinglawii F. Mull. (GW 04/04) | Ocimum basilicum L. (MS 08/04) |
| | Piscidia grandifolia (Donn. Sm.) I.M. Johnst. (DK 31/05) | | Pandanus dubius Spreng. (MS 30/04) |
| | Planchonia papuana R. Knuth (DK 45/05) | | Scaevola sericea Vahl (MS 63/04) |
| | Riedelia carallina (K. Schum.) Valeton (DK 18/05) | | Schismatoglottis calyptrata (Roxb.) Zoll. & Moritz (MS 83/04) |
| | | | Sida rhombifolia L. (MS 76/04) |

Identified to Genus only (Voucher)

| Christia sp. (BK 008/06) | Cinnamomum sp. (DK 54/05) | Aglaia sp. (GW 56/04) | Archidendron sp. (MS 01/04) |
| Clematis sp. (BK 049/06) | | Asclepias sp. (GW 79/04) | Davallia sp. (MS 70/04) |
| Neonauclea sp. (BK 061/06) | | Cissus sp. (GW 59/04) | Dillenia sp. (MS 81/04) |
| Phrynium sp. (BK 014/06) | | Clerodendrum sp. (GW 87/04) | Graptophyllum sp. (MS 14/04) |
| Vanilla sp. (BK 012/06) | | Desmodium sp. (GW 101/04) | Homalanthus sp. (MS 05/04) |
| | | Mitracarpus sp. (GW 20/04) | Marattia sp. (MS 16/04) |
| | | Papuechites sp. (GW 65/04) | Melastoma sp. (MS 36/04) |
| | | Parsonia sp. (GW 29/04) | Villebrunea sp. (MS 13/04) |
infections (e.g., “Grille”) and ectoparasitism (e.g., scabies); the category “REP” contains all sort of reproductive conditions, e.g., impotence, abortion, menstrual syndromes, contraception and fertility, etc. The exception to this method of categorization is malaria, which is generally well recognized throughout the Sepik. Overall, skin conditions were most frequently treated (73 instances), with respiratory conditions (60 instances), fever (39 instances), gastrointestinal conditions (36 instances) and malaria (29 instances) rounding out the top five conditions. The top five conditions in the respective reports were: for MS (fever—19, skin—18, headache—16, respiratory and gastrointestinal—12 reports each); BK (skin—22, respiratory—15, gastrointestinal

Fig. 1 Traditional plant usage pattern by plant part utilized across four study areas in East Sepik province in percentile of total for each study area; y = young

Fig. 2 Method of preparation of plants for traditional medicines across four study areas in East Sepik province in percentile of total for each study area; MS = masticated then spit on affected area(s), R = raw; S = succus (crushed)
conditions—7 wounds—6, and pain—5 instances): DK (skin—16, respiratory—8, malaria and wounds—5 instances each, and fever—4 instances); GW (respiratory—25, skin and malaria—17 each, gastrointestinal conditions and fever—14 instances each). The relative frequencies of ailments/conditions are presented in Fig. 4. Outlier conditions, those reported once and not reported in the other areas were urinary conditions (incontinence, URINE; and delousing, INSECTICIDE) from the MS report; use for burn conditions (BURN), magical poisoning

Fig. 3 Mode of administration of plant based traditional medicines across four study areas in East Sepik province in percentile of of total for each study area; P_to_Plant = patient to plant transfer of blood

Fig. 4 Coded ailments treated with plant based traditional medicines across four study areas in East Sepik province in percentile of of total for each study area; BITE = insect or snake bite; BLOOD = hematological issues including coagulation; BONE = bone related injury or disease; CANC = cancer; CV = Cardiovascular; CHILD = childhood disease; DENT = dental disease; FEV = fever; GAST = gastrointestinal disease; HEAD = headache; INF = infection; MAGIC = disease of unidentified etiology; MAINT = health promotion, including failure to thrive; MAL = Malaria; NUT = nutritional supplement; OCC = ocular diseases; ORG = diseases thought to affect one particular organ; POS = envenomation or poisoning; sometimes this includes transnatural causation; PSYCH = psychiatric diseases or syndromes; REP = reproductive diseases including childbirth related issues; RESP = respiratory diseases; SKIN = dermal related diseases; often includes infectious disease; SWELL = swelling of whole body or part of the body; WOUND = wound related diseases or syndromes
(MAGIC) and child health improvement (CHILD) from the DK area; and cancer (CANC) and cardiovascular condition (CV) from the GW area.

Most common families of plants used by healers interviewed
By far the most common genus was *Ficus* (11), followed by *Euphorbia* (7), *Piper* (6), *Plectranthus* (6), *Cassia* (5), *Passiflora* (5), and 4 instances each of: *Acalypha*, *Alpinia*, *Alstonia*, *Calamus*, *Crinum*, *Gnetum*, *Laportea*, *Merremia*, *Mucuna*, *Phyllanthus*, *Syzygium*, *Uncaria*, and *Zingiber*.

Lesser known medicinal plant species of East Sepik
Those plants identified to the species level and not found in the Bougainville and Eastern Highlands reports were matched against our medicinal plants of PNG reference database, consisting of historical reports largely by Holdsworth and associates. The following plants were not described in the literature which the database encompasses: *Averrhoa carambola* L. (BK 039/06 & DK 01/05), *Camposperma brevipetiolatum* Volkens Volkens. (DK 56/05), *Capsicum annuum* L. (DK 15/05), *Caryota mitis* Lour. (DK 26/05), *Cascabela thevetia* (L.) Lippold (BK 028/06), *Chrysopogon aciculatus* (Retz). Trin (MS 50/04), *Clitoria ternatea* L. (GW 91/04), *Curcuma longa* L. (BK 029/06), *Cycas rumphii* Miq. (BK 002/06), *Endospermum labios* Schodde (DK 40/05), *Endospermum formicarium* Becc. (GW 28/04), *Endospermum medullosum* L.S.Sm. (MS 89/04), *Erythrina serrulata* Krukoff (GW 18/04 & MS 42/04), *Hydrastele costata* F.M. Bailey (GW 83/04), *Intsia bijuga* (Colebr.) Kuntze (DK 33/05 & GW 08/04 & MS 46/04), *Milletia pinnata* (L.) Panigrahi (GW 30/04), *Planchonia papuana* R. Knuth (DK 45/05), *Riedelia corallina* (K. Schum.) (DK 18/05), *Schismatoglottis calyptra* (Roxb.) Zoll. & Moritz (MS 83/04), *Sterculia shillin-glawii* F. Muell. (GW 04/04), and *Tinospora arfakiana* Becc. (GW 82/04).

*Capsicum annuum* L. and *Curcuma longa* L. are commonly grown in many gardens across PNG, yet it was surprising to note the paucity of medicinal uses previously reported for PNG. *Ipomoea pes-caprae* (L.) R. Br. (BK 020/06 & MS 26/04) also did not appear to be part of the older literature, however, it was recently found to be used in the New Britain Province where the leaves are rubbed onto the skin affected by jelly fish stings [12]. The sap is used in the BK area for respiratory ailments, and the succus from the leaves is reported by MS to be used in Kairiru for fever/pain via oral consumption.

Comparing East Sepik with Eastern highlands and Bougainville provinces
The combined dataset of the East Sepik, Eastern Highlands and Bougainville reports encompasses 276 plant genera, of which only 22 were reported in common from our other published data sets; Bougainville 112 genera, Eastern highlands 121, and East Sepik 154 genera (see Fig. 5). The frequency of shared genera is given in Table 3. The plant genera with the highest common use citations (> = 10) are *Ficus* sp. 29, *Alpinia* sp. 16, *Piper* sp. 15, *Syzygium* sp. 12 and *Alstonia* sp.11. The predominance of *Ficus* sp. is not surprising since *Ficus* represents a very large genus in PNG [13].

Regional utilization of plants
Comparison of plants used medicinally in our published data sets to a general list of plants from the same regions allowed for an analysis of utilization preferences. Medicinally over- and under-represented plant families are given in Table 4, while medical plant utilization is given in Table 5. Comparison shows that the number of plant families significantly underutilized, when compared against the regional flora, breaks down as follows: in East Sepik (ES) province Poaceae are underutilized, while in the Eastern Highlands (EH) and Bougainville (BV) Orchidaceae are underutilized.

The number of plants overutilized varies (ES: n = 15; EH: n = 25 and BV: n = 12) but is relatively stable as percentage of plants found in the regional database at 0.66, 0.7 and 0.78 % for ES, EH and BV, respectively. East
Sepik shares overutilization of Fabaceae, Gnetaceae and Zingiberaceae with Bougainville and overutilization of Asteraceae and Lamiaceae with Eastern Highlands, while Eastern Highlands and Bougainville share no overutilized plant families.

When the UPNG Traditional Medicines Database was used to assess utilization, the underrepresented plant families were the Verbenaceae in East Sepik and the Euphorbiaceae in the Eastern Highlands. No plant family met the \( p = 0.05 \) criterion in Bougainville, however, Euphorbiaceae was the top ranked underutilized plant family (data not shown). The number of overutilized plants is varied (ES: \( n = 4 \); EH: \( n = 17 \); BV: \( n = 12 \)). Among the overused plant families East Sepik shared the Arecaceae with Bougainville. Several plant families reappear in this analysis, e.g., the Asteraceae and Winteraceae from the Eastern Highlands province and the Gnetaceae and Zingiberaceae in Bougainville. The statistical requirements of the comparison method resulted in some plant families appearing in the overutilization category represent a single report from the region for that plant family. This could not be avoided since the East Sepik reports are included in the UPNG Traditional Medicines Database total. As the PNG Medicinal Plant Database database grows in the future the stringency of the analysis will improve.

Traditional inspection of the information gathered yielded information about plants not widely used, poorly annotated or used for different ailments than those in locales where use of the plant is more common. Plants without annotation in the recent PNG Medicinal Plant Literature include:

- **Alocasia cucullata** (Lour.) G. Don surprisingly did not yield any crossreferences in the PNG database, even when using synonyms. It is used in Chinese medicine for snakebite, abscesses, rheumatism, and arthritis [14] and has recently been identified as containing anticancer compounds [15, 16].

- **Averrhoa carambola** L. (starfruit) fruit is used for cuts and asthma in PNG, and also widely used throughout the world for a variety of ailments, seemingly only in India as antihemorrhagic [17].

- **Caryota mitis** Lour. has no further medicinal annotation for use in PNG, but is used several Asian countries for a variety of ailments, e.g., against hemorrhoids, male sexual dysfunction, and rheumatoid arthritis in Bangladesh [17].

- **Chrysopogon aciculatus** (Retz). Trin is used in the East Sepik for swelling. The plant is used in Ayurveda as a diuretic [17, 18].

- **Clitoria ternatea** L. is used for infertility in PNG and similarly in Ayurveda, where fresh root juice in fresh goat milk is used for pregnancy [18], however, the plant is used for a dizzying array of conditions and ascribed activities [17].

- **Endospermum medullosum** L.S.Sm. has been described previously as used against rheumatism [18], perhaps similar to the use against general body pain in the East Sepik.

- **Erythrina merrilliana** Krukoff reveals a dearth of information regarding medicinal uses. The plant is however known to produce toxic alkaloids [19].

- **Gnetum gnemonoides** Brongn. yielded very little information as to medicinal use, but has been described to contain a variety of stilbenes [20].

- **Hemigraphis reptans** (G. Forst.) T. Anderson ex Hemsl. is used in the East Sepik as the whole plant to treat centipede bite. The root is expressed into water to facilitate birth (speeding up delivery) on Vanuatu [21].

- **Intsia bijuga** (Colebr.) Kuntze has annotations as a detoxicant and against diarrhea, toothache, adenopathy and swelling [22].

- **Macaranga clavata** Warb. is used in East Sepik for skin infections, but has no recent mention in the literature for

### Table 3 Plant Genera in common utilized in Bougainville, Eastern Highlands and East Sepik Provinces

| Genus            | Bougainville | Eastern Highlands | East Sepik | Total |
|------------------|--------------|-------------------|------------|-------|
| Ageratum         | 2            | 1                 | 1          | 4     |
| Alpinia          | 7            | 5                 | 4          | 16    |
| Alstonia         | 4            | 3                 | 4          | 11    |
| Aristolochia     | 1            | 1                 | 2          | 4     |
| Barringtonia     | 2            | 1                 | 1          | 4     |
| Ficus            | 11           | 7                 | 11         | 29    |
| Graptophyllum    | 1            | 1                 | 1          | 3     |
| Hemigraphis      | 1            | 2                 | 1          | 4     |
| Leucosyke        | 1            | 1                 | 1          | 3     |
| Litsea           | 1            | 1                 | 2          | 4     |
| Melastoma        | 1            | 2                 | 1          | 4     |
| Mucuna           | 3            | 1                 | 5          | 9     |
| Musa             | 2            | 1                 | 2          | 5     |
| Piper            | 4            | 5                 | 6          | 15    |
| Plectranthus     | 2            | 1                 | 6          | 9     |
| Psidium          | 2            | 1                 | 2          | 5     |
| Sida             | 1            | 1                 | 1          | 3     |
| Smilax           | 1            | 3                 | 1          | 5     |
| Syzygium         | 4            | 4                 | 4          | 12    |
| Uncaria          | 2            | 1                 | 2          | 5     |
| Zingiber         | 1            | 2                 | 4          | 7     |

Database database grows in the future the stringency of the analysis will improve.
Table 4 Overrepresented and underrepresented plants for each province when compared to the regional plant diversity as recorded in the PNG Plant Database

| Province          | # in PNG PlantDB | # in ES Medical Plants Reports | Inferior Credible Interval | Superior Credible Interval | Difference to interval (margin) |
|-------------------|------------------|--------------------------------|---------------------------|----------------------------|--------------------------------|
| East Sepik        | 2258             | 207                            | 0.080                     | 0.104                      | -                              |
| Overrepresented Families |          |                                 |                           |                            |                                |
| Araceae           | 13               | 7                              | 0.289                     | 0.770                      | 0.184                          |
| Zingiberaceae     | 14               | 6                              | 0.213                     | 0.677                      | 0.108                          |
| Marantaceae       | 3                | 2                              | 0.194                     | 0.932                      | 0.090                          |
| Solanaceae        | 9                | 4                              | 0.187                     | 0.738                      | 0.083                          |
| Euphorbiaceae     | 83               | 22                             | 0.182                     | 0.369                      | 0.078                          |
| Convolvulaceae    | 13               | 5                              | 0.177                     | 0.649                      | 0.072                          |
| Datiscaeae        | 1                | 1                              | 0.158                     | 0.987                      | 0.054                          |
| Fabaceae          | 82               | 19                             | 0.154                     | 0.334                      | 0.050                          |
| Gnetaceae         | 4                | 2                              | 0.147                     | 0.853                      | 0.042                          |
| Davalliaee        | 8                | 3                              | 0.137                     | 0.701                      | 0.033                          |
| Lamiaceae         | 42               | 10                             | 0.135                     | 0.386                      | 0.031                          |
| Anacardiaceae     | 18               | 5                              | 0.126                     | 0.512                      | 0.021                          |
| Asteraceae        | 19               | 5                              | 0.119                     | 0.491                      | 0.015                          |
| Menispermeaceae   | 15               | 4                              | 0.110                     | 0.524                      | 0.006                          |
| Poaceae           | 156              | 156                            | 0.010                     | 0.080                      | 0.028                          |
| Underrepresented Families |        |                                 |                           |                            |                                |
| Eastern Highlands | 3549             | 156                            | 0.038                     | 0.051                      | -                              |
| Overrepresented Families |        |                                 |                           |                            |                                |
| Ebenaceae         | 2                | 2                              | 0.292                     | 0.992                      | 0.241                          |
| Winteraceae       | 2                | 2                              | 0.292                     | 0.992                      | 0.241                          |
| Acanthaceae       | 12               | 5                              | 0.192                     | 0.684                      | 0.141                          |
| Hyloxidaceae      | 1                | 1                              | 0.158                     | 0.987                      | 0.107                          |
| Smilacaceae       | 7                | 3                              | 0.157                     | 0.755                      | 0.106                          |
| Plantaginaceae    | 5                | 2                              | 0.118                     | 0.777                      | 0.067                          |
| Lamiaceae         | 21               | 5                              | 0.107                     | 0.454                      | 0.056                          |
| Arallaceae        | 17               | 4                              | 0.097                     | 0.476                      | 0.046                          |
| Commelinaceae     | 2                | 1                              | 0.094                     | 0.906                      | 0.043                          |
| Elaeagnaceae      | 2                | 1                              | 0.094                     | 0.906                      | 0.043                          |
| Actinidiaceae     | 14               | 3                              | 0.078                     | 0.481                      | 0.027                          |
| Asteraceae        | 103              | 13                             | 0.076                     | 0.204                      | 0.024                          |
| Bignoniaceae      | 3                | 1                              | 0.068                     | 0.806                      | 0.016                          |
| Casuarinaceae     | 3                | 1                              | 0.068                     | 0.806                      | 0.016                          |
| Lecythidaceae     | 3                | 1                              | 0.068                     | 0.806                      | 0.016                          |
| Symplacaceae      | 3                | 1                              | 0.068                     | 0.806                      | 0.016                          |
| Onagraceae        | 9                | 2                              | 0.067                     | 0.556                      | 0.016                          |
medicinal use. No scientific background information was located, hence this particular plant may be understudied. The same is also true for Macaranga darbyshirei Airy Shaw, used in the East Sepik as an antivenom, but not elsewhere mentioned for medicinal purposes. Pandanus dubius Spreng. was not found to have any properly referenced medicinal annotations, but appears to have a fairly recent research record including discovery of two novel alkaloids, dubiusamines-A and dubiusamines-B [23].

Piper mestonii F.M. Bailey leaves used for fresh cuts and wounds do not seem to be described elsewhere. No biochemical investigation could be located in the Dictionary of Natural Products [24].

Planchonia papuana R. Knuth appears to be not used medicinally elsewhere. It is a timber tree and perhaps as such has not attracted attention; however, in an antiviral screen in our lab fractions from P. papuana exhibited anti-HIV activity [25].

Plectranthus parviflorus Willd., along with Plectranthus blumei (Benth). Launert, and Plectranthus myrianthus Briq. belong to a genus prominent for production of essentials oils [26] and with multiple annotations for antimicrobial activity, but do not seem to be described elsewhere in the PNG plant literature. The utilization of these plants for sores, ulcers and fresh cuts appear to be in line with the activities of chemicals found in Plectranthus species [27].

Table 4 Overrepresented and underrepresented plants for each province when compared to the regional plant diversity as recorded in the PNG Plant Database (Continued)

| Family        | # in PNG PlantDB | # in BV Medical Plants Reports | Inferior Credible Interval | Superior Credible Interval | Difference to interval (margin) |
|---------------|------------------|-------------------------------|---------------------------|----------------------------|--------------------------------|
| Theaceae      | 9                | 2                             | 0.067                     | 0.556                      | 0.016                          |
| Begoniaceae   | 10               | 2                             | 0.060                     | 0.518                      | 0.009                          |
| Balsaminaceae | 4                | 1                             | 0.053                     | 0.716                      | 0.002                          |
| Caprifoliaceae| 4                | 1                             | 0.053                     | 0.716                      | 0.002                          |
| Icacinaceae   | 4                | 1                             | 0.053                     | 0.716                      | 0.002                          |
| Oxalidaceae   | 4                | 1                             | 0.053                     | 0.716                      | 0.002                          |
| Selaginellaceae| 4               | 1                             | 0.053                     | 0.716                      | 0.002                          |
| Usneaceae     | 4                | 1                             | 0.053                     | 0.716                      | 0.002                          |

Underrepresented Families

| Family        | # in PNG PlantDB | # in BV Medical Plants Reports | Inferior Credible Interval | Superior Credible Interval | Difference to interval (margin) |
|---------------|------------------|-------------------------------|---------------------------|----------------------------|--------------------------------|
| Orchidaceae   | 191              | 1                             | 0.001                     | 0.029                      | −0.009                         |

Bougainville (BV) Reports vs PNG PlantDB (BV Total Flora)

| Family        | # in PNG PlantDB | # in BV Medical Plants Reports | Inferior Credible Interval | Superior Credible Interval | Difference to interval (margin) |
|---------------|------------------|-------------------------------|---------------------------|----------------------------|--------------------------------|
| Overrepresented Families

| Family        | # in PNG PlantDB | # in BV Medical Plants Reports | Inferior Credible Interval | Superior Credible Interval | Difference to interval (margin) |
|---------------|------------------|-------------------------------|---------------------------|----------------------------|--------------------------------|
| Verbenaceae   | 3                | 3                             | 0.398                     | 0.994                      | 0.280                          |
| Musaceae      | 2                | 2                             | 0.292                     | 0.992                      | 0.175                          |
| Zingiberaceae | 19               | 9                             | 0.272                     | 0.685                      | 0.155                          |
| Gnetaceae     | 3                | 2                             | 0.194                     | 0.932                      | 0.077                          |
| Areaceae      | 19               | 7                             | 0.191                     | 0.592                      | 0.074                          |
| Marattiaceae  | 6                | 3                             | 0.184                     | 0.816                      | 0.067                          |
| Caricaceae    | 1                | 1                             | 0.158                     | 0.987                      | 0.041                          |
| Xanthorrhoeaceae | 1        | 1                             | 0.158                     | 0.987                      | 0.041                          |
| Leaceae       | 4                | 2                             | 0.147                     | 0.853                      | 0.029                          |
| Fabaceae      | 53               | 12                            | 0.135                     | 0.356                      | 0.018                          |
| 9              | 3                             | 0.122                     | 0.652                      | 0.004                          |
| Thelypteridaceae | 30            | 7                             | 0.119                     | 0.411                      | 0.001                          |

Underrepresented Families

| Family        | # in PNG PlantDB | # in BV Medical Plants Reports | Inferior Credible Interval | Superior Credible Interval | Difference to interval (margin) |
|---------------|------------------|-------------------------------|---------------------------|----------------------------|--------------------------------|
| Orchidaceae   | 74               | 1                             | 0.003                     | 0.072                      | −0.015                         |

85 Bougainville, EH Eastern Highlands, ES East Sepik, PNG PlantDB Papaua New Guinea Plant Database [10]
Table 5 Overrepresented and underrepresented plants for each province when compared to the regional plant diversity as recorded in the UPNG Traditional Medicines Database

| Eastern Highlands (EH) vs UPNG TradMed DB | # in UPNG TradMed DB | # in EH Medical Plants Reports | Inferior Credible Interval | Superior Credible Interval | Difference to interval (margin) |
|------------------------------------------|-----------------------|--------------------------------|-----------------------------|----------------------------|--------------------------------|
| Total                                    | 1176                  | 147                            | 0.107                       | 0.145                      | -                              |
| Overrepresented Families                  |                       |                                |                             |                            |                                |
| Monimiaceae                              | 2                     | 2                              | 0.292                       | 0.992                      | 0.147                          |
| Plantaginaceae                           | 2                     | 2                              | 0.292                       | 0.992                      | 0.147                          |
| Winteraceae                              | 2                     | 2                              | 0.292                       | 0.992                      | 0.147                          |
| Melastomataceae                          | 7                     | 4                              | 0.245                       | 0.843                      | 0.100                          |
| Asparagaceae                             | 5                     | 3                              | 0.223                       | 0.882                      | 0.078                          |
| Smilacaceae                              | 5                     | 3                              | 0.223                       | 0.882                      | 0.078                          |
| Onagraceae                               | 3                     | 2                              | 0.194                       | 0.932                      | 0.049                          |
| Pittosporaceae                           | 3                     | 2                              | 0.194                       | 0.932                      | 0.049                          |
| Asteraceae                               | 47                    | 13                             | 0.170                       | 0.418                      | 0.024                          |
| Phyllanthaceae                           | 1                     | 1                              | 0.158                       | 0.987                      | 0.013                          |
| Caryophyllaceae                          | 1                     | 1                              | 0.158                       | 0.987                      | 0.013                          |
| Chloranthaceae                           | 1                     | 1                              | 0.158                       | 0.987                      | 0.013                          |
| Elaegnaceae                              | 1                     | 1                              | 0.158                       | 0.987                      | 0.013                          |
| Oleaceae                                 | 1                     | 1                              | 0.158                       | 0.987                      | 0.013                          |
| Polygalaceae                             | 1                     | 1                              | 0.158                       | 0.987                      | 0.013                          |
| Tiliaceae                                | 1                     | 1                              | 0.158                       | 0.987                      | 0.013                          |
| Proteaceae                               | 4                     | 2                              | 0.147                       | 0.853                      | 0.001                          |
| Underrepresented Families                |                       |                                |                             |                            |                                |
| Euphorbiaceae                            | 88                    | 3                              | 0.012                       | 0.095                      | -0.012                         |

Bougainville (BV) Reports vs UPNG TradMedDB

| # in UPNG TradMed DB | # in BV Medical Plants Reports | Inferior Credible Interval | Superior Credible Interval | Difference to interval (margin) |
|----------------------|--------------------------------|-----------------------------|----------------------------|--------------------------------|
| Total                | 1177                           | 146                         | 0.106                      | 0.144                         | -                              |
| Overrepresented Families |                             |                              |                            |                                |                                |
| Areaceae             | 10                              | 7                            | 0.390                       | 0.891                        | 0.246                          |
| Leeaceae             | 2                               | 2                            | 0.292                       | 0.992                        | 0.148                          |
Riedelia corallina (K. Schum.) Valeton, in the Zingiber family, is used for menstrual cramps, but seems to be otherwise undescribed for medicinal uses elsewhere.

The leaves of Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi are used in East Sepik to treat skin sores. No other mention was found in the PNG literature. The stems of Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi are however used in Chinese medicine for treatment of lumbago and arthralgia [18].

Sterculia shillinglawii F. Muell. has no previous annotation for PNG, but is known to be used in the Solomon island as a tonic and to reduce fever [18].

Tinospora arfakiana Becc. likewise lacks further medicinal descriptions from PNG and does not seem to have been studied from any other area, making it a potentially understudied plant.

Uncaria lanosa var. appendiculata (Benth.) Ridsdale was mentioned twice in the reports and in both instances to treat fever, but also gastrointestinal diseases, malaria, and malnutrition. No other mention for ethnomedical use could be located from PNG or other locales. However, a recent publication hints at a potential anti-depressant effect of ethanolic extracts of Uncaria lanosa var. appendiculata (Benth.) Ridsdale [28].

Uncaria orientalis Guillaumin, used to treat shortness of breath in the East Sepik, lacks pharmacological annotation, but has been investigated extensively biochemically [29, 30].

Conclusions
This report shows that in the East Sepik province of PNG the patterns of plant usage for medicinal indications is highly varied. This is true even though many of the same plants are used in ethnologically distinct regions. There is a tendency for widely used plants to be used for multiple diseases, often with differing preparation of the parts utilized and differing modes of administration. One such example is Alstonia scholaris (L.) R.Br. which shares only the route of administration between all areas. Regardless, plants not previously documented as being used medicinally can still be uncovered, e.g., Cascabela thevetia (L.) Lippold, a plant known to contain highly toxic cardiac glycosides [31] and Dendrocnide cordata (Warb. ex H.J.P. Winkl.) Chew cannot be found as being used medicinally, however, toxicity from leaves, which are used in East Sepik, has been documented [18].

Comparison of plant utilization across study areas can likewise uncover plants which share use. A good example is the genus Alpinia, for which gastroenterological, respiratory and reproductive use are cited for Bougainville. In the Eastern Highlands it is used for gastroenterological and respiratory conditions. In the East Sepik it is also used for respiratory conditions. Alpinia is in the ginger family, widely used culinarily and medicinally around the world, with traditional medicinal uses for several of the described symptoms.

Likewise, dissemination of knowledge of useful phytomedicinal practices amongst areas that share key flora may aid health practices in those areas. In any case, further studies and phytochemical analyses need to be completed before addition of plants to the pharmacopeia for PNG (a goal of the National Policy for Traditional Medicine in PNG). The UPNG Traditional Medicines Database, while still being populated with data, can already be utilized to show correlations and extract lead information for targeting certain plants for further study. Further enhancements and perhaps adaptation of other data sources (e.g., the PNG Plant Database with up-to-date plant nomenclature) would drive statistical discovery of
medicinally neglected plant genera. It is shown here that transregional comparisons are possible, but require careful recoding of previous reports and standardization of database entries and terminology.

Analysis of frequency of use of plant families in the medical tradition points to certain biases. This can ultimately be useful in targeting plants for biochemical investigation. However, if the desired outcome of the ethnobotany endeavor is to highlight useful plants for the pharmacopeia, then finer grained data is needed in order to dissect the wealth of information gathered, (e.g. precise geographic location including environmental conditions, etc.). Annotation with biochemical information, conservation status, toxicity data would yield utility for a more diverse set of scientists. To this end the diverse efforts of PNG botany, ethnobotany, ethnopharmacology and plant conservation need to collaborate more rigorously to define useful interfaces for each other’s data needs. Nevertheless, we have been able to successfully show that medicinal plant use in terms of families utilized in the East Sepik resembles Bougainville provinces more than it does the Eastern Highlands. Future work with larger data sets will address whether such similarities are due to similarities of available flora or other causes.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
MK wrote and edited the manuscript. MKB prepared ethnobotanical data sets for use in the manuscript. DAK, GW, BK and MS performed interviews and wrote reports under guidance of PPR and TM who also reviewed the manuscript. All authors read and approved the final manuscript.

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