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ABSTRACT

Ethnopharmacological relevance: Documentation of Australian bush medicines is of utmost importance to the preservation of this disappearing and invaluable knowledge. This collaboration between the Yaegl Aboriginal community in northern New South Wales (NSW), Australia and an academic institution, demonstrates an effective means of preserving and adding value to this information.

Materials and Methods: Questionnaire-guided interviews were performed with community Elders under a framework of participatory action research. Medicinal plant knowledge was collated in a handbook to aid interviews and to be used as an ongoing resource by the community. Specimens for all non-cultivar plants that were discussed were collected and deposited in herbaria with unique voucher numbers. This medicinal knowledge was checked against the literature for reports of related use and studies of biological activity.

Results: Nineteen Elders were interviewed, leading to discussions on fifty four plant preparations used for medicinal purposes. These plant preparations involved thirty two plants coming from twenty one families, reflecting the botanical diversity of the area. The plants retained in the Yaegl pharmacopoeia correspond to their accessibility and ease of preparation, reflected in their ongoing utilisation. Several plant uses did not appear elsewhere in the literature.

Conclusions: This study is the first comprehensive documentation of the medicinal knowledge of the Yaegl Aboriginal community. It has been conducted using participatory action research methods and adds to the recorded customary knowledge of the region. The customary medicinal knowledge retained by the Yaegl Aboriginal community is related to the evolving needs of the community and accessibility of plants.

Classification: Anthropological and historical studies in ethnopharmacology

Keywords: Medicinal Plants; Ethnobotany; Australian Aboriginal; Participatory Action Research; Customary Medicinal Knowledge; New South Wales

1. Introduction

The continent of Australia stands as a valuable setting for ethnopharmacological research. Being one of the world's seventeen megadiverse countries (Williams et al., 2001), it has a wealth of plant resources. The state of New South Wales (NSW) occupies a south eastern portion of the Australian land mass. Its vegetation represents a microcosm of the Australian continent with tropical savannas and rainforests, temperate broadleaf forests, alpine and sub-alpine, semi-arid and arid rangelands and deserts (Department of the Environment Water Heritage and the Arts, 2010).

Aboriginal people have lived in Australia's harsh climates for centuries, generating strong links and an intimate understanding of the dynamics of the land over generations. However, as with Indigenous communities in many parts of the world, there has been an alarming rate of loss of traditional languages and knowledge of Australian Aboriginal people. This has been influenced by globalisation, marginalisation, environmental pressures and economic and health inequity (Sutherland, 2003). Indeed the diminishing numbers and dislocation of peoples from their traditional environments, is seeing the disappearance of the knowledge holders and practitioners at a faster rate than the plants themselves (Anyinam, 1995). Deforestation of areas has also had significant consequences for the availability and accessibility of ethnomedicines, with only approximately 30% of pre-European native vegetation remaining in the farmed regions of NSW (Benson, 1999).

This study focuses on the customary medicinal knowledge held by the Yaegl people, who live in and around the towns of Maclean and Yamba, situated along the banks of the Clarence River, in the Northern Rivers region of northern NSW. The first residents of the area were the Yaygir tribe after whom the neighboring Yuragyir national park was named and Yaegl derived its name (McSwan, 1992).

Ulgundahi Island is one of the numerous river islands of the Clarence River located off the township of Maclean. The island has been occupied by Aboriginal people since 1880, when many retreated to and/or were relocated to the island from the surrounding areas through pressure from the growing agriculture industry in the area. It was gazetted as an Aboriginal Reserve in 1904, and accommodated a school, store and a church (McSwan, 1992), and remained populated by many Aboriginal families until the late 1950s (Heritage Branch, 2008). The Aboriginal families were encouraged to be self sufficient through farming and 'living off the land' with strict rationing of food and medicines, which were not always able to be provided during the flood times (Heritage Branch, 2008). The recurrent flood episodes eventually drove the families from the island to the mainland and the coastal town of Yamba, where there was plenty of bush foods and medicines to draw on (Heritage Branch, 2008). The Yaegl community and descendants of those who lived on the island maintain a strong connection with the place. The island continues to be used by the Yaegl Aboriginal community for educational tours and organic farming. The use of bush medicines and resources has been maintained largely on a needs basis, transmitted through oral means, with much knowledge being lost as needs changed with European colonisation.

There have been various studies documenting the use of bush medicines among Australian Aboriginal communities (Beck and Balme, 2003; Edwards and Heinrich, 2006; Hiddins, 1999; Isaacs, 1987; Jones et al., 2007; Lassak and McCarthy, 2008; Low, 1990; O'Connell et al., 1983; Pearn, 2005), but little focus has been placed on the Aboriginal use of traditional medicines in NSW (Packer et al., 2011a). This is especially the case for the north coast region of NSW where specific records

have until now been largely limited to an account of white settlers' observations (Ryan, 1964) and an archaeological survey of this region (Byrne, 1990), which makes mention of some of the available bush resources. The first written record from an Indigenous perspective focussing on this region is an academic thesis, which makes reference to bush foods and medicines as part of an ethnohistorical study (Heron, 1991).

This study, conducted as a partnership between Yaegl Elders and Macquarie University researchers, is the first comprehensive study on the ethnomedicinal knowledge of the Yaegl people of the north coast region of NSW. The aim of this study is to promote the preservation of the invaluable but disappearing knowledge of the Yaegl Elders and to gain a greater understanding of the medicinal importance of the flora of the region.

2. Methods

2.1 Study Area

The approximate area traditionally occupied by the Yaegl people is outlined in Fig. 1, as determined by recent Native Title discussions (National Native Title Tribunal: NC96/38) and spans 29.22-29.87°S latitude and 153.03–153.39°E longitude. Being one of the smaller tribal groups, the dispersal and loss of tradition suffered by some of the larger tribes, such as the Bundjalung to the north of the Clarence is not as evident in this group (McSwan, 1992).

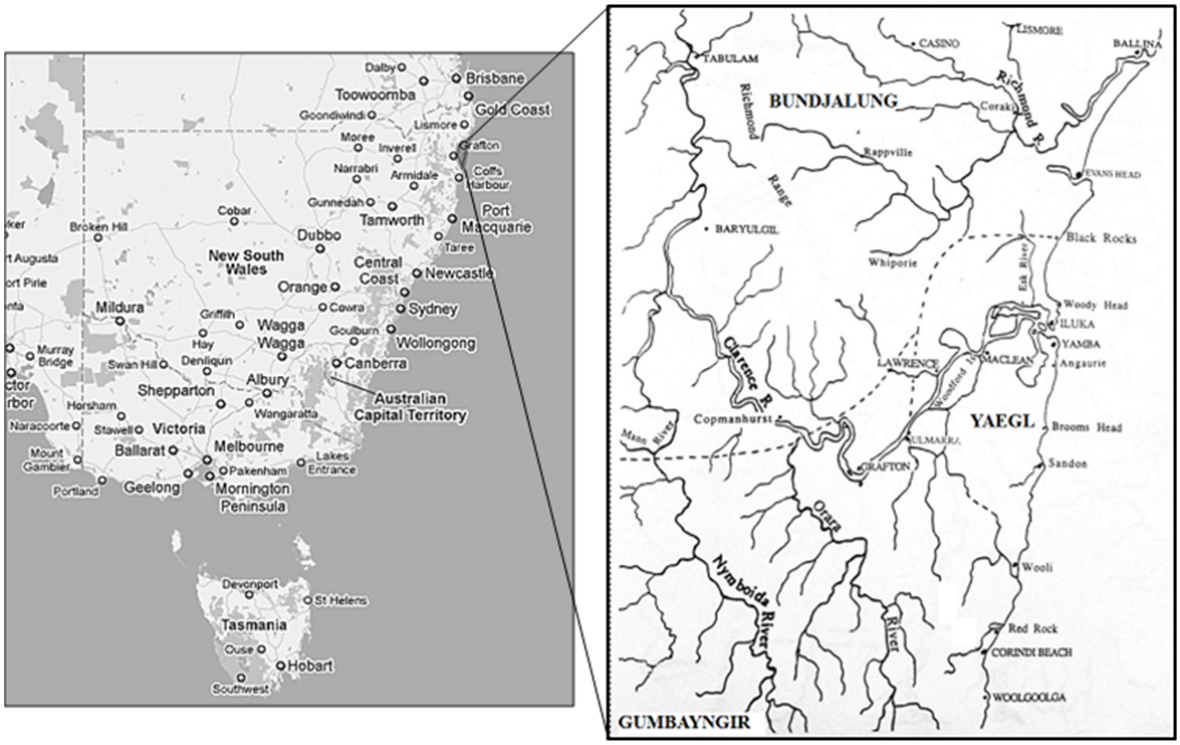

Fig. 1. Map of north eastern New South Wales, indicating the study area (updated from Heron, 1991)

Yaegl country (Fig. 1) approximately equates to the area encompassed by the Australian Bureau of Statistics' Statistical Local Area region of Clarence Valley (A) – Coast (SLA) National Regional Profile (Australian Bureau of Statistics, 2006). As of 2006, this region had a population of 20189, 4.1% of whom identified as being Indigenous. The dominant Indigenous community in this area is

Yaegl with strong links to the Bundjalung nation. Since the 1930s, the townships of Yamba and Maclean have been the two central communities in Yaegl country (Kijas, 2009).

2.2 Participatory Action Research (PAR)

This research follows UNESCO guidelines (UNESCO, 2007) relating to the establishment of cooperative research agreements with Indigenous communities and the NH&MRC Values and Ethics: Guidelines for Ethical Conduct in Aboriginal and Torres Strait Islander Health Research (NH&MRC, 2003). Key to this research is an understanding of the cultural values and contemporary needs of the community, and it is performed in parallel with benefit sharing activities. Our work and research outcomes ensure that reciprocal rights and responsibilities are identified in written agreements with the communities.

The collection of data for this part of the project was performed under a PAR framework (Baum et al., 2006). As the essence of PAR is as an evolving process, regular visits were made to the community for meetings to update on the progress of the project and encourage feedback from the participants. Meetings were also used to inform community members of the framework and progress of the project and to encourage involvement. Ethics approval (reference number: HE27FEB2004-R02750) was obtained from Macquarie University prior to the commencement of this study and updated as the study progressed (HE27JUL2007-RO5356).

2.3 Interviews

Participants were largely selected via a 'snowballing' (Weiss, 1995) rather than a random sampling technique, whereby trust was gained through referrals and word of mouth. The sample size was largely achieved by the length of time that the research group was involved with the community to gain trust and a cohesive working relationship. Interviews were carried out over two periods, 2004-05 and 2009-11, during which time eight visits to the community were undertaken and on one occasion, a selection of Elders travelled to the university.

A total of nineteen participants were interviewed. Twelve participants were interviewed during the 2004-05 period. An additional seven participants were interviewed during the second round of interviews in 2009-11, with seven of the initial participants interviewed on both occasions. The process of collecting information from the community Elders was an evolving process as trust in the relationship was developed and information was collected and collated. Contact and capacity building activities continued throughout this time. With the consent of the participants, most of the interviews were recorded in both audio and visual format using minimally intrusive equipment. All respondents were over the age of fifty, and fifteen of the nineteen were female Elders.

The initial focus of the interviews was in-depth conversations with key respondents (Etkin, 1993), who were the elected senior male and female custodians of the community. The senior male custodian had independently performed academic research into the cultural history of the region (Heron, 1991) and was therefore particularly knowledgeable about the plant uses of the region. Other Elders either participated in focus groups or were interviewed on an individual basis using semi structured interviews (Etkin, 1993) depending on their preference. Where possible interviewees were given multiple opportunities for discussion or contact with the interviewers to add to, or build on the detail of the information already provided. Twelve (63%) of respondents were interviewed on at least two separate occasions and the key respondents on as many occasions as possible (up to seven times in

one case). Interviews were performed in a location chosen by the participant and ranged from the participant's home, the community centre, to walks in the field. In many cases a combination of locations was used.

Discussions were guided by a questionnaire developed with the intention of collecting comprehensive and standardised information for entry into a database (Gaikwad et al., 2008). Although this questionnaire was used to guide the interview, it was only completed at the conclusion of the interview with the aid of the audio and visual recordings and notes. This was done in order to have minimal disruption to the interview and to keep a comfortable and relaxed air about the process. As knowledge was collected, it was consolidated into a draft version of a handbook (Packer et al., 2011b) to promote discussion and confirmation of consensus in subsequent interviews. This booklet was built upon and on completion of the interview process, published and returned to the community for local use. Additional information regarding culture and history that was discussed during the interviews was also recorded.

Voucher specimens were collected for all non-cultivar species and deposited in either the Herbarium of the National Herbarium of NSW or the Macquarie University Herbarium and registered with the Index Herbariorum, New York Botanic Gardens (http://sciweb.nybg.org/science2/IndexHerbariorum.asp), with the acronym MQU. A unique identity number was generated (Table 1) and the identity of species confirmed. All other species and genera were confirmed in the field by one of the authors (DH), a botanist. The reported utilisation of medicinal plants was compared against printed English language texts and journal articles (searched against SciFinder Scholar, PubMed and Google Scholar), to determine the extent of their use in other communities and the current knowledge of their biological activity. Terminology and classification of conditions are often not clearly defined, both with respect to the interview proceedings and existing texts. Therefore, it is not always possible to draw direct correlations between reported applications and biological activities.

3. Results and discussion

Table 1. Summary of information collected through interviews and literature search on Yaegl customary medicinal plants

Scientific name[a]	Common Name	Habitat	Endemicity[c]	Part used[d]	Local Medicinal Uses	N.I. (n = 19)[e]	Agreement of literature with customary use[f]	Literature with reference to different customary use	Biological activity
***Alocasia brisbanensis* Domin** (MQ 73008910) ARACEAE	Cunjevoi	RFM	N	!L, St	burns and boils, cuts, sores, open wounds, ulcers	3A, 9B	none found[#]	(Hiddins, 1999; Lassak and McCarthy, 2008; Leiper and Hauser, 1984; Rahmatullah et al., 2010b)[#]	(Mulla et al., 2011; Mulla et al., 2010; Mulla et al., 2009a; Mulla et al., 2009b; Tien et al., 2004; Wang and Ng, 2003)[#]
				L	muscle injury	1B	none found		
				L	green ant bites	2B	none found[#]		
***Alphitonia excelsa* (Fenzl) Benth.** (NSW 792677) RHAMNACEAE	Soap tree, Red ash	RFM/Sc	N	L	antiseptic hand wash	2A, 2B	(Barr et al., 1988; Lassak and McCarthy, 2008; Leiper and Hauser, 1984; Webb, 1969)	(Brock, 2001; Cribb and Cribb, 1984; Isaacs, 1987; Lassak and McCarthy, 2008; Low, 1990; Vaughan, 1986; Webb, 1969)	(Rogers et al., 2002; Rogers et al., 2000)
***Ananas comosus* (L.) Merr** BROMELIACEAE	Pineapple	Cult	I	Sk, L	cleansing tonic	1B	(Kalpna et al., 2011)	(Kataki, 2010; Kulip, 2003; Morton, 1987; Sharma et al., 2001; Taussig and Batkin, 1988)	(Bhui et al., 2010; Hossain and Rahman, 2011; Kataki, 2010; Taussig and Batkin, 1988; Xie et al., 2007)
***Canavalia rosea* (Sw.) DC.** (MQ 73008909) FABACEAE	Coastal jackbean	C	N	L	boils and sores	2A, 1B	(Bhagya and Sridhar, 2009)	(Cribb and Cribb, 1984; Lassak and McCarthy, 2008; Low, 1990)	(Pattamadilok et al., 2008; Prabhu et al., 2010)
***Capsicum* spp.** SOLANACEAE	Chillies	Cult	I	F	colds, flu,	1B	(Nandwani et al., 2008)	widely reported eg (Dasgupta and Fowler, 1997)	widely reported eg (Surh and Lee, 1996)
***Carica papaya* L.** CARICACEAE	Paw paw	Cult	I	L	cancer	1B	(Caamal-Fuentes et al., 2011)	(Emeruwa, 1982; Farnsworth, 1988; Lohiya et al., 1994; Ong and Norzalina, 1999; Rahmat et al., 2002; Rahmatullah et al., 2010a; Tona et al., 1998)	(Abdullah et al., 2011; Eno et al., 2000; Mehdipour et al., 2006; Osato et al., 1993; Otsuki et al., 2010; Seigler et al., 2002; Tona et al., 1998)
***Centella asiatica* (L.) Urb** (MQ 73008907) APIACEAE	Centella	RFM/ R/ OD	C	L	arthritis	1A, 2B	(Brinkhaus et al., 2000; Senthilkumar et al., 2009; Singh, 2010)	widely reported eg (Zainol et al., 2003)	widely reported eg (Brinkhaus et al., 2000)
***Citrus x taitensis* Risso** (NSW 792671) RUTACEAE	Bush lemon	Cult	I	F	colds	2A, 4B	(Mabberley, 2004)	widely reported eg (Del Río et al., 2004)	widely reported eg (González-Molina et al., 2010)

Scientific name[a]	Common Name	Habitat	Endemicity[c]	Part used[d]	Local Medicinal Uses	N.I. (n = 19)[e]	Agreement of literature with customary use[f]	Literature with reference to different customary use	Biological activity
***Citrus sinensis* (L.) Osbeck** RUTACEAE	Oranges	Cult	I	F	colds	1B	widely reported[‡]	(Anesini and Perez, 1993; Lu et al., 2006)	(Ahmad and Beg, 2001; Anagnostopoulou et al., 2006; Parmar and Kar, 2008)
***Corymbia intermedia* (R.T. Baker) K. D. Hill & L. A. S. Johnson** (NSW 792670) MYRTACEAE	Pink bloodwood	Sc	N	X	warts	1B	none found	(Gilbert, 1966; Locher and Currie, 2010)[#]	none found [#]
				X	stops bleeding from cuts	1B	(Cribb and Cribb, 1984; Isaacs, 1987; Latz, 1999)[#]		
***Cleome viscosa* L.** [^] CAPPARACEAE	Tickweed, spider flower	OD	I	NS	antiseptic for cuts	1B	(Cribb and Cribb, 1984; Lassak and McCarthy, 2008; Leyland, 2002; Low, 1990; Mali, 2010)	widely reported eg (Mali, 2010)	(Gupta and Dixit, 2009; Mali, 2010; Reddy, 2009; Sudhakar et al., 2006; Williams et al., 2003)
***Diplocyclos palmatus* (L.) Jeffrey** (MQ 73008904) CUCURBITACEAE	Snakeberry	RFM /C/ R	N	F	skin infections	1B	(Mosaddik and Haque, 2003)	widely reported eg (Mosaddik and Haque, 2003)	(Chowdhury et al., 2003; Ganesan et al., 2004; Manandhar, 1998; Mosaddik et al., 2000)
				F	ringworm	2A, 2B	(Mosaddik and Haque, 2003)		
***Duboisia myoporoides* R. Br.** (MQ 73007957) SOLANACEAE	Corkwood, corkybark	RFM/ Sc	N	L	topical anesthetic and antiseptic	1A, 2B	none found	none found[#]	widely reported eg (Shukla et al., 2003)
***Eucalyptus* spp.** MYRTACEAE	Eucalypts, gum trees	Sc	N	L	bronchitis, clear throats, coughs	2B	widely reported eg (Cermelli et al., 2008)	(Cermelli et al., 2008; Cribb and Cribb, 1984; Isaacs, 1987; Leiper and Hauser, 1984)	widely reported eg (Cermelli et al., 2008)
				L	colds	1A	(Vaughan, 1986)		
				B	sores, scabies	1B	(Webb, 1969)		
***Eupomatia laurina* R. Br.**[%] EUPOMATIACEAE	Guava	RFM/ C	N	L	stomach ache	3B	(Khan et al., 2001)	(Khan et al., 2001)	(Khan et al., 2003; Khan et al., 2001)
				F	diarrhoea	1A	(Khan et al., 2001)		
				F	laxative	1A	(Khan et al., 2001)		
***Hibbertia scandens* (Willd.) Gilg** (MQ 73008905) DILLENIACEAE	Yellow vine	C/ Sc	N	NS	sores, rash	2A	none found	none found	none found

Scientific name[a]	Common Name	Habitat	Endemicity[c]	Part used[d]	Local Medicinal Uses	N.I. (n = 19)[e]	Agreement of literature with customary use[f]	Literature with reference to different customary use	Biological activity
***Hypochaeris radicata* L.** (MQ 73008912) ASTERACEAE	Dandelion	OD	I	L	liver disease	1B	(Mahesh et al., 2010; Schütz et al., 2006)[§]	none found[§]	none found[§]
				L, St	boils	2A	widely reported eg (Lassak and McCarthy, 2008)		
***Ipomoea brasiliensis* (L.) Sweet** (MQ 73007958) CONVOLVULACEAE	Beach morning glory	C	N	L	pain from jelly fish	1B	(Bandaranayake, 1999; Isaacs, 1987; Pongprayoon et al., 1991; Tao et al., 2008; Wasuwat, 1970)	widely reported eg (Tao et al., 2008)	widely reported eg (Tao et al., 2008)
				L	headaches	1A	(Rogers et al., 2000)		
				L, St	arthritis	1A	(De Souza et al., 2000; Lassak and McCarthy, 2008; Pongprayoon et al., 1991; Tao et al., 2008)		
***Lophostemon suaveolens* (Sol. ex Gaertn.) Peter G. Wilson & J. T. Waterh** (MQ 73008908) MYRTACEAE	Apple gum	RFM /Sc	N	A	wounds	1A	none found[§]	none found	none found
				X	cuts, sores, open wounds, acne	1A	none found		
***Melaleuca* spp.** MYRTACEAE	Tea tree, paperbarks	R /Sc	C	L	colds, flu	1A, 3B	(Cribb and Cribb, 1984; Lassak and McCarthy, 2008; Vaughan, 1986)	(Budhiraja et al., 1999; Isaacs, 1987; Leiper and Hauser, 1984)	widely reported eg (Carson et al., 2006)
				L	cough	1B			
				L	mosquito repellent	1A			
***Opuntia* spp.** CACTACEAE	Prickly pear	OD	I	F	asthma	1B	none found*	(Feugang et al., 2006; Hasse et al., 2008; Hernandez-Galicia et al., 2002; Shedbalkar et al., 2010)	(Feugang et al., 2006; Shedbalkar et al., 2010)
***Phytolacca octandra* L.**[^] PHYTOLACCACEAE	Inkweed	OD	N	F	ringworm	3A	(Escalante et al., 2002; Moreno and Rodriguez, 1981)	(Escalante et al., 2002)	(Escalante et al., 2002)
***Pteridium esculentum* (G. Forst.) Cockayne** (MQ 73008209) DENNSTAEDTIACEAE	Bracken fern	C/ RFM/ R/ OD/ Sc	C	L, X	insect bites/ stings	1A, 1B	(Daw et al., 2007; Hiddins, 1999; Lassak and McCarthy, 2008; Low, 1990)	(Agnew and Lauren, 1991; Daw et al., 2007; Lassak and McCarthy, 2008)	(Agnew and Lauren, 1991; Daw et al., 2007; Lassak and McCarthy, 2008; Smith et al., 1988)

Scientific name[a]	Common Name	Habitat	Endemicity[c]	Part used[d]	Local Medicinal Uses	N.I. (n = 19)[e]	Agreement of literature with customary use[f]	Literature with reference to different customary use	Biological activity
***Rumex* sp.** POLYGONACEAE	Dockleaf	OD	I	L	stings	5B	widely reported[‡]	widely reported eg (Sahreen et al., 2011)	(Pereira et al., 2011; Sahreen et al., 2011)
***Sida rhombifolia* L.** (MQ 73008914) MALVACEAE	Paddy lucerne	OD	C	L	gastric, diarrhoea	2A, 7B	(Assam JP et al., 2010; Lassak and McCarthy, 2008; Low, 1990; Webb, 1969)	widely reported eg (Assam JP et al., 2010)	widely reported eg (Assam JP et al., 2010)
***Smilax australis* R. Br.** (NSW 792674) SMILACACEAE	Lawyer vine, sweet sarsaparilla	RFM	N	L	diabetes	1B	none found	(Isaacs, 1987; Lassak and McCarthy, 2008)	none found[#]
				L	blood cleanser	1A	(Brock, 2001; Lassak and McCarthy, 2008)		
***Smilax glyciphylla* Sm.** (NSW 792380) SMILACACEAE	Narrow leaf sarsaparilla	RFM	N	L	pain, arthritis/rheumatism	1A	(Lassak and McCarthy, 2008; Low, 1990)	(Cox et al., 2005; Isaacs, 1987; Low, 1990)	(Cox et al., 2005)
				L	coughs, catarrh	1A	(Lassak and McCarthy, 2008; Low, 1990; Webb, 1969)		
				L	clear skin problems	1A	none found		
				L	purify blood, revitalising tonic	1A	(Gilbert, 1966; Isaacs, 1987)		
				L	diabetes	1B	none found		
***Solanum mauritianum* Scop.** (MQ 73008906) SOLANACEAE	Native tobacco	OD/ C/ RFM	I	L	mosquito repellent	1A, 1B	none found	(Jäger et al., 1996; Lindsey et al., 1999)	(Lindsey et al., 1999)
***Solanum tuberosum* L.** SOLANACEAE	Potato	Cult	I	Sk	boils	2B	(Kalpna et al., 2011; Leporatti and Ivancheva, 2003; Mamedov et al., 2005; Vlachojannis et al., 2010)	(Guarrera et al., 2005)	(Eichhorn and Winterhalter, 2005; Pihlanto et al., 2008; Slanc et al., 2009)
***Sonchus oleraceus* L.** (MQ 73008913) ASTERACEAE	Milkweed, milkthistle	OD	I	X	warts	1A, 3B	(Jimoh et al., 2011; Latz, 1999)	(Gould et al., 2006; Guarrera et al., 2005; Isaacs, 1987; Jimoh et al., 2011; Singh, 2010)	(Conforti et al., 2008; Elkhayat, 2009; Gould et al., 2006; Jimoh et al., 2011; Schaffer et al., 2005; Yin et al., 2007)
				NS	cancer	1A	(Csupor-Löffler et al., 2009; Thomson and Shaw, 2002)		
				L	asthma	1A	(Ahmad, 2006)		
***Tagetes minuta* L.** (MQ 73008915) ASTERACEAE	Stinking roger	OD	I	L	mosquito repellent	2A	(El and Karakaya, 2004; Gillij et al., 2008; Isaacs, 1987; Makhaik et al., 2005; Neher, 1968)	(Eguaras et al., 2005; Isaacs, 1987; Ranilla et al., 2010; Tereschuk et al., 1997; Upadhyaya et al., 2010)	widely reported eg (Upadhyaya et al., 2010)

Scientific name[a]	Common Name	Habitat	Endemicity[c]	Part used[d]	Local Medicinal Uses	N.I. (n = 19)[e]	Agreement of literature with customary use[f]	Literature with reference to different customary use	Biological activity
***Urtica dioica* L.** [^] URTICACEAE	Stinging nettle	OD		NS	arthritis	1A, 1B	widely reported eg (Randall, 2003)	widely reported eg (Randall, 2003)	(Cummings and Olsen, 2011; İlhami Gülçin et al., 2004; Komes et al., 2011; Riehemann et al., 1999)

[a] voucher numbers: MQ prefix – Macquarie University Herbarium, NSW - National Herbarium of New South Wales. [%] Identification of plant taken from (Heron, 1991), [^] no plant with diagnostic floristic feature was able to be preserved for deposit. Identity determined by botanist D. Harrington. [b] C - coastal environs, Cult - cultivated plant, OD - open or disturbed land, R - river bank, RFM - rainforest margin, Sc – sclerophyll forest. [c] C - cosmopolitan species, N - species native to NSW, I - species introduced to NSW. [d] A - ash, B - bark, F - fruit, J - juice of fruit, L - leaf, R - root, Sk - skin of edible portion, St - stem, W - whole plant, X - sap/latex/resin, NS - not stated or unknown. ! - harmful properties if not prepared correctly. [e] N.I. – number of informants, A - senior community elder, B - community elder. [f] [#] literature refers to closely related species, [§] literature refers to phenotypically similar plant, * component in traditional Chinese medicine compositions. 'widely reported' used where more than eight relevant references found. ǂ reports largely limited to (but well reported in) folklore.

3.1. Informants and holders of traditional medicinal plant knowledge

Of the nineteen Elders interviewed, the majority (79%) were female. The male respondents referred to treatments administered by their mother, aunt or grandmother. This is in accordance with the women being the traditional practitioners of customary medicine. Twenty two of the thirty two plants discussed were mentioned by at least one of the senior Elders, indicating the wealth of knowledge held by these respected individuals. During the period of the study, two of the three senior female Elders with whom we had had discussions passed away, highlighting the urgency in having this information recorded.

Seventy five percent of the plants were mentioned by at least two Elders as being of medicinal value. Six of these plants (*Alocasia brisbanensis, Citrus x taitensis, Diplocylos palmatus, Rumex* sp*, Sida rhombifolia, Sonchus oleraceus)* had a high level of agreement with more than five Elders reporting their use, indicating the value of these plants to the community as a medicinal resource. *Alocasia brisbanensis* was the most widely reported plant used by the Yaegl community during this study, with *Smilax glyciphylla* having the most diverse uses and *Eucalyptus* spp. having the greatest number of methods of application. The plants identified in this study cover twenty one families, with Myrtaceae being the most dominant, followed by Solanaceae. This is not remarkable as these families also appear among the most abundant of the region (PLANTNET, 2010).

3.2 Ethnopharmacological usage

This study revealed the knowledge of fifty four (single plant) preparations held by the Yaegl Aboriginal Elders (Table 1), twenty two of which had at least two corroborating reports. The distribution of uses of medicinal plants (Fig. 2) largely reflects a symptomatic approach to the treatment of disease. The highest numbers of plants are used for conditions likely to be encountered in the field, i.e. as a 'first-aid' response to wounds, burns, bites, stings. In this situation, ease of access is a priority. The number of plants used to treat colds reflects the multitude of symptoms associated with such an illness. Plants used to treat conditions such as wounds, sores and boils, as well as plants used for their antiseptic properties, are likely to have some level of antimicrobial activity. The large number of plants used for these purposes reflects a common need for antimicrobial agents and further study of such plant preparations may provide alternate sources of novel antimicrobial agents.

Most plants reported to be of medicinal value by the Yaegl community (Table 1) feature in customary pharmacopoeia of different communities or have been widely incorporated into mainstream herbal medicine, with some exceptions such as *Lophostemon suaveolens* and *Hibbertia scandens*. Other plants (eg *Alocasia brisbanensis* for muscle injury, *Corymbia intermedia* for warts, *Duboisia myoporoides* as a topical anaesthetic and antiseptic, *Solanum mauritianum* for stings and as a mosquito repellent, and *Smilax australis* and *S. glyciphylla* as treatments for diabetes) have been widely accepted as of medicinal value, but for different purposes.

Certain plant species (eg *Alocasia brisbanensis,* and *Corymbia intermedia*), although not reported in the literature, are closely related to plants that have been documented in the literature as having similar medicinal uses. This could reflect variation based on locally occurring plant resources. Additionally, plants with a similar phenotype may have been misconstrued. For example, dandelion was identified in this study as *Hypochaeris radicata* instead of the widely recognised *Taraxacum officinale,* as a treatment

for liver disease. This may have occurred due either to a current lack of familiarity with the plants, or an evolved variation to the traditional pharmacopoeia.

Most of the plants listed in Table 1 have had their biological activity studied and many have had at least some of their chemical constituents isolated. There is, however, room for further investigation in this area, especially with reference to the novel treatments identified in this study.

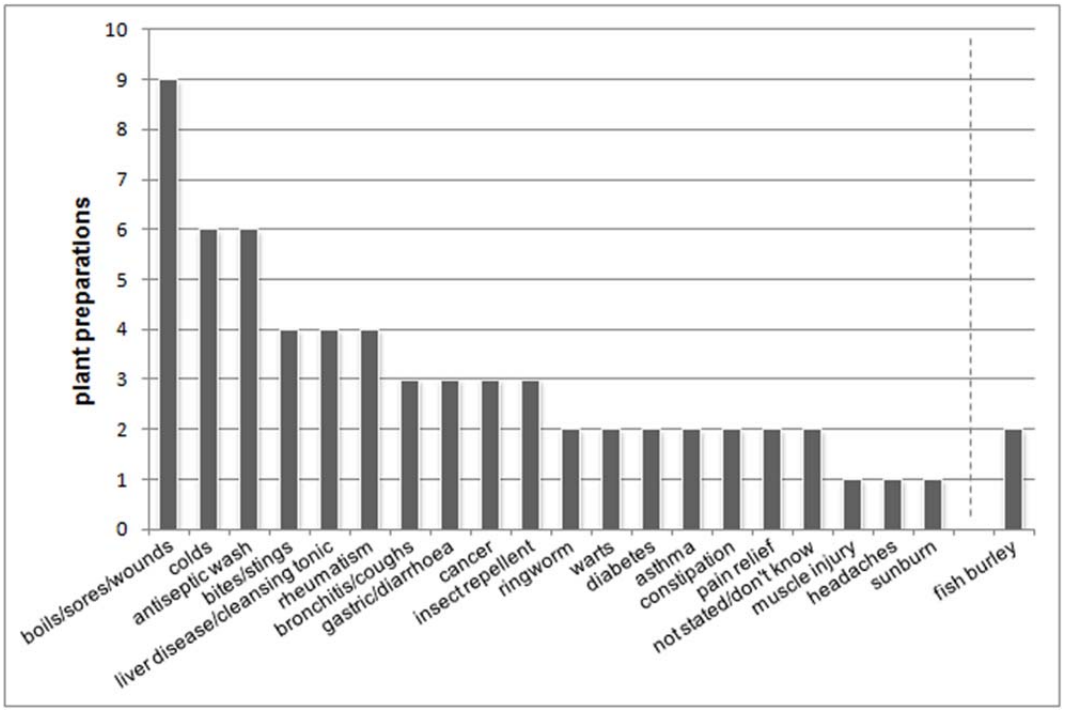

Fig. 2. Plant preparations (n=54) used in the treatment of various conditions

The dominance of leaves (56%) and fruit (13%) as the two plant parts most used in medicinal preparations (Table 1) largely reflect their accessibility, while causing minimal impact to the plant itself, thus allowing sustainability of this resource. The great majority of plants used for medicinal purposes are used in a direct manner with fresh plant material (Fig. 3) applied externally, i.e. with no or very limited preparation required for use (eg crushing of berries or leaves). This is obviously beneficial to the ease of use of these plants, which can be applied while away from equipment or a heat source.

Common preparation methods include infusions and decoctions. The term infusion is used loosely as the suspending of plant (usually leaf) material in either cold or pre-warmed water. A decoction refers to the preparation of plant material by boiling or heating in water, while 'warmed directly' refers to the gentle heating of the plant material without the use of water. These definitions reflect the lack of detail of preparation able to be recalled by some informants. It was noted by the Elders that these techniques changed and evolved, sometimes with the advent of more convenient technologies, such as the billy can for boiling water.

In some cases, the preparation or application methods of some plants, identified as of medicinal importance, were either unknown to the informant or were not disclosed to the interviewer. The plants listed as a resource refer to those plants used to aid the prevention of disease, for example as an insect

repellent. Specific preparation or application methods were omitted from Table 1 at the request of the community.

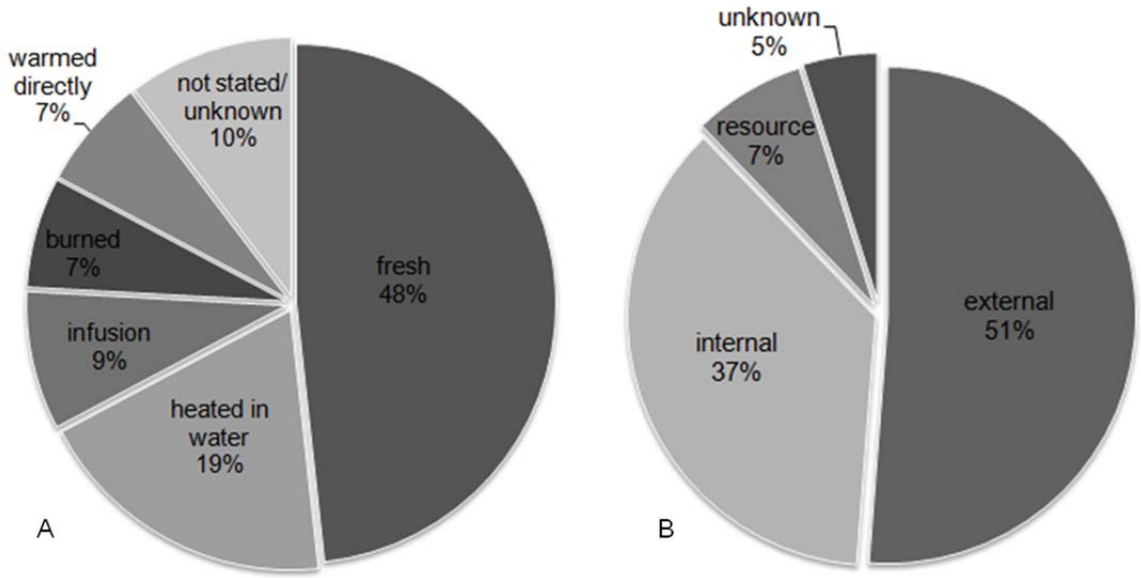

Fig. 3. a) Methods of preparation (n=54) of plants used in customary medicine by Yaegl community. b) Methods of application (n=41) of plants used as customary medicine, as discussed during interviews with Yaegl Elders

3.3 Local habitat of medicinal plants

The plants used for medicinal purposes as outlined in Table 1 are found in habitats that can be linked to the movement of the Yaegl people during recent history, since the early 20th century (Heritage Branch, 2008; McSwan, 1992) i.e. within the recollection of the interviewed Elders and their immediate ancestors. The habitat providing the greatest source of medicinal plants for the community was areas of open or disturbed land, such as clearings upon which the reserves or camps were situated (Fig. 4). With rainforests having such a wealth of biodiversity, their easily accessible margins have also provided the community with a trove of medicinal resources. Those plants available along the river and on the adjacent flood plains would have been easily accessible when living on Ulgundahi Island and at the riverside camps. Families also relied largely on accessibility to bush resources around the coastal region, to where they often relocated during flood or holiday periods (Heritage Branch, 2008). The current residents of the coastal town of Yamba and coastal regions are particularly knowledgeable about these resources.

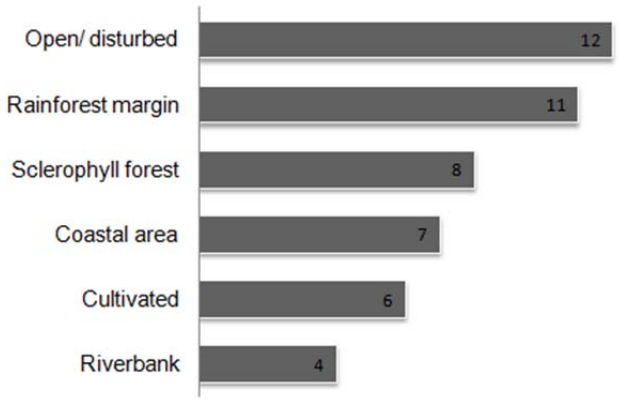

Fig. 4. Distribution of plants (n=32) used medicinally by the Yaegl community across local habitats.

Some plants, such as *Diplocyclos palmatus,* used for the treatment of ringworm, and *Smilax glyciphylla,* prepared as a sweet tonic, were reported widely as being of medicinal value to the community, however locating these plants was not easy. These species (now threatened in the area) may reflect further issues of the maintenance of medicinal resources in cleared land and a lack of sustainable or conservation methods to preserve this valuable botanical diversity (Heywood, 2011).

3.4 Endemicity of plants

Customary medicinal knowledge is contemporary and evolving. In this light, it cannot be assumed that all knowledge held by Aboriginal people came solely from their own long relationship with the Land. In the same way as early settlers (Gilbert, 1966) and more recently research scientists (Fabricant and Farnsworth, 2001; Jones et al., 2007), nutritionists (Brand-Miller and Holt, 1998) and herbalists (Jagtenberg and Evans, 2003) have drawn on and adapted the knowledge of Indigenous people, their influence has also been seen on the Yaegl pharmacopoeia (eg dandelion, oranges). This is evident in the only slight dominance of native plants (47%) over introduced species (40%).

Some additions to the local Indigenous pharmacopoeia may have also come from substitutions determined by the lack of availability of a certain plant (eg the omnipresent *Solanum mauritanium* may have substituted 'native tobacco' (*Astrotricha latifolia* or *A. longifolia*, which are now less abundant). That is, as a native plant became less accessible, a similar, introduced, more accessible species may have been trialled. If this produced a similar effect to that which they had traditionally used and was more accessible, it may have been incorporated. Introduced diseases would also have required adaptations and development on the existing knowledgebase. Those diseases previously unfamiliar to the Indigenous people, such as diabetes and some viral infections, would have required the development of appropriate treatments.

As Aboriginal knowledge has been traditionally passed down the generations in an oral format, and as written records by early settlers of the knowledge of the Indigenous Australian are somewhat scarce, it is difficult to determine precisely what knowledge of medicinal plants was held before the impact of European settlement. In one document describing the early settlement of New South Wales and their use of the land, it can be assumed that the settlers learned much from the locals about the value of this foreign environment.

“(Captain Arthur) Phillip himself regretted that he was "without the smallest knowledge of botany" and "without one botanist", in a "country which has such a variety of plants ...” (Gilbert, 1966)

He did however send convicts to collect fruits, having a high Vitamin C content, shown to be useful against scurvy. These fruits included Geebungs (*Persoonia* spp.), Lillypillies (eg *Acmena smithii*), and Pigface (*Carpobrotus uequilaterus* (*sic)),* all of which still feature as a food resource for the Yaegl people (Packer et al., 2011b). *Smilax glyciphylla* was selected to make a tea as a general health tonic for the settlers, which correlates to its use by the Indigenous community. Other medicines were also made from ‘Red Gum’ (kino from such trees as Bloodwood (*Eucalyptus gummifera*) *(*syn*. Corymbia gummifera)* (Gilbert, 1966), which correlates to the use of the closely related species, *C. intermedia* in this study. All the plants listed above are native to NSW, thus it is unlikely the new settlers would be familiar with the value of these plants, without some input from the local Indigenous peoples. The uses of these plants correlate well with the recorded uses by the Yaegl Community (Table 1).

4. Conclusions

This study documents fifty four uses for thirty two medicinal plants as a result of interviews with nineteen Aboriginal Elders and reflects the community’s relationship with the Land and their utilisation of the available resources. Much of the knowledge that has been retained comes from those Elders who grew up on Ulgundahi Island and subsequently lived on reserves on the margins of town by the river and along the coast. This reflects the habitats of the plants that have remained in use. Those plants requiring minimal preparation and being readily accessible remain as the most prevalent in the existing local pharmacopoeia. Use and knowledge of customary medicine has been retained largely on the basis of needs and accessibility, with a decline in the transmission of this valuable knowledge fragmenting this wisdom. Thus, with the increasing integration of the Indigenous community with the mainstream community, this knowledge will be quickly lost, unless it is thoroughly documented. This study of medicinal plants as used by the Yaegl community adds to the growing archive of Australian Aboriginal customary medicine, which is essential to the preservation of this knowledge and for stimulating the interest of future generations.

5. Acknowledgements

The authors thank the Yaegl Elders, particularly the respondents for sharing their knowledge on behalf of the Yaegl community – Ronald Heron, Jessie Randall, Della Walker, Lillian Williams, Judith Breckenridge, Carmel Charlton, Darren King, Rosemarie Vesper, Muriel Burns, Beatrice Heron, Owen Kapeen, Thelma Kapeen, Eileen McLeay, Glenda McPhail, Lester Mercy, Lenore Parker, Irene Randall, Kevin Randall, Lenny Waters. The authors acknowledge passed Elders and are grateful to their family for permitting the inclusion of their knowledge. We are grateful to Michael and Deidre Randall and the Yaegl Local Aboriginal Land Council for assisting in the initiation and execution of the project. We would also like to thank Miranda Wakefield and Robyn Peterson for assisting in the collation of interview data. This project would have not been possible without the financial support provided by Macquarie University in the form of PhD scholarships to the authors Joanne Packer, Nynke Brouwer, Jitendra Gaikwad and funding from the Australian Institute of Torres Strait Islander Studies (AIATSIS, #G2003/6781) and the National Health and Medical Research Council (NH&MRC, #488504).

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