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ASSESSING CULTURAL AND ECOLOGICAL VARIATION IN ETHNOBIOLOGICAL RESEARCH: THE IMPORTANCE OF GENDER

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ABSTRACT.—Contending that a significant portion of current ethnobiological research continues to overlook cultural variation in traditional ecological knowledge (TEK) and practice, this paper explores the potential impacts of gender-imbalanced research on data collection, hypothesis testing, and the formulation and application of ethnobiological inventories and theories. A multidisciplinary review of over 220 studies addresses commonly held stereotypes underlying gender-imbalanced field research and demonstrates the need for more inclusive, finely-tuned studies which disaggregate indigenous knowledge and practice by gender. The paper outlines factors underlying gender-based spatial and temporal variation in ecosystem exposure and traditional ecological knowledge in rural societies worldwide, and discusses how these factors contribute to gender differences in wild food harvesting, biodiversity and agrobiodiversity maintenance, natural resource management, and the transmission and conservation of sacred and secular customs. The review concludes with suggestions for designing and implementing more inclusive research.

Key words: indigenous knowledge, traditional ecological knowledge, gender, natural resource management, agrobiodiversity.

RESUMEN.—Este artículo explora los impactos potenciales del desequilibrio de género en la recolección de datos, la prueba de hipótesis y la formulación y aplicación de inventarios y teorías etnobiológicas, al argumentar que una porción significativa de las investigaciones etnobiológicas actuales continúan desatendiendo la variación cultural en el conocimiento ecológico tradicional (TEK). Esta revisión multidisciplinar de más de 220 trabajos estudia los estereotipos que subyacen a las investigaciones de campo con distorsiones basadas en el género, y demuestra la necesidad de realizar estudios que sean más completos y detallados para lograr distinguir las diferencias en el conocimiento y en las prácticas basadas en el género. Este artículo describe algunos factores que contribuyen a las diferencias de género debidas a la influencia del ecosistema en el espacio y el tiempo, que a su vez resultan en diferencias de género en el TEK en las sociedades rurales del mundo. El artículo también discute cómo estos factores contribuyen a las diferencias de género en la cosecha de productos silvestres, el mantenimiento de la [agro]biodiversidad, el manejo de los recursos naturales y en la transmisión y conservación de las costumbres sagradas y seculares. Se

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concluye con algunas sugerencias para diseñar e implementar investigaciones etnobiológicas más completas.

RÉSUMÉ.—La plupart des recherches actuelles en ethnobiologie continuent de négliger la variabilité culturelle quant à la pratique et le savoir écologique traditionnel (SET). Aussi, cet article examine les répercussions potentielles liées aux études dont le ratio femme-homme est déséquilibré, que ce soit sur le plan de la récolte de données, de l'évaluation des hypothèses, de l'application et la formulation de théories ou de l'élaboration d'inventaires ethnobiologiques. Une revue pluridisciplinaire basée sur plus de 220 études fait ressortir les stéréotypes les plus communs qui sous-tendent ce type de déséquilibre en recherche et montre l'importance d'études plus minutieuses et plus englobantes qui s'attarderont à séparer la pratique et le savoir traditionnel en genre. Cet article souligne les facteurs qui sont à la base de la variabilité temporelle et spatiale liée au genre; celle-ci joue tant sur le plan de la compréhension écosystématique que des savoirs écologiques traditionnels des sociétés rurales du monde entier. Nous discutons également de la contribution de ces facteurs quant aux différences entre les activités de récoltes en nature associées aux hommes et aux femmes ainsi que de leurs gestions de la biodiversité et de l'agrobiodiversité, des ressources naturelles et de leurs modes de transmission et de conservation des coutumes sacrées et profanes. Cette revue se termine par des suggestions menant à la planification et la mise en place de recherches plus compréhensives.

INTRODUCTION

Ethnobiological knowledge and practice within any culture vary by geographical origin, residence, ethnicity, religion, occupation, educational background, social status and relations, income class, age, and gender (Heckler 2002; Ross 2002; Somnasang and Moreno-Black 2000; Voeks 2003; Zent 1999). Biological resources are known and used by local populations for food, feed, medicine, and utilitarian and social ends, as well as in rituals, cosmologies, spiritual and magical practices, songs, and narratives. Despite the underlying heterogeneity in the cultural systems we research, most ethnobiological surveys are not based on research designs that account for the variation extant in our study populations. In a review of ethnobiological (n = 296) and ethnobotanical (n = 424) studies contained in the *Journal of Ethnobiology* and *Economic Botany* respectively between 1981 and 2004, only 6–7% of the studies reported on a range of both tangible and intangible biodiversity uses, and less than 5% of the research articles examined gender-based variation in ethnobiological knowledge and practice.[1] The current *modus operandi* in most ethnobiological field studies involves purposive or judgment sampling, i.e., selecting a small number of ''key informants,'' who may or may not represent the collective variation in ethnobiological expertise present at the research site(s). Otherwise known as the ''cultural consensus model'' (Romney et al. 1986), this technique assumes cultural homogeneity, i.e., that no subcultures exist within the society being studied. Adherents assume the oldest, most well-recognized members of a community are more likely to possess the majority of the knowledge held within the community (Bernard 2002), reasoning that the researcher's limited

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time is best spent interviewing a handful of senior individuals. In most indigenous societies, cultural norms grant men greater public access and recognition than women (Iyam 1996; Zelinsky et al. 1982). Thus, by default, the group of prominent individuals interviewed by ethnobiologists are often predominantly, if not exclusively, male (Phillips et al. 1994; Zent 1999). Yet within most societies, male and female work roles and social networks are differentiated enough to represent distinct subcultures (Hess and Ferree 1987), occupying spatially and temporally distinct zones (Reichel 1999). In the words of Brown and Switzer (1991:5), ''[w]omen's uses of the environment prove to be sufficiently different from those of men to represent a distinct habitat, in the ecological sense.''

In biological surveys, statistically sound experimental design and standardized sampling protocols (e.g., plots, transects) enable researchers to comprehensively and accurately assess variation in study populations. Just as an ecological inventory limited to measuring angiosperms is insufficient to characterize an entire habitat, limiting our informants to a single social stratum—e.g., only interviewing men or wealthier households—is insufficient to capture the variation extant in socially heterogenous communities. Applying a scientifically rigorous approach to ethnobiological research requires acknowledging the sociocultural heterogeneity within the community being researched, and incorporating recognition of different social strata in the research design (see Bernard 2002). Gender[2] is a particularly critical variable, as it is highly correlated with other sociocultural factors, including birthplace, residence, occupation, educational background, social status and networks, resource access, and income class (di Leonardo 1991; Sarin 1998). Under-representation of female ethnobiological expertise (emic or etic) in scientific studies—unfortunately still a common practice (Zweifel 2001)—not only signifies the systematic exclusion of a significant portion of our study populations, it also limits our capacity to comprehensively and accurately assess variation in cultural knowledge systems and practices. The theoretical and practical repercussions of male-biased, or gender-imbalanced, ethnobiological research have not been carefully studied. The question begs to be answered: what are we missing? What impact does gender-imbalanced research have on data collection, hypothesis testing, and the development and application of theoretical frameworks? How might gender-imbalanced approaches lead to distorted conclusions about the depth and range of ethnobiological knowledge and practices of our study populations?

This paper advocates a more gender-balanced approach to ethnobiological research by analyzing over 220 interdisciplinary gender-inclusive studies from Africa, Asia, Australia, Melanesia, Oceania, the Pacific Islands, the Americas, the Arctic, Europe, and the Middle East, including our own work in Indonesia and Tanzania. Our literature review was conducted using University of California electronic databases (BIOSIS, CAB Abstracts, Current Contents, JSTOR, Melvyl, Pro-Cite, Web of Science/Web of Knowledge, among others), back-referencing bibliographies of published studies, combing through texts in the authors' private libraries, volume-by-volume review of major society journals, and successive internet searches (Google and Google Scholar) during 2001–2005. Although this paper focuses specifically on gender as a critical cultural variant,

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we discuss other forms of variation in ethnobiological knowledge and practice including age, occupation, religion, social status, residential location, and patterns of mobility. Our analysis of the determinants of gender-based variation in ethnobiological knowledge and practices hinges on an examination of the links between gender-based spatial and temporal variation and patterns of exposure to, and involvement in, cultural and ecological systems. Our results suggest that gender-imbalanced research can result in significant methodological and theoretical oversight. To counter this potential bias, we propose ways to better represent cultural variation in ethnobiological studies by realigning research design and field methods to result in more gender-inclusive research.

WHY IS IT IMPORTANT TO ACKNOWLEDGE GENDER DISTINCTIONS?

Women and men have separate and unique relationships with biodiversity. Some of the key questions enabling researchers to distinguish areas of female and male expertise in biodiversity knowledge, access, use, management, and conservation include: who gathers and hunts wild species, and when, where, and how do they do this? Who manages different elements of the household's agricultural portfolio? How is biodiversity-based knowledge generated, maintained, and transmitted within the community? What is the range of biodiversity-based practices in the community, who engages in these practices, and why, when, how, and how often do they do so? Here, we offer examples of answers to these questions, within an overall framework describing how and why gender distinctions have often been overlooked in the past.

Stereotypes Obscure Reality.—Sex-based assumptions—i.e., men are the big game hunters, women the gatherers of plants and small organisms—overlook the potential plurality of roles played by both sexes and undermine the contribution of women to household diets (Leacock 1981; Slocum 1975). Early ethnographies (e.g., in the 1800s) of indigenous societies supported this stereotypical division, in part due to the preponderance of male explorers relating primarily to male community leaders. Later studies documented female participation in both small and large game hunts and demonstrated that women hunter-gatherers of native societies including the Pacific West and Northwest, the American Southwest (Heizer and Elsasser 1980; Hunn 1981), Southern Africa (Lee 1968:33), and Northern, West and Central Australia (Goodale 1971; Tonkinson 1991) typically provided 50–90% of household dietary intake. Among the Agta of eastern Luzon, the Philippines, women hunt wild pig, deer, monkey, and other game (Estioko-Griffin 1993; Griffin 1999); Australian Western Desert women hunt kangaroos and emus (Tonkinson 1991); Woods Cree women hunt moose, caribou, and bear (Brightman 1996); Aka women capture duikers, python, and mongoose (Noss and Hewlett 2001). On Cheju Island, South Korea, only women dive for shellfish and seaweed (Cho 1989); in Papua New Guinea, women dive for freshwater prawns (Williams 1940/1941). Women participate in communal hunting expeditions for big game in many cultures, including the Yokut, Mono, and Miwok in Central California (Dick-Bissonnette 1998), the Iroquois (Brown 1975), the Matses of the Peruvian Amazon (Romanoff 1983), the Ache of Paraguay

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(Hurtado et al. 1985), the Mbuti of the eastern Congo Basin (Bailey and Aunger 1989; Wilkie and Curran 1991), and the Chipewyan (Brumbach and Jarvenpa 1997), Inuit (Borré 1991), and Netsilik of Northern Canada (Endicott 1999). Women of the Mpiemu (Central African Republic) make critical contributions to game capture, including the performance of a secret dance at times of fish or meat scarcity (Giles-Vernick 2002). Even if women do not participate directly in the hunt, their tracking and spotting of large game (Biesele and Barclay 2001; Hunter et al. 1990) indicates they possess significant knowledge regarding the habits and habitats of the animals hunted. For communities that are highly dependent on foods harvested from the wild, women's reconnaissance of both small and large game is a critical source of information for hunters (Draper 1975).

In cultures where both genders hunt and/or fish, as Davis and Nadel-Klein (1997) note, gender stratification is linked more to specific techniques used or species targeted than to participation in the activity itself. Among both the Bun (Papua New Guinea) and the Baka (southwestern Cameroon), both genders fish in freshwater, but with different methods: women use individual nets or form dams while men disperse botanical toxins (Agland 1990; McDowell 1995; Simo and Nchoj 1995). In Oceania, women tend to use simpler fishing technologies (e.g., bare hands, baskets, nets) where men tend towards more complex technology (e.g., spears, hooks and lines, watercraft) accompanied by more complex beliefs and taboos; and in societies where both women and men fish in deepwater off-reef zones (e.g., Moala, Lau, and Atiu), the fishing of highly valued species such as bonito, tuna, and turtle is restricted to men (Chapman 1987; Firth 1984). In eastern Fiji, where women specialize in marine food procurement, women know more about ''local distribution, relative abundance, catchability and daily seasonal variability of resources, appropriate procurement techniques and the interrelationships between these factors...[m]en frequently don't even know the names of fish'' (Botkins 1980:4).

Ownership of a Given Resource Does Not Necessarily Equal Usership of, and Hence Familiarity with, That Resource.—Although gender often determines the rights of a person or group to ownership, management, and gathering of a natural resource (e.g, in societies where men are de facto owners of land or property), the actual users of the resource may or may not be the same gender as the owner. Throughout Africa, women in patrilineal societies are not permitted to plant trees, since tree-planting confers ownership rights to land (exclusively a man's privilege in many areas), but women are allowed to harvest from trees (Fortmann and Bruce 1988). In other areas the opposite is true: among the Ibo of Nigeria, a woman may have property rights (*nkwu ana*) in palm trees, but she cannot do the harvesting (tapping for palm wine or gathering palm nuts) herself, as this is a male task (Lebbie and Guries 2002; Obi 1988). This disparity in ownership versus use can lead to inaccurate data collection by ethnobiologists who interview the owners, rather than users. For example, in Pfeiffer's work with cashew-growers in eastern Indonesia, men were most often listed as plantation owners, but women were more likely to be involved in the day-to-day management of the cashew groves, and were often more intimately familiar with associated pests (Pfeiffer 1998). In other areas, tree ownership is even more

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complex, and can be conferred separately on different tree species and/or different tree products. For example, in Jola communities (The Gambia), the fruits, leaves, branches, and trunks of uncultivated trees can all be claimed at separate times by different people (Madge 1995).

Coarse-grained Studies Fail to Note Key Distinctions in Resource Management and Knowledge.—Studies that conflate female and male knowledge and practices may minimize important gender distinctions in agroecological expertise. In both farming and forestry systems, men seem the most visible: they are most likely to attend and speak at meetings, receive agricultural inputs (extensions services, aid), and have official project participant status (FAO 1990; Momsen 1991). This over-recognition of men is particularly ironic, because twice as many women as men work in agriculture-related activities in developing countries (Odame et al. 2002). Studies of agrobiodiversity—crop management, selection, breeding, and development—that either fail to disaggregate their results by gender and/or rely primarily or exclusively on male informants (see examples in Brush 1999; Doss 2002), ignore the distinct gender roles played out within specific portions of the cropping cycle. This sort of ''coarse'' or macro-analysis can produce ambiguous or misleading results by failing to connect gender-differentiated roles with distinct types and levels of agroecological knowledge. Take the example of seed selection—a critical component of agrobiodiversity maintenance. In some cultures, both men and women are responsible for seed selection during planting and/or harvesting; in other societies women control the seed selection and planting for major grain crops. This is true for the Kpelle of Liberia (Gay 1995), the Moru of Sudan (Sharland 1995), the Igorots of the Philippines (Tauli-Corpuz 2001), and the Mande of West Africa (Carney 2001). Women-controlled agriculture and horticulture is particularly prevalent in areas with high levels of seasonal or semipermanent male out-migration (see Momsen 2004; Song and Jiggens 2003; Thomas-Slayter and Rocheleau 1995). In many societies it is the women who are most responsible for the practical aspects of maintaining household germplasm seed banks. This is true for rice (Oakley 2003; Setyawati 1997), beans (Sperling 1992), grains (Tsegaye 1997), taro (Cleveland and Murray 1997), millet, gram, lentil (Ramprasad 1999a, 1999b), potato (Scurrah et al. 1999), and sorghum (Scurrah-Erhart 2003). Where women and men control different aspects of seed selection, the division of responsibilities can signify gender-distinct sets of knowledge: male crop selectors are often more familiar with the effects of different environmental conditions and agronomic practices on yield, while female germplasm managers are expert not only in the morphological characteristics of different seeds, but also in the identification and control of vertebrate and invertebrate seed pests, and in the collection and preparation of phytochemical pesticides and other post-harvest cultural practices. Agricultural surveys that inaccurately assign sole or primary responsibility for a suite of crops or animals to only one gender overlook the multifaceted, collaborative aspects of agricultural systems. Rural households manage a complex portfolio of crops and livestock, and there is significant variation in the degree of involvement of either sex in any component of a given cropping system (Overholt et al. 1985). Women and men may be responsible for the same crops, but in geographically separate

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locations (Overholt et al. 1985; Smedley 2004) or for temporally distinct growth phases of crops or livestock—as Rubin (1992:175) notes, ''gender remains the major differentiating feature in time use in agricultural households.'' More accurate assessments of the range and variation of agroecological knowledge and practices among both male and female farmers require surveys that are disaggregated into different activity phases: decision-making, land-clearing, sowing, transplanting, weeding (and other forms of pest control), harvesting, processing, and storage.

Unseen Knowledge and Practices Lead to Inaccurate Portrayals.—Cultural naïvete among Western academicians studying other societies can lead to narrow assumptions about men's or women's roles in those societies. These ''cultural blindspots'' develop because researchers literally do not witness men and/or women involved in certain activities because they do not expect to see such involvement (Slatter 1984). For example, throughout North America, culturally-specific rituals (including vision quests, offerings, and gathering of ethnobotanically important plants) conducted on sacred sites in the landscape by Native Americans have gone largely unseen, and therefore unrecognized, by the dominant culture for centuries (McLeod 2004). In addition, due to cultural prohibitions and restrictions on the transmission of certain gender-specific ritual, spiritual, and medicinal practices, entire knowledge systems have gone unrealized and unreported by ethnobiological scholars. One example lies in the persistent image of shamans as predominantly male, which obscures a reality where both genders serve as spiritual guides and herbalists throughout the developing and developed world. Documenting this reality has sometimes required the revision of earlier work, such as the recent coverage of prominent spiritual leaders and medicine women in the American West, including Florence Jones (Abbe and Frank 2003), Mabel McKay (Sarris 1994), and Walking Thunder (Walking Thunder 2001), and the documentation of female ceremonial practices in Australian Aboriginal societies. Male researchers throughout the 1920s–1970s (e.g., Warner 1937) characterized aboriginal women as having little or no significant spiritual roles, due to women's supposedly inferior status (Bell 2001; Rohrlich-Leavitt et al. 1975). Studies by women in the 1930s—1980s documented aboriginal women's critically important biological knowledge in sacred ceremonies, demonstrating that Aboriginal women were as thoroughly involved in ritual and religious activities as Aboriginal men (Bell 1983; Burbank 1989; Kaberry 1939). As Bell (2001:468) notes, ''[w]omen ... had a separate sacred ritual life which was at times pursued independently of the men and at others intertwined with men's ceremonies.'' Throughout aboriginal Australia, ceremonial duties and ritual ethnobotanical practices associated with sacred landscapes are gender-differentiated according to the ritual laws of each sex (Sky 1995); men and women exhibit some shared and some separate knowledge of Dreamtime activities and traditional mythologies (Bell 1983; Edmunds 1996).

A similar ethnographic revision is underway in the Eastern Cape Province of South Africa where early ethnographers mistook the Xhosa *igoqo* (roughly translated as ''woodpile'')—a highly sacred ritual construction by women—as merely a source of firewood, not realizing the piled wood to be constructed of

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distinct tree species in culturally-specific formations (Cocks et al. 2003). In Native American nations, including the Salish/Okanogan (Garceau 2001), Wintu (Jones 1997), Diné (Walking Thunder 2001), Pomo (Sarris 1994), Shoshone (Fowler and Turner 1999), Chumash (Groark 1996), and Yokut, Mono, and Miwok (Dick-Bissonnette 2003), both genders are recognized as powerful spiritual and herbal healers. In Burundi both genders enter the hereditary profession of rainmaker; throughout Africa women are powerful spiritual mediums and spirit-possession cult leaders (Berger 1976), a tradition that continues among Afro-Brazilian Candomblé populations based in Amazonia (Voeks 1997). Among the Lio of Flores Island, both women and men perform ritual acts as priest-leaders during planting, harvesting, and temple construction ceremonies (Howell 1996). In Dusun societies of Brunei Darussalam, female shamans (*balians*) are exclusively responsible for the practice of spiritual medicine in highly specialized ceremonies known as *tamarok* that involve animal totem construction, sacred dancing, and trances (Antaran 1993, cited in Voeks 2001). Women shaman, spiritual mediums, and phytotherapists are also active in the societies of the Iukagir (Ivanov 1999), Ju/'hoansi (Shostak 1981), Karo of Sumatera (Steedly 1989), the Maasai (Butz 2000) and Mijikenda of Kenya (Nyamweru 2003), Mentawis of Siberut Island (Ave and Sunito 1990), Meratu Dayak (Tsing 1987), Tlingit (Klein 1995), Tolowa of North America (Halperin 1980), the Shona and Bantu of Zimbabwe (Frommer 2002), and the Warao of Venezuela (Wilbert 2002), among many others.

THE BASIS FOR GENDER VARIATION IN ETHNOBIOLOGICAL KNOWLEDGE AND PRACTICE

Gender is a key factor in determining variation in ethnoecological knowledge and practice and the maintenance of biocultural diversity (biological taxa and cultural traditions) critical to household and community survival. The simplest definition of gendered knowledge is ''that which is held either by men or by women ... plant knowledge is gendered to the extent that a gender division of labor exists with respect to the use, management, and conservation of plants'' (Howard 2003:22). Yet gender-differentiated ethnobiological knowledge is due to reasons beyond a division of labor (Boserup 1970; Sachs 1996), and even the concept of gendered labor division requires fine-tuning when applied to the multifaceted and often fluid roles played by women and men in natural resource management and use. Additional cultural factors interacting with gendered labor divisions complicates our analysis of ethnobiological gender distinctions, necessitating a multifactorial analysis of cultural variation. Such a multifactorial analysis would include the following variables: gender-specific modes of knowledge transmission (Frommer 2002; Ohmagari and Berkes 1997; Turner 2003); gender-differentiated social networks (Price 2003); gender-based cultural roles and spiritual taboos that influence societal beliefs and norms regarding each sex's involvement with different components of managed and unmanaged ecosystems (Howard 2003; Jacobs 2003; Nyamweru 2003; Reichel 1999); marital [re]location patterns (Sky 1995); gender differences in access to natural resources (Fortmann and Rocheleau 1997; Rocheleau 1995); and sex-based differences in access to formal and external knowledge (Coast 2002). These sociocultural

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variables result in gender-separate knowledge and use patterns that are influenced across time by culturally-defined social units (i.e., age, kinship relations, and status; see Spector 1983) and across space by culturally-determined movement patterns (e.g., within and outside settlement boundaries; see Pfeiffer 2004). In both traditional and modern societies, women and men have lesser or greater access to certain types of knowledge at different stages in their lives, just as they have access to different ecosystems due to changes in household welfare, family residential configurations (e.g., whether the wife or husband change residency after marriage), employment, or education opportunities. Social unit distinctions are exemplified by variation in women's and men's participation in hunting, gathering, and cultivation activities based on their age class, which relates not only to physical ability but also to social position. For example, among the Chipewyan, women without child-care responsibilities are more likely to hunt than those with children (Brumbach and Jarvenpa 1997), and in many agrarian societies, older men will work in household gardens—a role often eschewed by younger males. The interactions among these and other factors result in significant variation in women's and men's relationships with components of biocultural diversity in their homelands. Differences in women's and men's responsibilities for a variety of ethnobiological activities (e.g., food procurement and processing, crop and livestock management, traditional crafts and rituals, etc.) are also expressed across a range of spatial and temporal scales, resulting in gender-differentiated knowledge of the abundance, distribution, and behavior of wild and domesticated plant and animal species in different habitats, ecosystems, and landscapes. The following five sub-sections, which discuss gender differentiations at different systematic, geographical, topographical, and temporal scales, exemplify the results of these multifactoral and multiscale interactions.

Gender-differentiated Species-specific Knowledge.—Variation in male and female knowledge of biological taxa occurs for a number of reasons, including differential access to natural resources, geographic origin, different harvesting strategies, cultural roles, and gender-differentiated knowledge transmission. Amongst the Ibo, gender divisions in the types of trees owned and managed (men tend to own timber trees, women own fruit trees) leads to women and men specializing in different tree taxa (Obi 1988). In many societies, including the Kwere and Zigua tribes in eastern Tanzania, men traditionally work with arborescent plants, while women work with herbaceous species (Luoga et al. 2000). In Manggarai (Indonesia) societies, wives tend to originate from outside the community (virilocality), and thus are less familiar with local plant species in their new home environments than their husbands, who were born and raised in the area (Pfeiffer 2002). This is also true for other ethnic groups, including the Maasai (von Mitzloff 1988), where Butz has observed similar plant-recognition patterns. In some societies where women and men gather and hunt in the same locations, but focus on different taxa, gender-distinct wild harvesting strategies imply gender variations in specialized knowledge. For example, among the Tukanoa of Colombia, men primarily hunt mammals while women hunt amphibians, reptiles, and invertebrates, including over twenty species of insects

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(Dufour 1987); in Andamanese culture the men hunt mammals, while the women hunt fish and crabs (Pandya 1993). Among fishing communities, women have specialized knowledge of reef species' behavior patterns, habitats, and seasonal factors affecting the populations, whereas men's knowledge is greater for pelagic species (Chapman 1987). In traditional Native American societies, women often claimed exclusive rights to food plants requiring special management, such as berry patches and edible grasses (Compton 1993; Dick-Bissonnette 2003). In their study of trees on women's and men's farms in Kenya, Bonnard and Scherr (1994) found six plant species with gender-specific cultivation regimes: *Agave sisalana* Perrine ex Engelm., *Bridelia micrantha* (Hochst.) Baill., and *Albizia coriaria* Welw. were only planted on women's farms, while *Combretum molle* R. Br. ex G. Don., *Euphorbia candelabrum* Tremaut ex Kotschy, and *Sesbania bispinosa* (Jacq.) Steud. ex Fawc. & Rendle were only grown on men's farms. In a study of Bangladeshi home gardens, Wilson (2003) documented gender-distinct plant cultivation patterns, with women cultivating only native plants, and men only exotic (introduced) plants.

Species-specific knowledge is often a result of culturally-defined norms that restrict social or ritual ecological knowledge and/or practices to a single sex. In societies where one gender is more responsible for ceremonial food/plant material procurement, and the other for the processing and/or presentation of those plant materials, each gender specializes in ethnobiological knowledge and practices associated with the ceremonial phase with which they are most acquainted. For example, the preparation of certain foods can be highly gender-specific: for Creek Indians the preparation of soured maize (*Zea mays* L.) gruel (*sófki*) is a female-only task, directly and exclusively related to the ''procreative power of women'' (i.e., menstrual cycles—see Bell et al. 1993). Creek men must stay physically separate from all *sófki* preparation activities except for the provision of firewood. A reverse situation is found in Rotuma, where the latter phases of the traditional production of *mena* (turmeric powder and oil from *Curcuma longa* L.) are performed exclusively by men, because women are not allowed to enter the area where the rhizomes are cooked in earthen ovens (McClatchey 1993). In Sri Lanka, women's reproductive cycles prohibit their participation in crop protection rituals conducted by men to rid rice paddy of certain pests (Kahandawa 2003); amongst the Nyima Nuba of Sudan, men are prohibited from setting foot in sesame (*Sesamum indicum* L.) plots once the seeds have been planted by women, who retain exclusive rights over the crop (Bedigian and Harlan 1983). In the rural and periurban communities of the Eastern Cape (South Africa), Xhosa women and men create and maintain separate ethnically unique ritual structures made of native woody plants gathered locally (Cocks and Wiersum 2003). The *ubuhlanthi* (livestock enclosure), constructed exclusively by men, is used both to house animals and as a place for men to conduct rituals and other male-specific social practices. The *igoqo* 'woodpile' is a carefully maintained structure constructed and used exclusively by women as both a ritual and private space to conduct female-specific ceremonial activities. Only certain types of carefully selected wood are collected for both the *igoqo* and the *ubuhlanthi*, and the knowledge of the plant taxa and harvesting locations is gender-specific. Among the Mijikenda of Kenya, men control women's access to

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sacred *kaya* groves, where women are allowed limited participation in specific rituals in certain parts of the forest. Only men access the most sacred parts of the forest, leading to different types of knowledge and gender differentiated levels of ethnobotanical valuation of *kaya* forest (Nyamweru 2003).

Traditional cosmological beliefs involving certain plants or animals can also lead to gender-specific knowledge about those species. In New Guinea, gathering of a certain wild yam (*mwau*, *Dioscorea* L. spp.) involves gender-circumscribed behavior that respects the *mwau* as an entity with a significant personality. Only women harvest *mwau*, and when doing so are prohibited from talking to anyone or using literal terminology to name their gathering implements (Namunu 2001).[3] Women or men ignoring these restrictions are ridiculed, bringing shame on their entire family (Namunu 2001; Sillitoe 2003). Elsewhere in New Guinea (Trobriand Islands) the sex roles are switched, and yam gardens are exclusively cultivated by men (Weiner 1980). In Australia, yams are treated with special care: ''yam dreaming'' ceremonies are carried out, on a gender-specific basis, to encourage yam growth (Toussaint 2001).

Women and men's ethnobotanical medicinal and ritual knowledge often overlaps, but also frequently diverges. On Siberut Island, Indonesia, both genders act as traditional healers, but the occupation of recognized medical specialist positions as *kerei* (highly trained shaman), *siagai-laggek* (a trained healer without religious connotations), or *sirua-mata* (a type of medium) by one gender or the other varies geographically (Ave and Sunito 1990). Among Dayak tribes of Borneo, women are recognized as being more generally knowledgeable about medicinal plants (Caniago and Siebert 1998; Gollin 1997b), but both genders specialize in different types of medicinal knowledge: men are more familiar with plants to treat serious wounds, and to use as fish poisons, whereas women are more familiar with treatments for common ailments such as stomach ache and fevers (Gollin 2001). Within a husband-wife healing team of the Tado (Flores Island, Indonesia), the husband specializes in liver ailments, the wife on midwifery and ''female'' complaints. Both husband and wife spoke of species and uses that the other did not mention during repeated, separate interviews (Pfeiffer 2002).

Gender-specific Knowledge of Plant or Animal Parts.—Significant gender differences in ethnobiological knowledge emerge if an organism or parts of an organism are used in activities dominated by one sex. Both Madge (1995) and Harris and Mohammad (2003) report gender differences in the types of wild forest products collected by West African cultural groups; Stagegaard et al. (2002) report gender-differentiated use and knowledge of forest products by the Mestizo communities in the Peruvian Amazon (refer to Table 1). In areas where women are primarily responsible for wild food gathering and processing, women have much more sophisticated knowledge about plant toxins than men (FAO 1987; Howard 2003). As Draper (1975) notes, ''successful gathering over the years requires the ability to discriminate among hundreds of edible and inedible species of plants at various stages in their life cycle.'' In the Solomon Islands where women specialize in reef gleaning, they possess extensive knowledge of the ''spawning seasonality, feeding habits, and periodicity of many invertebrates'' (Aswani and

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TABLE 1.—Gender-differentiated ethnobiological knowledge: summaries of selected studies.

Researchers	Location	Findings
Wild-harvested food: terrestrial ecosystems		
Dei et al. 1989	Ghana	While both genders engage in hunting and trapping, women and children gather a wider variety of forest products and hunt smaller forest species than do men.
Dufour 1987	Colombia (Tukanoan Amerindians)	Due to differential access to game and fish, women and children gather and consume a greater diversity and quantity of insects than do men.
Somnasang and Moreno-Black 2000	Thailand	Adult women and girls were able to correctly identify more wild plants, insects and fish than their male counterparts (quantitatively statistically significant results).
DeWaal 1989	Sudan	Female-headed households had higher survival rates than male-headed households because women were more knowledgeable in the collection of wild foods (wild grass, rice, finger millet, fruits).
Hoskins 1982	Sierra Leone	Women able to list 31 wild-harvested products, men could list only 8.
Harris and Mohammed 2003	Northern Nigeria (Manga, Hausa, Fulani)	Of the 31 wild foods marketed, 15 species were exclusively marketed by women, 2 exclusively by men.
Wild-harvested food: marine ecosystems		
Baker 1993	Northwestern Australia (Yanyuwa)	Men specialize in open water marine fishing; women specialize in terrestrial harvesting of wild plants and animals.
Siar 2003	The Philippines	Use of the coastal zone was spatially differentiated by gender: women harvested the intertidal zone while men fished on the coral reefs, thus knowledge of marine species was gender-differentiated according to the habitats occupied by the different aquatic species.
Steward and Faron 1959	South America (Yahgan/Yamana)	Women dove for shellfish; men hunted marine animals and birds.
Ecological Knowledge		
La Torre-Cuadros and Ross 2003	Mexico (Maya)	Quantitatively different knowledge by gender (based on the diversity of species reported) regarding vegetation in different ecological habitats.

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TABLE 1.—Continued.

Researchers	Location	Findings
Ethnobotanical knowledge: woodlands/grasslands		
Goebel 2003	Zimbabwe	Gender differences in the types of woodland products named, the areas where resources are collected, and the relative amounts of resources collected in each area.
Madge 1995	The Gambia	Measurable correlation between gender roles and gendered uses of forest products.
Hanazaki et al. 2000	Brazil Atlantic Coast (Caiçara)	Men knew more about plants used for medicines and handicrafts, women knew more about edible species.
Fortmann and Nabane 1992	Zimbabwe	Women have a wider knowledge of tree species than men, due in part to women's collection of firewood, fruit, and fodder.
Kristensen and Balslev 2003	Burkina Faso (Gourounsi)	For plants used for vegetable sauces, firewood, construction, and medicine, the level of knowledge for women and men was similar; but men knew more about edible fruit species.
Letsela et al. 2003	Lesotho	Women could list more plant species used for firewood and edible vegetables; men could list more medicinal plant species.
Sacred and medicinal ethnobiological knowledge		
Reichel 1999	Northwest Amazon, Colombia (Yukuna and Tanimuka)	Gender-distinct, specialized knowledge relating to cultivated, ritual, and medicinal plants, as well as hunted and gathered species.
Cocks and Wiersum 2003	South Africa (Xhosa)	Women and men create and maintain separate, ethnically distinct ritual structures constructed from different sets of woody plant species.
Gollin 1997b	Borneo (Kenyah Dayak)	In general, women possessed greater medicinal knowledge; women were more familiar with treatments for common ailments (e.g., stomach ache and fevers), and had a broader knowledge of the secondary forest and cultivated species; men more familiar with plants used to treat serious wounds, in rituals, as fish poisons, and with primary forest species.
Stagegaard et al. 2002	Peru	Men had higher knowledge of tree-derived medicinal products; women more knowledgeable about medicinal uses of weeds, herbs and crops.
Agricultural/agroforestry systems		
Rochleau et al. 2001	Dominican Republic	Gender-distinct, and at times completely separate, control over crops and livestock within the household agricultural portfolio.
Wickramasinghe 1997a	Sri Lanka	Decisions regarding household utilitarian plant products are made largely by the women, whereas men make decisions regarding commercial plant products destined for the market.

Weiant 2004:303). In Indonesian and Californian communities where basket-weaving is still practiced, both men and women are familiar with the plant materials used in basketry. However, male and female basketweavers tend to be more intimately acquainted with the plant parts gathered, processed, and used specifically for the basket types in which they specialize. For example, in eastern Indonesia, women specialize in *roto* (round carrying baskets made from pandan fronds (*Pandanus* Rumph. Ex L. f. spp.)) and *loce* (woven pandan frond mats), whereas the men specialize in *lancing* (huge bamboo rice storage bins made from stems of *Dendrocalamus asper* (Schultes f.) Heyne) (Pfeiffer 2002). In California, women are more likely to weave than men, and thus are more familiar with basketry plant materials such as the stems of deer grass (*Muhlenbergia rigens* Hitchc.), sedge (*Carex barbarae* Dewey ex Torr.), and woodwardia fern (*Woodwardia fimbriata* Sm.), as well as redbud (*Cercis occidentalis* Torr.) and willow (*Salix* spp.) branches (Anderson 1999; Bibby 1996). In many cases the plants used in basketry require intensive in situ cultivation such as pruning, coppicing, or periodic burning to harvest material of suitable quality (Anderson 1999). Constant contact with the plant parts used in basketry (e.g., shoots, stems, stalks, roots, or fibers) at different growth stages (emergence, immaturity, reproduction, senescence) and turgor (wet, moist, dry) leads to highly specialized, gender-differentiated knowledge regarding the morphological and physiological plant characteristics, including but not limited to tensile strength and flexibility, anatomical structure, pest incidence and damage, and age/growth stage of the material used (Bibby 1996).

Gender-based Spatial Variation in Ethnobiological Knowledge.—Gender-specific labor responsibilities, culturally-determined rules of movement, and degrees of resource access lead to gender variation in ecosystem exposure, and hence spatial variation in ethnobiological knowledge and practice. For example, within most agrarian households, women and men manage different components of the household's agricultural portfolio (Momsen 2004; Sachs 1996): women are more likely to control the household gardens (Oakley 2004; Watson and Eyzaguirre 2001)—an often overlooked source of high biodiversity containing hundreds of plant types (Mendez et al. 2001; Polosakan and Soedjito 1997), minor crops (Haq 2004), and subsistence foods, while men control the agroforestry plots and commercial crops (Trenchard 1987; Trinh et al. 2003). Among the Birom of northern Nigeria, women are responsible for spatially distinct cropping areas (Smedley 2004). This is also true in The Gambia, where Mandinka women cultivate rice in the wetlands and swamps while men cultivate millet, sorghum, maize, and groundnuts in dryland areas (Carney 1993; Trenchard 1987). Yet even this dichotomized representation can be misleading in an era where women are increasingly involved in commercial agricultural operations (Spring 2000), hence the need to disaggregate agricultural systems data both by crop type and by activity phase.

Gendered spatial distinctions also occur in foraging activities. In rainforest societies, men tend to gather from primary forest areas (often located far from the homestead) while women harvest wild and domesticated plants from secondary forests and field margins closer to settled areas (Gollin 2001; Kainer and Duryea

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1992; Nyamweru 2003). For example, among the Garífuna of Nicaragua, women knew more about plants growing in disturbed areas along forest edges and roadsides, whereas men were more knowledgeable about wild plants deeper within the forest (Coe and Anderson 1996). In other areas both men and women collect from old-growth and secondary-growth forests (Ireson 1997) or are forced to wild-harvest from more peripheral areas further from the homestead (Rocheleau 1988). In African dryland regions, among settled and seminomadic societies, men are primarily responsible for grazing livestock while women collect water, fuelwood, and wild foods (Becker 2000; Smedley 2004). In Nepali Sherpa and Pakistani communities women tend livestock (Carpenter 1997; Daniggelis 2003); among the Saami, both women and men traditionally herded reindeer (Larsson 2005); and in many Amazonian societies all household members collect firewood and wild foods. Throughout Pacific coastal areas (both mainland and island societies), men tend to fish along the reef or in deeper sea waters while women fish from shallower areas, reef glean, or collect shellfish, crustaceans, echinoderms, and seaweeds in estuarine and intertidal flats and mangrove forests (Aswani and Weiant 2004; Chapman 1987; Hviding and Baines 1996; Meehan 1977; Moss 1993; Rickard and Cox 1986; Siar 2003; Slatter 1984; Titcomb 1972).

In many societies male and female domains are clearly delineated: this is especially true in parts of Africa, the Middle East, and South Asia where purdah and other forms of female seclusion are practiced (e.g., Bedigian and Harlan 1983; Gerold 1991; Wilson 2003). Among the Kirati of Nepal, agricultural activities designated as ''outdoor work'' (*bairo ko kam N*) culturally pertain to masculine domains; whereas ''indoor work'' (*bhittro ko kam N*) is considered a feminine domain (Gurung and Gurung 2002); this social and philosophical dichotomy is echoed in other communities, including the Lio of Indonesia (Howell 1996). For the Tigrayan people of Ethiopia, ''kitchen work''—including the processing of plant and animal products—is so strongly defined as women's work that men are considered effeminate if they enter the cooking area (Lyons and D'Andrea 2003). Among the Maasai, the storage and distribution of milk obtained from a variety of livestock is so strongly defined as a woman's domain that it is considered extremely dishonorable for men to enter storage areas to inspect or measure women's collections of milk-filled calabashes (von Mitzloff 1988). Similar beliefs exist amongst Warao men of Venezuela, where phytomedicine is *de facto* a women's area of specialization, because the kitchen hearth is the principal site for preparing herbal medicines (Wilbert 2002). For both the Penan of Borneo (Brosius 2001) and the Chipewyan of Canada (Sharp 1981), the forest/bush is seen as being the domain of men, the camp that of women and children. In Indonesia, among Muslim, Christian, and animist rural communities, cultural strictures which strongly discourage women from unaccompanied travel or work outside the homestead result in women's frequenting areas that are close to the household compound; areas that are recognized as public domains where other women are likely to be present (e.g., riversides, threshing areas); or areas that are more ecologically disturbed habitats (e.g., agricultural clearings). Men do not suffer from similar restrictions on their movement, and tend to travel more widely through habitats that are farther from the household compound and that

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are located in less ecologically disturbed areas (e.g., primary forest) (e.g., Ertug 2003; Pfeiffer 2002; Pieroni 2003).

Spatial variation between genders also occurs at different heights where wild plants and animals are collected (e.g., in the tree canopy) and at different topographical elevations (e.g., in montane areas). For the Baka of Cameroon (Agland 1990) and the Dayak communities in Borneo (Buchmann and Nabhan 1996), honey-gathering from bee nests high in rainforest trees is exclusively men's work. Palm tree tapping for palm wine is a man's job, both in West Africa and in Indonesia, as is coconut palm nut gathering and the collecting of other edible or medicinally useful species involving tree climbing (Hays 1974; Obi 1988). In Micronesia, the collection of breadfruit in some societies (e.g., the Yap) is socially restricted to men due to moral codes regarding female modesty, whereas in other areas (e.g., on Ponape Island), both sexes climb trees (Atchley and Cox 1985). In Papua New Guinea, Mauna women are culturally restricted from gathering wild foods above 2500 meters (Hays 1974).

Gender-based Temporal Variation in Ethnobiological Knowledge.—Temporal variation in ethnobiological knowledge and practices by sex occurs when women and men work in the same agricultural or natural resource systems, but are primarily responsible for different activity phases (Cloud 1985). For example, in detailed calendars of agricultural activities distinguished by gender, Shields and Thomas-Slayter (1993) showed that Filipino women farmers were responsible for distinct phases of crop and livestock maintenance and processing from their male counterparts. In their study of enset (*Ensete ventricosum* (Welw.) Cheesman) cultivation in Ethiopia, Tsegaye and Struik (2002) discuss how cultural restrictions determine gender divisions for different phases of the crop; for example, during enset processing it is taboo for men even to enter the enset fields. In a quantitative study of seasonal time allocation among Muslim Melayu and Iban Dayak communities on Borneo, Colfer et al. (1999) found statistically significant gender differences in hunting, fishing, and forest product collecting activities, demonstrating that women played a greater role in all three of these activities than was previously known. In West Africa, Guyer (1991) notes that cultivation of ancient native staple food crops is characterized by a temporal interweaving of gender-defined activity phases she terms ''interdigitation.'' In her study of the Kikuyu (Kenya), Ewe (Ghana), and Kusasi (Ghana), Trenchard (1987) outlines the gender division of labor which exists even in areas termed male or female ''private'' fields: women and men regularly work on each other's fields, either as unremunerated labor or in exchange for food and drink. On Lombok Island (Indonesia), the temporal division of labor and activities practiced by a husband-wife herbalist team results in gender-differentiated ethnobotanical knowledge. The wife sells freshly prepared health tonics in the morning, while her husband specializes in externally manufactured powdered remedies marketed during the afternoon and evening hours. Since the wife specializes in fresh materials, she is a better source of information on where, when, and how to acquire local plant resources (Pfeiffer 2004). In coastal communities in the Solomon Islands and Australia, men spend a greater amount of time fishing during calmer weather, but women and children provide the

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majority of household protein from wild-harvested coastal resources (e.g., shellfish) during rougher weather when men's fishing is suspended (Baker 1993; Hviding and Baines 1996).

In areas where women and men are present in the same habitats but at different times during the year, gender-based variation in traditional ecological knowledge is based on familiarity with different seasonal components of the life cycles of plants and animals—and interspecies interactions—present in those habitats. For example, seasonally nomadic herders in African communities (where men and boys are principally responsible for herding free-ranging animals such as cattle and water buffalo) or in Asian mountain communities (where women and children herd cows and goats) gain a greater cognizance of plant and animal vegetative and reproductive cycles based on the ecosystems they visit during different time periods. For settled agricultural communities, native plant and animal life cycles occur alongside different seasonal crop activity phases, encouraging gender specialization in agroecological knowledge. For example, in eastern Indonesia and other Asian societies, women are primarily responsible for the planting and weeding of certain crops, including paddy rice, during the rainy season (Saradamoni 1991). Given the seasonal nature of plant life cycles, women are more likely to come in contact with certain plants growing concurrently with the young rice during the wet season (such as *saung senduk* (*Limnocharis flava* Buchenau), a swamp plant with edible leaves) which disappear from the paddies during the dry (harvesting) season (Pfeiffer, personal observation, 2000).

Gender-based Variation in Species Encounter Rates.—Spatial and temporal distinctions in ethnobiological knowledge and practice along gender lines leads to gender-specialized knowledge of plants and animals, as well as ecosystem properties and processes, such as ecological indicators, succession patterns, and seasonal cycles (Turner 2003). Ecological expertise, therefore, is a function of contact frequency—women or men will know more about a given bioresource depending on how frequently they encounter it. In situations where the mobility of one gender is more spatially limited than the other—which is often the case for women—the range of species and habitats encountered may also be limited. Yet those who tend to spend more time within a limited set of areas may develop a deeper familiarity with the species and habitats (bioresources) in those areas due to greater overall exposure frequency. In other words, even if women operate in a lower range of habitat diversity, their overall temporal duration in each habitat is relatively high, increasing their encounter rate (i.e., the number of observations per unit time) for the bioresources and ecological events within each habitat. Conversely, in situations where one gender is more spatially expansive than the other—often the case for men—a wider range (or higher number) of species and habitats may be encountered, but the time spent in each area tends to be more limited. This leads to lower overall familiarity with the bioresources encountered, due to lower overall exposure frequency for the bioresources and ecological events within each habitat. We assume that wherever one gender's encounter rates with a given bioresource or ecological event are higher than the other gender's, their ecological knowledge will be more detailed and potentially

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more accurate. Butz (personal observation, 2004) has found these patterns to be true for her fieldwork with Maasai communities in northern Tanzania, where women and girls are responsible for livestock (goats, sheep, and donkeys) confined to areas within a several-kilometer circumference of the village compound (*en'kang*), and men and boys graze large herds of cattle across a range of geographically distant seasonally distinct habitats.

Distinctive domains of knowledge possessed by each gender, or ''gender-based knowledge systems'' (Reichel 1999), include gender-specialized ecological knowledge and practices. The existence of gender-based knowledge systems means that both women and men are responsible for using, managing, and conserving different components of biocultural diversity; thus, gender-balanced research entails paying equal attention to both genders, and how their knowledge varies both spatially and temporally.

DESIGNING AND IMPLEMENTING GENDER-BALANCED RESEARCH

Incorporating the cultural and ecological variation extant in our interdisciplinary studies requires the development of specific methodologies: this is especially true when attempting to incorporate gender variation in ethnobiological knowledge and practice. In this section we examine different stages of the research process with the aim of suggesting gender-sensitive approaches and techniques that can improve the overall quality and rigor of field-based research.

Team Composition.—Gender-imbalanced teams are susceptible to cultural restrictions in data gathering, leading to incomplete and/or inaccurate conclusions. A mixed-gender team is more likely to achieve gender balance in its approach to hypothesis formulation and data gathering (Dewalt and Dewalt 2002), but careful attention will need to be paid to the potential impact of gender power dynamics within the research team itself (Logan and Huntley 2001). Just as we have outlined gender differentiations in ecosystem exposure and knowledge acquisition and transmission for the communities where we conduct research, ''[m]en and women have access to different settings, different people and different bodies of knowledge'' (Dewalt and Dewalt 2002:86). Cultural norms in many communities restrict interactions between the sexes, especially one-on-one interviews (Bernard 2002; Dewalt and Dewalt 2002; Howard 2003). More conservative Islamic societies enforce a range of prohibitions regarding women's interactions with men, while in caste-based societies (e.g., India, Nepal, Bangladesh), rural women are exceptionally shy with foreign male researchers (Rusten and Gold 1995). In ethnobiological research, information gathered is often of a gender-sensitive nature (Haverkort 1999). As we discussed earlier, in many societies, gender taboos regarding male-only or female-only ceremonial or medicinal knowledge prevent or complicate the divulgence of specific information between the sexes.[4] For example, among the Maasai of Tanzania women are not allowed to attend or even know the exact location of certain feasting ceremonies (*olpul*) involving mainly the male warrior class (*ilmurran*) (Burford et al. 2001; Butz 2000). This cultural restriction prevented Butz from gathering complete data on plants relating to ceremonial practices, as even the

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name of the ceremony was privileged knowledge. Parallel taboos exist in other cultures such as the Mansi (Russia), where women are prohibited from viewing idols in forest glades or in the ''male'' parts of their own households (Fedorova 2001). In Brazil, Mundurucú men play wooden musical instruments (*karökö*) that contain ancestral spirits: women may hear, but not see, these instruments (Murphy and Murphy 2004). Similar strictures are held by Mappurondo communities (Sulawesi), where men's construction of bamboo and palm musical instruments (*tambolâ*) may not be viewed by women (George 1993). Yet the inverse may also be true: details regarding the origin and meaning of certain female-only ritual language relating to environmental forces in Mappurondo society are kept secret from men (George 1993). In Australia, men are not always permitted to witness women's secret songs or visit women's sacred sites (Sky 1995). Sacred medicinal knowledge, such as plants used for female- or male-specific illnesses, is often gender-privileged information (Frommer 2002). For example, while men in Maasai or Bantu culture often know the basic plants for certain women's reproductive health issues, specialty plants used in rituals such as private naming or blessing ceremonies, or during birthing complications tend to be known only by women (Johns et al. 1994). Men may be aware of the specialty plants and the general purpose for which they are used, but they often do not know the correct preparation, dosage, or time of most effective administration (Butz 2000). These examples of cultural restrictions on same-sex interactions, gender-specific sacred sites, and ceremonial and medicinal knowledge demonstrate the need for a mixed-gender team in order to collect valuable information without violating cultural and/or sacred taboos.

Choice of Study Topic and Research Design.—Research topics and methods can be gender-biased if the researcher(s) are unaware of gender differences in a given knowledge system and select lines of inquiry that lead to misdirected hypotheses or conclusions about the knowledge system. Studies of dominant, charismatic, or more readily ''obvious'' ethnobiological practices (e.g., common foods) or species can result in the under-representation of the ethnobiological knowledge held by a given community and significant gaps in our knowledge base. Ethnobiological research that focuses on a certain species or habitats, and uses the results to represent ethnobiological knowledge held by the society at large can lead to gender-biased conclusions about the community's knowledge base if the taxa studied are better known by people of one sex or the other. In a study by Wester and Yongvanit (1995) comparing women's and men's knowledge in northeastern Thailand, the research focused on ten food plants—a choice which most likely favored women in their role as the purchasers and preparers of family meals. Women in all age groups scored higher than men in the survey, but it is unknown if a similar pattern would emerge if a larger plant group were surveyed, e.g., plants used not only for food, but for medicine, timber, or animal feed as well. In eastern Indonesia, Pfeiffer (2002) performed a quantitative analysis of gender differences in edible native fruit plant knowledge and use. The initial analysis grouped all respondent knowledge scores (men and women from 93 households) for all 85 plant taxa surveyed. At first glance men had higher average scores than women, leading to an initial conclusion that men had higher

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plant knowledge, overall, than women. Succeeding data collection exercises demonstrated that these results were misleading due to unintended bias in the plants selected for the survey. Men scored higher because most of the edible fruit taxa surveyed were woody species found principally in primary forests, ecosystems frequented more often by men than women. When the ethnobotanical study was broadened to include plants exhibiting different growth forms (both woody and herbaceous) and habitats (primary and secondary forests), women's specialized knowledge emerged: although men knew more about woody species growing in primary forests, women knew more about herbaceous species growing in secondary forests and household gardens (Pfeiffer 2002). These findings are congruent with other studies based in Southeast Asian rainforests and West Africa savanna (Gollin 1997; Kristensen and Balslev 2003 — see Table 1).

Informant Choice and Hypothesis Formulation.—The above examples of gender-sensitive ethnobiological knowledge and practice illustrate two important points. First, it is crucial to recognize when gender-sensitive issues can exist within otherwise apparently gender-neutral contexts, in order to ask the best questions of the appropriate people. Second, gender differences can play a part in the development of research hypotheses that measure or compare gender differences in ethnobiological knowledge, or assess the degree of cognizance by men or women about the other sex's knowledge. In the American Southwest, the wide range of edible plants gathered primarily by women were so thoroughly underreported by early ethnographers that many species gathered by women remain unrecorded or briefly mentioned as ''weeds'' or ''seeds'' (Bean and Lawton 1993). These gaps in our knowledge base have an impact on current research: lack of specific data on precisely which native grass taxa were wild-cultivated by Native American women frustrates current researchers' efforts to analyze potential anthropogenic influences on native grass diversity. Sometimes determining the lack of knowledge about a particular taxon or subject is just as important as identifying what is known about it. For example, in a study on non-timber forest products used in rural Mali, men mentioned almost the entire range of products collected by women but inaccurately estimated the frequency of women's collection activities (Gakou et al. 1994). Cloud (1989) reports that statistical accuracy regarding women's involvement in agricultural activities increases when interviewers question women directly rather than relying on the reports of male household members. An interview with a woman in any given household on agronomic, ethnobiological, or economic issues associated with a certain suite of plant or animal resources will produce very different results than the same sort of questions posed to a man. Gender-balanced research requires not only that we are aware of gender differences, but that we actively seek out both women and men, and interview them separately from each other.

Data Gathering Techniques—the Challenge of Including Women in Sampling Design.—To achieve our goal of gender-balanced research, we need to pay attention to women's social and economic realities. In many societies women are reluctant to interact with researchers in a public place or with outsiders who are perceived as

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being from a more powerful social class; thus an ''extra effort'' is necessary to include women in study groups. In a study of diet, income, and agriculture on St. Vincent, Grossman found that women were hesitant to be interviewed in public, so he arranged for home-based interviews (Grossman 1998). Kenyah Dayak women interviewed by Colfer and colleagues (1985) frequently cited childcare as a reason for not attending community meetings on the headman's veranda, and during a later study conducted by Gollin (2001) and colleagues, they reported that ''only men participated in [ethnobotanical focus] group interviews. Home visits made up for these imbalances in data collection'' (Gollin 1997:137). In a study of wild food use and famine foods in Nigeria, Harris and Mohammed (2003) ascertained that their female informants' discomfort during interviews led to the women limiting their responses (and thus underreporting their knowledge) to shorten the interviews. Nepali researchers found that women heads of households are reluctant to initiate interactions with officials due to their relative inexperience with social interactions with outsiders, as well as their overwhelming workload (Bhattarai et al. 1989).

In most agrarian communities, women carry a ''triple load''—they are responsible for agricultural tasks and/or natural product collecting outside the home, household maintenance, and childcare (see the figures cited in Emecheta and Murray 1981; Quraishy 2001; Wickramasinghe 1997b). Time-budget surveys performed by researchers worldwide consistently demonstrate that women perform physically heavier work (by working at hard labor, menial tasks for cumulatively longer durations of time) and work more hours than men (Dankelman and Davidson 1988). Women's additional workloads often limit their accessibility to researchers in the following ways: they are less likely to attend public community meetings; they are less likely to have extended amounts of ''free time'' for interviews (especially if they belong to lower income households); and their need to multi-task during interviews can shorten their responses (thus decreasing the amount of information shared). Even when they do attend group meetings, they tend to speak less frequently or freely as men (Fortmann and Rocheleau 1997). Overall, women's responsibilities make them less ''visible'' to researchers, and thus their knowledge is more likely to be underestimated or overlooked. By increasing our attentiveness to women's cultural restrictions, workload, and time limitations, we can achieve more gender-balanced research. Practical ways to achieve this include identifying gender divisions of labor at our research site; scheduling meetings and interviews during times when women are less likely to be fully occupied (e.g., in the dry or winter season for agricultural communities or in the evenings after meals have been served); scheduling interviews in places where women feel more comfortable; assisting women with their tasks while conducting an interview (e.g., helping to weed garden plots, gather water, or process agricultural/wild-harvested products); and arranging for childcare during meetings and interviews. These forms of assistance can ultimately benefit the researcher, as they often result in more extensive data collection, a more sophisticated understanding of certain ethnobiological practices and products (certain processing nuances and/or additional data only emerge when a task is actually performed) and stronger ties with the research participants.

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Translation Issues.—Another potential source of gender bias in ethnobiological research involves the interpretation of an individual's knowledge by a person of the opposite sex—a topic that has been exhaustively addressed in the anthropological literature (see Morgen 1989). For example, both men and women have been known to underestimate or disparage the other sex's knowledge (Dankelman and Davidson 1988; Sperling 1992). In addition, the gender of the translator can affect the quality and content of the interview if culturally-induced power relations influence the interview structure. In most rural societies researchers rely on male translators, as women are more likely to be fluent only in the local language due to gendered differences in access to formal and exogenous knowledge (FAO 1993). This was true in Butz's research: women in Maasai culture tended to be monolingual in Maa (their traditional language), whereas men were more likely to be bilingual in Maa and Swahili (the *lingua franca* of Tanzania) due to their dealings with other tribes through trade (Butz 2000). Butz experienced gender-based translation problems in her work when reviewing transcriptions of taped interviews between a male Maasai translator and female Maasai expert on the topic of upper respiratory infections. The transcriptions revealed that the translator relayed different information than the informant expressed. In several instances throughout the interview the translator felt that the information expressed by the female expert was either inaccurate or not relevant to the research question posed, and either neglected to fully translate the response, substituted an alternative explanation, or redirected the question without the researcher's knowledge. It is unclear from the tape transcriptions which responses are ''correct'' or ''incorrect,'' but the noted discrepancies illustrate an important point regarding differences in male and female knowledge, as well as the need for caution when drawing conclusions from data collected through a third party. Pfeiffer (1993) experienced similar problems with male translators while interviewing female farmers during her agricultural research with Yoruba communities in Nigeria; until she gained relative fluency in Yoruba and was able to redirect questions, the direction and content of her interviews were subject to unauthorized change by male translators who believed they knew better than either the female farmer or the female researcher. Later in Pfeiffer's research she switched to a female translator, who demonstrated greater attentiveness and accuracy during the interviews, and was equally respectful to both male and female farmers.

Gender-based translation issues can be exacerbated when dealing with highly charged subjects such as medicinal or ceremonial knowledge. An already sensitive situation can be further impaired when ''an outsider'' is used as a data collector or translator. A second translation example from Butz's research involves a non-Maasai male translator and a female Maasai expert on the gender-sensitive subject of women's reproductive health. During the course of this interview it quickly became apparent that the woman was holding back information due to both the ethnicity and gender of the translator. Butz identified the problem when the female expert claimed ignorance of matters about which she had previously demonstrated knowledge in the field. Attributing the discrepancy between the expert's apparent and stated knowledge to the presence of an unfamiliar male (the translator), Butz asked the translator to

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leave temporarily despite the potential for ensuing linguistic difficulties in communication; the subsequent content of the interview improved dramatically as the female expert began sharing more freely with the researcher.

Data Analysis.—Earlier in this paper we noted the dangers of relying on coarse-grained measurements or macroanalyses for assessing variation in ethnobiological knowledge and practice. Four ethnobotanical studies cited below demonstrate the need for more finely-grained data analysis. In both Pfeiffer's (2002) study of edible native fruit knowledge in eastern Indonesia and Rusten and Gold's (1995) study of tree fodder knowledge in Nepal, initial macroanalyses (when the data were grouped and compared between categories) yielded no significant differences between genders. It was only when microanalyses were performed—i.e., statistical tests of differences within individual categories—that gender differentiation in ethnobotanical knowledge emerged. For example, Pfeiffer did not detect significant differences in male and female knowledge for certain plants until she compared men's with women's response scores (using a two-tailed *t*-test) for specific uses of each individual plant species. Rutsen and Gold detected significant differences in male and female tree fodder knowledge and use only after they compared men's and women's preferences for specific tree species.

Data-scoring methods can also be gender-biased, leading to inaccurate analyses. In Pfeiffer's study of native edible fruits, male knowledge appeared greater as knowledge scores were calculated based on the frequency of plant use within predetermined categories set by the researcher (Pfeiffer 2002). Knowledge scores simply indicated the relative presence/absence of knowledge about a given plant and did not increase if a respondent knew more than one use of that plant within any of the pre-set categories (e.g., a respondent who knew different recipes within the category of ''food'' or ''medicine'' received the same score as another respondent who could only describe one recipe), but were increased if the respondent could name a use in another category. Thus, if both genders knew that a given plant was used both as food and medicine, but men described an ''other'' use (such as making a toy) and women did not, the men received a higher score. This gender bias in data scoring was only discovered after finer analyses were performed: initial lump-sum histograms simply showed men scoring higher than women in terms of overall ethnobotanical knowledge.

A similar bias may occur when only one type of knowledge is studied, or only one level of knowledge is recorded. Two recent field studies measuring gender differences in plant knowledge focused on taxonomic awareness (e.g., the number of plant names known), but did not go beyond nomenclature recognition to analyze knowledge about the plants' uses. In both studies men collectively scored higher then women. A Samoan study performed by Ragone et al. (2004) measured the number of breadfruit (*Artocarpus altilis* (Z) Fosb.) cultivar names known by women or men, but did not analyze deeper levels of knowledge, although the authors noted that the ''second most knowledgeable person about breadfruit names was a woman'' (Ragone et al. 2004:47) and attributed her expertise to an inherited ceremonial title and concomitant responsibility to maintain family traditions. In their research on palm knowledge in Ecuador, Byg

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and Balslev (2004) counted the names of palms known by women or men, but did not analyze gender differences in knowledge and use, despite noting that both genders harvest and process palm products. A potential danger with this type of limited analysis is the propensity to conflate ethnotaxonomic knowledge with ethnobotanical knowledge—i.e., equating plant name familiarity with deeper knowledge about plant growth, distribution, phenology, and the range of tangible and intangible uses. Although it is not always possible to perform more comprehensive analyses, we need to acknowledge the limitations of our studies when making claims about gendered or cultural variation in ethnobiological knowledge.

Improving Research Design.—A number of the issues described in this section can be overcome by longer-term field residence (Kemper and Royse 2002), involving the local populace as research associates (Grenier 1998), and designing research methods that allow for inclusive, detailed surveys that capture the variation of ethnobiological knowledge extant in a given community (Jiggens 1986). Methods for achieving more representative sampling are described in Gary Martin's (2004) ethnobotany manual, Johnson's (1990) ethnographic handbook, Dewalt and Dewalt's (2002) participation observation manual, and in many social science research handbooks. Questionnaires, maps, surveys, and reporting tables incorporating gender variation in natural resource access, use, and control can be found in gender analysis handbooks by Hess and Ferree (1987), Feldstein and Poats (1989), and Thomas-Slayter et al. (1993). Consulting the methods and discussion sections of gender-balanced studies listed in this paper's bibliography can also yield insights into ways to conduct future research with the aim of more comprehensively and accurately researching the wealth of ethnobiological knowledge possessed by rural communities worldwide.

CONCLUSIONS

> One of the great faults of cultural descriptions that center upon males, whether they do so intentionally or not, is that they are one-dimensional, not just in their neglect of the female but in their treatment of the men. (Murphy and Murphy 2004:xiv)

This review of several hundred gender-inclusive field studies from a wide range of academic disciplines (applied, cultural, environmental, and medical anthropology, archaeology, conservation biology, cultural, historical and human ecology, ethnography, agricultural and environmental studies, gender studies, geography, history, international development, Native American, African and Asian studies, nutrition, and rural sociology) has illustrated a wealth of gender distinctions in ethnobiological knowledge and practice. This extensive documentation of gender-based cultural variation stands in contrast to studies published in our discipline's core journals, which to date have yielded only a handful of studies where gender distinctions are recognized. This lack of gender consciousness in research methodology results in biased research design, imbalanced analysis, and potentially erroneous conclusions, which in turn affect the theoretical and empirical implications of the studies. Much of the male bias in

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field studies stems from adherence to false stereotypes, i.e., that only men hunt, that owners of resources are more reliable informants than users, that visual observations by outsiders are objective and reliable, or that macroanalyses accurately portray community knowledge systems. Yet ethnobiological knowledge can vary between genders at the level of ecosystem, community, species, and plant or animal part (Rocheleau 1995; Zweifel 2001). Women and men both share and delegate responsibility for the cultivation, collection, management, and processing of a wide range of bioresources. This actuality is reflected in Table 1, a brief summary of twenty-two ethnobiological studies that found significant gender differences in knowledge regarding wild harvested foods (including survival foods and bushmeat), agroforestry species, sacred and medicinal plants, marine biota, and savanna and forest vegetation. The table supplements the extensive collection of examples contained in this review that demonstrates how going beyond sex-based stereotypes, distinguishing between resource ownership and use, developing more finely-grained studies which disaggregate survey data by gender roles, and recognizing our gender-based ''blind spots,'' enable researchers to distinguish gender-specific knowledge of species, communities, and ecosystems, as well as gender-differentiated spatial and temporal variation in resource access and management. Just as the recognition of spatial and temporal variation in ecological systems enables researchers to understand how system components behave both independently and in relation to each other, recognizing the patterns of spatial and temporal variation in cultural systems facilitates a more holistic understanding of the independent and interrelated factors underlying gender differentiation in ethnobiological knowledge and practice.

A recent position paper from researchers representing the Society of Ethnobiology and the Society of Economic Botany (Ethnobiology Working Group 2003) has called for greater attention to be paid to variation in ethnobiological knowledge systems. In this paper we have focused on gender-based variation in ethnobiological knowledge and practice, due to the critical link between gender and cultural mores. Yet gender is not the only criterion of variation that requires attention. Iyam (1996:388) notes that gender inequality is not simply a question of sex role differences, but also one of ''profound differentiation within the genders on the basis on either class, religious, race or ethnicity.'' Other sources of variation which merit attention in ethnobiological research include age, social status, kin and affinal relationships, occupation, religious affiliation, place of birth, residential location, and migration patterns. Sociocultural variation in our study populations merits the same rigor in representative sampling design and analysis that we apply to the biological systems at our study sites. Researchers frequently focus on 'specialists' who are assumed to be the most knowledgeable about particular subjects. Yet due to the existence of subcultures in societies where individuals pursue a range of different occupations, lay persons often have extensive knowledge differing from specialists (Alexiades 1999). In her work with the Kempo Manggarai, Pfeiffer and colleagues (forthcoming) have found that plant-based knowledge varies by age and occupation: although elders are widely recognized as being inherently more knowledgeable than their juniors, younger hunters, woodsmen, midwives,

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and self-taught herbalists demonstrate occupation-specific ethnobotanical awareness in relation to certain plants and uses that equals or surpasses some senior residents. Knowledge of different plants also varies by the type of mixed agricultural portfolio maintained by the household (i.e., the level of diversity present in the household's home gardens, agroforestry plots, irrigated and non-irrigated fields, and field margins), and the ecosystems surrounding each household's cultivated lands. Recognition of this variation, and incorporation of social strata into field methodologies will result in more accurate and comprehensive analyses of the cultural and ecological systems we research.

In the last part of this paper we presented a number of suggestions, stemming from our own studies and that of many others, regarding ways in which gender-balanced research can be conducted. We support Toussaint's call for ''en-gendered'' research frameworks that involve both genders as ''informants, interpreters, mediators, subjects and collaborators ... ideally inform[ing] all methods and the process of critical inquiry'' (2001:31). Without the equal inclusion of both genders in our scientific studies we are in danger of unconsciously practicing a ''sexualized representation of knowledge'' (Kohlstedt and Longino 1997:12)—i.e., a filtered and biased representation of reality through the lens of only one sex or the other. The acknowledgment of gender differences in resource use and knowledge is not only important for ethnobiological research: it is critical for biodiversity conservation, cultural revitalization, and resource management, as both women's and men's social networks and individual practices disseminate and conserve ethnobiological knowledge and cultural traditions.

NOTES

[1] Our literature review counted ethnobiological or ethnobotanical field studies; it did not include archival, economic, phylogenetic, agronomic, industrial, archaeological, biochemical, or similar reports. We defined ''gendered'' analyses as those studies explicitly including both female and male respondents, accompanied by some form of qualitative or quantitative analysis differentiating between the two genders. Studies containing only a few anecdotal comments regarding women or men did not meet our criteria. We found 12 papers incorporating gender analysis in the *Journal of Ethnobiology* (4% of all studies published to date), and 12 in *Economic Botany* (2.8% of the studies published during the same time period).

[2] In this paper we employ a binary or ''heterosexualized'' view of the terms ''sex'' and ''gender'' (Marshall 2000) by focusing on two sexes (female and male), because a thorough treatment of the gender continuum is beyond the scope of this paper. We acknowledge the existence of multiple, non-dichotomous genders including cross- and transgenders (transpersons), transsexuals, transvestites, homo- and bisexuals and ''third-sex'' identities (Bullough et al. 1997; Hubbard 1998; Meezan and Martin 2003). We define gender not only as ''the culturally and socially constructed differences ... found in the meanings, beliefs and practices associated with ''femininity'' and ''masculinity'' (Kendall et al. 1997) which can vary widely from one social context to another (Disch 1997), but also as a ''dynamically created and negotiated'' relationship between women and men (Davis and Nadel-Klein 1997). We use the terms ''sex'' and ''gender'' interchangeably throughout the text.

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[3] Only metaphors are permitted when naming the implements. This practice of using metaphors to avoid frightening or disturbing the plants is also used by the Manggarai when working in *mavo* (upland rainfed rice) fields (Erb 1999).

[4] Exceptions to this norm have been documented for researchers who gained admittance to settings otherwise prohibited to the opposite sex due to their ''outsider'' or ''asexual'' status—this is more often true for women (Murphy and Murphy 2004; Womack and Barker 1993). Both Pfeiffer and Butz have experienced this ''special status'' in their fieldwork.

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