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Commensurability of Scientific and Indigenous Ecological Knowledge in Coastal Melanesia: Implications for Contemporary Marine Resource Management Strategies

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Commensurability of Scientific and Indigenous Ecological Knowledge in Coastal Melanesia: Implications for Contemporary Marine Resource Management Strategies

Abstract

Fundamental ontological differences between scientific and indigenous ecological knowledge systems in coastal Melanesia have resulted in very different conclusions being drawn from similar sets of observations. The same inductive logic may lead both scientists and non-science-trained fishers to conclude that, say, square-tail trout aggregate at a certain phase of the moon in a certain reef passage, but different assumptions derived from disparate ontologies (in this case "traditional" Melanesian versus scientific) may lead to very different conclusions about why the fish are there. In some cases these differences have significant implications for the way marine resources are exploited, and managed (or not). Examples are presented here of non-scientific ontologies that underpin local beliefs about the biology or ecology of fished organisms that have led to poor management of stocks of these species. The potential for scientific education to "fill gaps" in indigenous knowledge systems (and vice versa) and thus lead to improved management is discussed in the light of some claims that scientific and traditional knowledge systems are incommensurable. The heuristic value of the purported absence of a (Cartesian) dualistic separation of nature and culture in traditional Melanesian cosmologies (relative to those of industrialised Western cultures) is explored with regard to indigenous conceptions of human agency over resource abundance, and the relevance this has for management and conservation. I also speculate about recent transformations of rural Melanesian ontological frameworks through Western/scientific influences, and the associated differences in knowledge systems between young and old members of society, again with respect to the implications these have for the work of proponents of resource management and biodiversity conservation in the region.

Introduction

Campaigns aimed at improving natural resource management and conserving biodiversity in the developing states of Melanesia differ in some important respects to those in the developed nations that provide aid funding for such work, for a range of political, economic and sociological reasons. This does not, however, appear to have stopped Western conservation agencies from taking a global approach to their trade and applying more or less the same methods (with notable exceptions, which I will discuss below) in the developing world. This has led to a number of problems, many of which I observed at first hand while working as a technical advisor for one of the World Wildlife Fund's "Community Resource Conservation and Development" Projects in the Western Solomon Islands. This project, like other ICAD (Integrated Conservation and Development) projects elsewhere in Melanesia experienced significant difficulties in achieving its "conservation and development" objectives (Ellis 1997; McCallum and Sekhran 1997; Van Helden 1998, 2001; West 2001).

Many of these difficulties relate to the profound disparity between the worldviews of Western conservation practitioners and those of the people they are trying to influence. Conservationists have typically been ignorant not only of the development aspirations of rural Melanesians (and other subsistence societies), but also of the ways in which those people think about a) the utilitarian (as opposed to *inherent*) value of "species", which is relevant to the Western-scientific "problematization" of extinction (Foale, 2001), and b) the ecology and population dynamics of economically important species. Many of the issues relating to the development aspirations of people in subsistence economies, and their apparent lack of a conservation ethic, particularly in

low-density populations (which includes most parts of coastal Melanesia), have been comprehensively reviewed elsewhere (Bulmer 1982, Scoones 1999, Smith and Wishnie 2000, Van Helden 1998, 2001) and are beyond the scope of this paper.

Here I wish to examine in some detail the ontological disparities between indigenous and scientific knowledge systems primarily regarding the ecology and population dynamics of economically important species, focusing on those species that constitute subsistence and artisanal fisheries. I will then go on to discuss ways in which each body of knowledge can be understood in terms of the other. I argue that this can often be done within a "naïve inductivist" or "naïve instrumentalist" context (sensu Chalmers 1982: 13, 148), but I also give examples of indigenous knowledge which is clearly not commensurable with scientific interpretations (Chalmers 1982: 136-142). I analyze a number of cases, mainly from the Solomon Islands but including some from elsewhere, of what could be termed "empirical shortcomings" of both scientific and indigenous knowledge. I examine to some degree the relationship between empirical and ontological frameworks, within each body of knowledge, but do not enter into any sort of detailed sociological or anthropological analysis of the sets of assumptions held by scientists or indigenous fishers in each case. My thesis here is that such complex analyses are in fact often not necessary, and that significant management outcomes can be achieved simply with some careful and intelligent communication.

Indigenous Knowledge and Marine Resource Management

Defending the rationalist approach

Many marine scientists are interested in and impressed by the indigenous knowledge of subsistence and artisanal fishers primarily because of its relative empirical strength, i.e. the larger "data set", or number of observations, from which the latter are able to inductively create generalizations about the behavior and ecology of the organisms they harvest. Consequently it is consistent for the scientifically trained researcher studying indigenous knowledge to compare that knowledge with scientific "truths" derived from performing inductivist or falsificationist experiments and observations in the field (Ayer 1951; Chalmers 1982: 5, 38), and/or reading the work of other scientists working in the same discipline. This "rationalist" approach is defensible if the scientist is working within the framework of "fact-gathering" for the purposes of improving fishery management (via building up the biological information-base) in a Western economic sense. The relatively large total amount of time that Palauan fishers collectively spent observing fish allowed them to inductively reason that certain large species of *Epinephelus* and *Plectropomus* aggregate at the entrances to certain passages in the reef in roughly the same months every year at roughly the same lunar phase (Johannes 1981). At the time Johannes published *Words of the Lagoon* (1981) this behavior was largely unknown to Western marine scientists. Moreover, it had significant utility in fishery management because of the fact that these spawning aggregations could potentially become the focus of management actions (such as spatial and temporal closures), assuming of course that the fish population was in need of such management (Johannes 1978, 1981, 1982). Indeed closures were in fact imposed by local Palauans in some areas (Johannes 1978, 1981: 84).

The dualist paradigm and interpretations of indigenous knowledge

An overview of the literature, and the data I generated at West Nggela, Solomon Islands (Foale 1998a,b, 1999), indicate, however, that the grafting of indigenous wisdom onto scientific knowledge is not necessarily always straightforward, or immediately and obviously beneficial for fishery management strategies. Many authors have remarked on the vastly different cognitive contexts, or ontological frameworks, within which many fishers make their observations, and the resultant dramatic differences in the observation statements they derive from those observations (Carrier 1987; Felt 1994; Lieber 1994; Hviding 1996). Carrier (1987) emphasizes that Ponams generally attribute all control over abundance of resources to God. Thus Ponams made no connection between their fishing activities and the declining abundance of vulnerable species such as marine turtles or dugongs. Given the syncretic nature of Christianity on Ponam (and most parts of Melanesia) this belief is almost certainly connected with traditional belief systems, which attributed

the health and abundance of natural resources to the spirit realm (Bulmer 1982; Groves 1991). This has led to a kind of fatalism about declining abundances of fishery resources that often precludes local management initiatives in situations where stocks are overharvested. The common West Nggela view that Cyclone Ida, which occurred in 1972, was responsible for the relatively small size of trochus (*Trochus niloticus*) harvests at the time of my fieldwork there (1994-6) is very likely underpinned by a similar ontology (Foale and Day 1997).

The lack of attribution, by people in many subsistence-based societies, of any human agency in resource depletion, or any potential for human intervention to in fact reverse the decline, is believed by many scholars (Berkes 1987; Descola and Palsson 1996; Hviding 1996) to be part of a worldview which radically differs from the Western dualistic conception of "nature" as separate from "culture". Dwyer (1996) presents a model whereby this nature/culture opposition becomes stronger in peoples' worldview as their production base becomes more intensified (and less dispersed), and the human domain more separated from the domain of spirits. The environmentalist movement in the West is very much rooted in this dualistic opposition, which allows people to see themselves as separate from and thereby able to control (and protect) the natural world (Dwyer 1994, 1996). Hviding (1996) argues that the ontology of Western science also contains this dualistic notion of the environment, and therefore the environmental knowledge of indigenous subsistence societies is largely incommensurable with it. As such he believes that attempts by scientists to appraise indigenous environmental knowledge with reference to scientific knowledge (the so-called study of ethnobiology), always grant epistemological privilege to the latter, and as such are failing to properly contextualise the information they are receiving from indigenous informants.

It is no doubt quite true that epistemological privilege has been granted to science in a number of studies of indigenous knowledge systems, and this has caused some researchers to take important aspects of that knowledge out of context. However, I believe Hviding's (1996) position is somewhat reactionary, and as such, worthy of some discussion. In his article he tries to discredit what he views as science's undeserved hegemony in studies of indigenous environmental knowledge, by giving an example of "Marovo [Lagoon, Solomon Islands] knowledge which involves direct epistemological confrontation with Western science" (Hviding 1996: 174). In this he describes the methods used by an old Marovo man, David Livingstone Kavusu, to determine the incubation period of hawksbill turtle eggs. Kavusu believes (in accordance with established Marovo lore) that the eggs hatch exactly 21 days after being laid, while the scientific reviews cited by Hviding give the hatching time as ranging from 55 to 70 days.

Hviding presents a translation of Kavusu's description of his method for determining hatching time, which he describes as "empiricist" and "at least as convincing as the fifty five to seventy days' hatching period documented in biological reports" (Hviding 1996: 177). He uses this to argue that Kavusu's knowledge comprises a "scientific paradigm on its own" which can not be assessed in terms of Western scientific knowledge (Hviding 1996: 178). He presents the two sets of knowledge as "alternative paradigms" and asserts that an understanding of what Marovo people do in relation to turtles and other things of the environment "cannot be reached through sole reliance on a comparison of indigenous knowledge with Western science, by granting epistemological privilege to the latter."

Inasmuch as it comprises an attempt to look at Marovo indigenous knowledge, and the culture in which it is embedded, as a locally autonomous entity, in isolation from all external influences, such an approach may have some validity, but I am skeptical about the reliability of these assumptions. I agree that there is more to understanding indigenous knowledge and its role in people-environment relations than simply judging the "veracity" of indigenous knowledge against science, but I believe that science is still a useful starting point for reaching such an understanding. By appealing to the empirical sophistication of Kavusu's methods for determining turtle egg hatching time, Hviding is in fact conceding the convergence of the two systems. Kavusu's methodology is precisely the same as that of the marine biologists. Kavusu tests an authoritative claim (that of his elders) that is presumably based on inductivist reasoning, by his own observation and logical deduction (Chalmers

1982: 5-7). Whether he ticks days on a calendar or ties knots in a string (the method Kavusu uses for counting days in the anecdote) is immaterial - they are analogous. Visual confirmation of the deposition of the eggs (which Kavusu did not do), and later emergence of the hatchlings, are all part of the same inductive/deductive "empiricist" methodology.

Thus Hviding is comparing Kavusu's (one man's) conclusions with the unanimously contrasting results of a substantial body of scientific research (Carr et al. 1966; Diamond 1976; Limpus et al. 1983; McKeown 1977; Witzell and Banner 1980), most of which was based on vastly greater observation time (i.e. the scientists observed the nests from the time the eggs were laid to the time they hatched), greater sample sizes, and more meticulous methods. I think Kavusu got it wrong, perhaps partly because he did not observe the eggs being laid, and perhaps partly for some other reason. Since Kavusu was told by his forebears (in the anecdote) that turtle eggs take exactly 21 days to hatch, perhaps his observations were coloured by his expectations. This is a common human trait which has been demonstrated in many situations (Bulmer 1982; Chalmers 1982: 22-28; Diamond 1989, 1991; Humphrey 1995: 110), and from which scientists are not immune either.

While Kavusu's asserted methodology and the conclusions reached might be depicted as representative of his society's understandings, and as such have their own validity, the empirical strength and accuracy in this case lies with science. If one fails to recognize this discrepancy, the validity and relevance of published scientific work on turtles is dismissed, and the instrumental usefulness of other aspects of Marovo indigenous knowledge about turtles is also thrown into doubt.

Hawksbill turtles are the basis of a lucrative and overexploited artisanal (and subsistence) fishery all over the Solomon Islands, which has seen dramatic declines in their populations since the 1970s (Skewes 1990: 29; Leary 1993: 35, 47). Given that the "monist" (i.e. anti-dualist) approach is purported to be the only solid premise for a 'contextualist' stance, i.e. one that considers traditional, pre-industrial societies as having something to tell us about how to live sustainably (Hornborg 1996; cf. Smith and Wishnie 2000), then the Marovo peoples' relationship with hawksbill turtles is perhaps not the best subject to use for such an approach. Moreover, unless a contextualist analysis considers (for the Solomon Islands at least) the existence of a Nation State, processes of acculturation, Christian missionization, Western education curricula, and dramatically altered contexts for transmission of knowledge, then it is unlikely to be accurate or relevant.

I think it is reasonable to assume a complex of ontological paradigms in Marovo and Nggela cosmologies, ranging from monist to dualist. This would be supported by Dwyer's (1996) model, since there is a mix of production bases in both societies, including dispersed (fishing) and intensive (swidden agriculture and pig husbandry). In parts of the Western Province of Solomons Islands people distinguish between "wild" and domestic pigs. The fact that the Nggela people use a system of prohibitions in an attempt to manage their trochus resource implies some conception of human agency over nature. Similarly there is likely to be a range of epistemological paradigms for indigenous environmental knowledge.

A more clear-cut example of ontological divergence between Western and non-western accounts of animal behaviour and ecology is contained in the anecdotes I recorded at Nggela concerning the occasional encounters between the land snake, *Dendrelaphus caligastra* (*Torokoe*), and the Crocodile Long-tom, *Tylosurus* sp. (*Malole*). These anecdotes (and I recorded at least 15 of them) all describe the snake (a terrestrial species) apparently trying to mate with the fish (in the sea), a behavior which has no scientific explanation. Identical stories were also recently recounted to Richard Hamilton (University of Otago, pers. comm.) by fishermen from the Reef Islands in the Eastern Solomons province of Temotu. Because I cannot find any scientific *or* sociocultural explanation which might shed light on this story, I regard this as an example of indigenous knowledge which is clearly epistemologically incommensurable with science. Johannes (1981: 131-147) has an entire chapter of incredible and improbable stories about the behavior of marine fauna recounted to him by Palauan fishers. Some of these were interpretable using scientific rationalist reasoning, and others were not.

A different epistemological perspective may be better suited to these latter stories, as well as the above Nggela snake-and-fish anecdote.

Two practical and instructive approaches for interpreting indigenous knowledge in the context of fisheries management are given by Felt (1994), and Johannes et al. (2000). Felt presents data on the indigenous knowledge of different groups of Newfoundland fishers concerning the natural history of salmon. Felt discovered that some groups of fishers (mainly on the north coast) were able to observe many more aspects of salmon biology, and population ecology, by virtue of their geographical proximity to rivers in which certain salmon stocks spawn. Other fishers (mainly south coast) were able to observe the salmon only at sea, and for a relatively short period of time, as the fish migrated past their villages, once a year. This difference in observational opportunity has lead to the latter group possessing what Felt calls a "partial, instrumental knowledge", which has also resulted in these fishers being less able to detect significant declines in salmon stock size (due to overfishing) than the former group.

Johannes et al. (2000) present several important examples illustrating the converse of the above. These authors critique work done by fisheries scientists (Blaber et al. 1990a,b) who investigated the impact of a lagoon-based bait fishery in the Western Solomon Islands (which is linked to the national industrial tuna fishery) on the food supply for larger species in the lagoon. In their assessment of the stocks that would potentially be affected by this fishery, the scientists measured fish abundances in the lagoon only in the daytime, and concluded that none of the species that they observed were ones that fed primarily on baitfish – hence the bait fishery was in their assessment not likely to seriously impact local subsistence fisheries. However Johannes et al. (2000) point out that if the scientists had consulted local fishers as part of their investigations they would have learned of a very large *nocturnal* in-migration to the lagoon of two species of barracuda, one of which is known to be a major predator of baitfish, and thus was likely to have been significantly impacted by the bait fishery. Johannes et al. (2000) go on to detail a number of other examples of situations where fisheries scientists and policy makers have ignored or failed to solicit indigenous knowledge about the natural history of the species in question, and have thereby made erroneous management decisions.

The important issue here is not simply that the ability to detect gaps in the empirical database is critical to a sound and fair assessment of both indigenous and scientific knowledge, but also that in many cases this is a relatively straightforward process, requiring little or no complex social analysis. However although the nature of modern scientific enquiry (with its process of publication and peer-review), and the vastly greater access to information that most scientists enjoy, means that scientists should ideally be able to change their approach relatively promptly as a result of such lessons, the situation is not necessarily so easy for indigenous fishers. Most of the latter do not have access to libraries, the Internet, or even a tame and articulate scientist. Therefore in the next part of this discussion I focus on what I regard as some of the more pressing issues in terms of common empirical gaps in local or indigenous fishing knowledge in the Pacific, and discuss some potential avenues for effective communication and education about these issues.

My research at Nggela showed that people there are obviously tuned into subtle increases in abundance of trochus at particular points in the lunar cycle; at least, my limited scientific analysis lends support to their observation statements (Foale and Day 1997, Foale 1998a,b). However, while they identified these times as good occasions to harvest trochus, they remained oblivious to the fact that the trochus were spawning at these times. More importantly, they were not making any connection between spawning stock density and recruitment strength, and my assessment of the trochus stocks at Nggela showed that recruitment failure was in fact occurring on many reefs (Foale and Day 1997). A striking example of the same problem can be seen in a mixed artisanal fishery in Chile (Bustamante and Castilla 1990; Castilla et al. 1985; Dr Rob Day, The University of Melbourne, pers. comm.). Here, the macro-alga, *Durvillea antarctica* and a large gastropod mollusk (*Concholepas concholepas*) are harvested by the same fishers. The method of harvesting the alga, which is able to reproduce asexually by budding off at the base, always ensures that one stipe (stalk) is left on a holdfast for subsequent production of new stipes. The mollusks on the other hand, which, like

trochus, have a planktonic dispersive larval stage (that the fishers are apparently ignorant of), are harvested much more intensively, and recruitment failure in this species is common. Recognizing the link between recruitment strength and spawning stock density requires a much larger set of observational data, encompassing reproductive and larval biology, dispersal ecology and settlement behaviour - observational data which is usually restricted to students of marine ecology and fisheries biology, and requires specialized tools such as microscopes and aquaria which are not normally available to most indigenous fishers.

The Nggela knowledge of trochus biology and population ecology is analogous to the "instrumental" knowledge of the scientists, Chilean and southern Newfoundland fishers in the above examples, who were unable to observe important aspects of the life cycle (such as nocturnal patterns of movement into lagoons, long spawning migrations or planktonic dispersal of larvae) of certain species. In most cases it is only where there is obviously a gap in the observational database, that other means of explaining biological and ecological patterns (not excluding supernatural, for non-scientists at least) are likely to be used (Humphrey, 1995: 55-57). The apparent fatalism of the Nggela people about trochus harvest declines is in my view at least in part due to their lack of knowledge about larval dispersal and recruitment. Indeed, the fishermen had what could be described as a classically instrumentalist theory about trochus population dynamics, which resulted in a commonly held belief in the existence of a large "el dorado" or super-stock of trochus living in deeper water which, as divers without access to SCUBA equipment or Hookah compressors, they were unable to reach. They assumed that the trochus they harvested were replaced by individuals from this deeper stock that wandered up to shallower parts of the reef. Although trochus have been recorded by biologists to occur as deep as 25m, this is quite unusual and relatively few are normally found below 7m depth (which is perhaps slightly shallower than the depth range of the average breath-hold diver) (Nash 1993). This accords with other scientific information about the diet of trochus, which is dominated by turf algae (Nash 1993), suggesting that trochus are not likely to be distributed far below the depths at which turf algae are abundant.

The above examples illustrate the way in which theoretical change can take place within a purely empirical/instrumentalist framework. The missing information concerns aspects of the organisms' biology (feeding and reproduction) that are entirely comprehensible to scientifically untrained observers, and should therefore be capable of effecting a shift in the way fishers think about processes of population replacement, and human agency in this context. By way of a contrasting example, such a shift in thinking is considerably less likely to take place with regard to modern environmentalist agendas concerning biodiversity conservation and species extinction. Elsewhere (Foale 2001) I have argued that the Western-scientific appreciation of the *inherent* value of species stems from an understanding of the theory of evolution and the concept of geological time. We scientists lament the accelerating rate of species extinctions because we know that it took an incredibly long time for them to evolve. These ideas conflict starkly not only with traditional Melanesian cosmologies of nature, including their creation myths, but also (and more importantly) with most forms of Christianity embraced by Papua New Guineans and Pacific Islanders (Ernst 1994), which espouse a literal interpretation of the Book of Genesis, and man's dominion over nature (cf. Hviding and Bayliss-Smith 2000: 292). And without a radical transformation in current education systems (an unlikely prospect in the short term, particularly in Western Melanesia), such ideas will no doubt continue to be rejected by them for some time to come.

While there are of course other western theoretical constructs underpinning the importance of biodiversity conservation (such as the interdependency of species within ecosystems – an idea which *does* fit relatively well with traditional Melanesian worldviews), the idea that species extinction represents a serious problem is in my view a particularly difficult one to "sell" to non-scientifically educated people anywhere. The implications this has for biodiversity conservation are therefore significant and cannot be ignored. In the meantime, I believe that in coastal Melanesia and the Pacific Islands (and perhaps beyond) a certain amount of biodiversity conservation can still be achieved as a *spin-off* of improved fishery resource management, in the short to medium term. This is because well managed resources can yield socio-economic benefits that can provide a hedge against the likelihood that people will choose other more destructive development options (such as

those offered by "predatory capitalists" such as transnational logging companies or the live reef fish trade) which may have drastic impacts on biodiversity.

If basic life-history information can be a) communicated effectively to fishers, and b) demonstrated in a concrete and practical way, then fishers are more likely to embrace it and use it, in synergy with indigenous knowledge, to improve their own management strategies. Examples of some of the more important categories of scientific information include basic reproductive biology, broadcast spawning behavior, planktonic larval phases, larval duration times, larval biology, settlement behavior, recruitment bottlenecks, trophic ecology at the various life stages, mortality rates at various life-stages, growth rates, and size at maturity (Foale 1998a). This information can be more effectively communicated with the aid of graphical tools such as photographs, posters, video and video animation, accompanied by textual and/or voice-over commentary which can provide the data that is less easily presented graphically such as, for example, larval survival times for various species. Realized increases in yields as a result of implementing permanent closures could also be demonstrated with written material, short documentaries, or if funding permitted, exposure tours of MPAs.

Whether any consequently revised (or new) management strategies could then be implemented also depends of course on a number of local and national institutional and governance-related factors. These include strength of local authority structures (which determines in part the capacity for enforcement of any regulations), and the presence/absence of any disputes over rights of access to and control over the resources. Success also depends to some extent on the biology of the species in question and the scale at which management initiatives are being attempted. For example, the larval survival time of trochus is on average around 3 days, which means that stock-recruitment relationships are quite strong on a relatively small scale, and are thus amenable to localized management efforts. This would tend to fit relatively well with most Melanesian land and sea tenure regimes (Foale and Macintyre 2000; cf. Nash et al. 1995). Trochus dispersal contrasts dramatically with that of lobsters (*Panulirus* spp), whose (heterotrophic) larvae typically spend a great deal longer (several months to more than a year) in the plankton, and can therefore disperse over vastly greater distances. More importantly, depending on prevailing current regimes, the dispersal can be predominantly unidirectional. Hence lobster larvae spawned in a remote section of the Northern Great Barrier Reef supply recruits to reefs in Southern and Eastern Papua New Guinea (Dennis 2001), which means that imposing harvest restrictions in these parts of Papua New Guinea may have much less utility for improving or maintaining yields there than protection of the spawning aggregations on the Northern Great Barrier Reef would. Management in this case would require effective governance and enforcement at national and international scales. Complex larval behavior among some species of fish also means that predicting dispersal patterns can be difficult (Swearer et al. 1999, Thorold et al. 2002; Warner et al. 2000), but on average such behavior results in more constrained recruitment patterns, which would reward local management efforts.

The future of indigenous fishing knowledge in Melanesia

Language, material culture and indigenous knowledge have all been subject to considerable erosion throughout the Pacific in the post-colonial era. Certain Nggela fish names were obviously disappearing at the time I conducted my fieldwork (e.g. *Maroho*: Rainbow Runner, *Elegatis bipinnulatis* was referred to by most people as "Rainbow"). Many of the traditional fishing techniques described to me by older Nggela fishers are no longer in use, and people with the skills to make the tools involved are probably quite scarce, if any remain at all. While some of the indigenous knowledge required for the old techniques has been adapted to new technologies, much has been made redundant by the increased efficiency of the new technologies. Given the potential (and realised) value of indigenous knowledge for improving fishery management, particularly if combined (where necessary) with scientific knowledge, its erosion through acculturation remains a cause for concern (Catala 1957; Johannes 1978, 1981; Johannes et al. 2000; Nordhoff 1930). Sadly there is now a great deal of self-disparagement of indigenous knowledge throughout rural Melanesia, which is related in part to the disparagement of traditional culture perpetrated by the missionaries, as well as to a kind of cultural cringe stemming from frustrations about the slow pace of development, and the

economic and technological dominance of neighboring countries. This results in either a lack of pride in local knowledge systems, or a sort of reactionary romantic primitivism among educated island elites that often takes its cue from similar attitudes among ignorant Westerners. Clearly neither of these situations is desirable.

The fact that many fishers are typically secretive about much of their knowledge is also part of the reason for its disappearance. In Melanesia, older people are disinclined to pass on their ecological knowledge to people other than their own children or those of their siblings. If these young folk are all being educated into Western curricula, they have less time to learn traditional ecological knowledge. Keesing (1991) relates the openness and egalitarianism of Kwaio society to the relative ease with which people who are disadvantaged structurally are still able to acquire knowledge, and the power it delivers, if they are sufficiently bright and ambitious. While the Kwaio system is somewhat exceptional, Crocombe (1993) stresses the need for Pacific Island societies to attempt to keep their information systems open. Crocombe reasons that outside forces (such as drug companies) in pursuit of indigenous knowledge for profit are likely to get it anyway given their enormous financial power. An example of this occurred in Marovo Lagoon in early 1995, where a foreign fishing company (Indian Pacific Seafoods), having obtained permission from the Provincial Premier, employed local fishers to harvest several tonnes of fish from a large spawning aggregation of *Plectropomus areolatus* in Charapoana Passage next to Uepi Island (this is the same spawning aggregation reported on by Johannes {1988}).

While younger people are increasingly missing out on a traditional ecological education, they may at the same time be more inclined to accept ideas of the limitation of resources, partly as a result of Western environmentalist influences, and partly through personal experiences of some of the more destructive legacies of previous fishing projects, and other extractive industries such as logging. Some of the better-educated young people I have worked with in the Solomon Islands have remarked on the relative difficulty of communicating ideas of resource limitation and vulnerability to over-exploitation, to older member of the communities they work with. Moreover for many people in developing countries the acceptance of information relating to resource limitations is also typically contingent upon a host of political and economic factors, discussion of which is beyond the scope of this paper (Foale 2001; Macintyre and Foale 2002a,b).

Conclusion and Recommendations

In summary, the indigenous knowledge of many Melanesian and Pacific fishers concerning the biology and ecology of the organisms they harvest could, for various reasons, be seen as lacking some important components for optimal management, particularly under contemporary artisanal market pressures. If supplemented with the expert knowledge of fishery biologists, however, such indigenous knowledge would undoubtedly prove more than adequate for the task of maximizing and sustaining yields of a range of marine resources.

While the postmodernist critique of rationalist approaches to the study of indigenous knowledge should be kept in mind by those working in this field, I believe it has little relevance to the contemporary study of fishing knowledge, in the Solomon Islands and elsewhere. Fishers should be encouraged to share their knowledge with fisheries biologists and resource managers, unless it is clearly likely to endanger important resources, or lead to some other form of Intellectual Property Rights abuse. Older fishers should be encouraged to pass on their knowledge, and this instruction should be incorporated into school curricula. Ideally a substantial (indeed the majority) of this time should ideally be spent as "prac" time, i.e. learning fishing techniques and knowledge. Such a program would reinforce the value of this knowledge both to children and their elders and work to resist the continuing disparagement, by many agents of development, of traditional customs and knowledge.

One of the commonest "empirical gaps" in indigenous knowledge about marine fauna concerns that part of the life cycle that is unseen by most fishers, i.e. broadcast spawning, planktonic larval

dispersal and subsequent settlement back on the reef. A host of powerful modern tools, such as video, and desktop publishing software, can be used to great effect to describe in detail these aspects of the life-cycle of economically significant species. Such tools are now well within the financial reach of many foreign-financed environmental and development NGOs and scientists working on resource management programs in Melanesia and other developing regions, and should be taken advantage of. Once the missing information is effectively communicated, it can be easily incorporated, in a purely instrumentalist sense, into indigenous knowledge frameworks, to permit a shift in local thinking about population dynamics, which would in turn potentially galvanize locally driven management initiatives. This would in many cases be much more effective than top-down measures, since a knowledge-based initiative would facilitate greater local "ownership" of the management program, and thereby greater success.

In the meantime conservative and expedient measures such as enforcement of size limits should be used wherever possible. If sufficient stock density information exists and governments possess adequate capacity for monitoring and enforcement, quotas should obviously also be utilized. While permanent or temporary closures can be problematic in Melanesia due in part to the system of customary marine tenure (Foale and Macintyre 2000), biologists should nevertheless strive to communicate to rural fishers the effectiveness of reserves in conserving brood-stocks of fished organisms and providing a safeguard against recruitment failure in surrounding areas.

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