

CULTURE CONTACT, CULTURAL ECOLOGY, AND DANI WARFARE

PAUL SHANKMAN

University of Colorado, Boulder

This article examines warfare among the Dani of the New Guinea Highlands in the context of two contrasting approaches: culture contact and cultural ecology. A recent article by Blick has suggested that with Western contact and new trade patterns, indigenous tribal warfare can escalate to genocidal proportions; the Dani are a case in point. However, an alternative analysis of the Dani data suggests that large-scale warfare was a pre-contact phenomenon and that this kind of warfare had an ecological basis. Ethnographic data from the Dugum Dani, historical data from the Ilanga Dani, and comparative data from the New Guinea Highlands lend support to an ecological approach.

Since the acclaimed documentary film *Dead Birds* was released in 1963, the Dani of the New Guinea Highlands have become one of anthropology's better-known cultures. Yet Dani warfare, so dramatically portrayed in the film, has not had an impact on anthropological theories of warfare comparable to that of accounts we have from groups like the Yanomamö and the Maring. This article examines Dani warfare in the context of two theoretical approaches, the first attributing the scale of Dani warfare to recent culture contact, and the second explaining its scale in terms of pre-contact cultural ecology.¹

The culture contact perspective on Dani warfare can be found in a recent article by Blick (1988), in which he argues that new trade patterns introduced by European contact have caused indigenous warfare in tribal societies to escalate to 'genocidal' or 'exterminative' proportions. He employs four ethnographic cases to support his hypothesis – the Jivaro, Iroquois, Maori and Dani – as well as broader data on warfare in the New Guinea Highlands and the North American Great Plains. While Blick's hypothesis may find support generally, the Dani case seems problematic because there is evidence of large-scale warfare among the Dani prior to contact. A review of Dugum Dani and Ilanga Dani ethnography suggests that the scale of warfare among these Dani groups developed in response to long-term ecological pressures rather than recent European contact. Although contact has played a role in the contemporary period, what Blick refers to as 'genocidal' warfare was probably part of pre-contact Dani culture.

Culture contact

Blick raises important questions about the nature of warfare in pre- and post-contact tribal societies, and his ideas are paralleled in Ferguson's general review (1990a)

of the major effects of culture contact. These effects include the introduction of new epidemic diseases, the development of new trade patterns and the actual subjugation of native peoples and their incorporation under state control (1990a: 52). Since the first two effects can precede the third over great distances and long periods of time, separating indigenous from exogenous factors can be extremely difficult.

In another article, Ferguson (1990b) convincingly demonstrates that contact effects have played a significant role in patterns of Amazonian warfare over the last five centuries. Yet Ferguson notes that:

most statements of theory screen out the impact. Contact effects may be recognized as influencing particular cases of war but are considered irrelevant for theory-building. Theory typically involves connecting war to some aspect or aspects of indigenous culture....Usually it is claimed that these indigenous factors explain the occurrence of war with the underlying assumption that recorded warfare is understandable as an expression of local culture (1990b: 237-8).

Ferguson contends that while anthropologists have sought to study warfare in pristine situations, 'literate observers usually arrive rather late in the encounter. The specter haunting anthropology is that culture patterns taken to be pristine may actually have been transformed by Western contact' (1990a: 238).

Ferguson's point is well taken, especially for areas where contact has occurred over long periods and where the various effects of contact may have interacted in complex ways. But if Amazonian warfare has continued for five centuries after first contact, the influence of the West on other areas such as New Guinea is more recent. In the New Guinea Highlands, most initial colonial contacts were made in the 1930s, and many areas did not experience permanent, effective contact until the 1950s. Although the New Guinea Highlands experienced a variety of consequences of Western contact prior to colonial intervention, this area may provide better evidence than Amazonia for determining the relative importance of indigenous and exogenous influences on warfare.

Blick focuses on one specific contact effect that he believes to have influenced warfare in a number of tribal societies. Emphasizing new trade patterns, Blick argues that tribal warfare with its revenge complex, when 'combined with an economic motive, primarily in the form of European-introduced trade goods such as guns, machetes, horses, etc., expands into a system of genocidal warfare previously unknown in tribal societies' (1988: 654). He finds that 'the revenge complex is the necessary condition and an economic motive the sufficient condition which together stimulate the adoption of tactics of genocidal war in post-contact tribal societies' (1988: 654). For the Dani, the economic motive was trade in machetes, a more effective combat weapon. I now turn to the Dani data to see to what extent they support Blick's theory.

Warfare among the Dugum Dani

The first outside observations of the Grand Valley were made in 1938 (Heider 1970: 303; see also Peters 1975: 2), with regular missionary contact beginning in 1954. Among the Dugum Dani of the Grand Valley that Karl Heider studied, effective pacification efforts by the Dutch began in 1961 just as Heider was completing his first period of fieldwork. While the Grand Valley was not 'pristine', warfare was an ongoing activity until that time.

Heider distinguishes two types of warfare among the Dugum Dani – ritual and secular – which differ in motivation, tactics, casualties and consequences. Ritual warfare, depicted in *Dead Birds*, involves hundreds of men on each side of a designated public battleground firing arrows in a highly individualistic fashion. The rationale for ritual warfare is revenge in order to placate the ghosts of the dead. These frequent wars are generally inconclusive and casualties are low. Raids involving clandestine attack by a dozen or so warriors are also included under the rubric of ritual war (Heider 1979: 99), but are often more deadly than the great ritual battles.

Secular warfare, on the other hand, does not invoke ideological rationales concerning spirits of the dead. It is brief and infrequent, employing a co-ordinated, large-scale clandestine attack at dawn; large numbers of men, women and children are killed; property is destroyed or taken and territorial boundaries are reworked.² But what is the relationship between these types of war? Are they distinct and related by different historical circumstances as Blick suggests, or are they inter-related phases in a single system of war?

Blick adopts the terms ritual and secular warfare for his analysis of the Dani, but in a manner that is different from Heider's usage. He states that Heider 'makes the distinction between the secular and ritual phases in that the first consists of *raids*, which tend to be bloodier, and the second of *battles*, which are more likely to be constrained' (1988: 662). In fact, Heider states that 'there are two quite different forms of fighting in the ritual phase, battles and raids' (1979: 99).

Blick then reasons that small raids escalated to genocidal warfare in the post-contact period, arguing that 'in contrast to the traditional situation in which a "few men" went on raids, this [post-contact] attack consisted of hundreds of men and results in large numbers of deaths' (1988: 663). While Blick notes that what he terms secular warfare ('raids') occurred before contact, he finds that 'it is the secular phase of warfare that appears to have undergone the most change since contact with the Europeans. Pristine secular warfare increases in scale' (1988: 663).

According to Blick, the reason for the alleged increase in the scale of warfare to genocidal proportions was the introduction of machetes and new European trade relations:

This recently introduced weapon, the machete, was part of Dani economic motivation in maintaining trading contacts with Europeans. The machete was then adopted for traditional secular warfare operations. With the increasing tendency of secular warfare to become genocidal in scale, the machete was viewed as an efficient killing tool and thereby earned its place in the Dani arsenal for future use in exterminative ventures much as the axe and machete were incorporated into Yanomamö warfare (Chagnon 1988: 986). It will be enlightening to discover in the future the exact role of the machete in Dani trade and warfare and whether or not the tendency towards genocidal warfare, at least within the secular realm, continues (1988: 664).

As evidence of a 'tendency towards genocidal warfare', Blick cites the only case of secular war in the post-contact period. In 1966, there was a massacre in which nearly 125 people – men, women and children – were murdered in about an hour by co-ordinated attack (roughly twenty people were killed in the counter-attacks). It was, in Heider's words, a 'quite extraordinary event' (1979: 106). 'The survivors were left with a devastation the likes of which a Dani might see only once in a lifetime' (1979: 105).

While 125 deaths is a large number of people by the standards of New Guinea Highlands warfare, does it represent a 'genocidal' scale? Blick states that 'it is not reported what proportion of the victimized group this figure consisted of' (1988: 664). But Heider does report that these 125 people belonged to a political confederation of about 2,000; hence the proportion killed in this confederation was roughly 6.25 per cent. of the total population (Heider 1979: 106; see also 1970: 178). Heider uses the term 'massacre' rather than genocide to describe this killing. Although Blick correctly notes that this massacre occurred during the post-contact period and that machetes introduced by Europeans were used along with spears, it is clear from Heider's work, upon which Blick relies, that killing on this scale may have been a pre-contact phenomenon as well.

Heider discovered secular warfare on his third visit to the Dani. He states:

For the first few years I was quite misled about Dani warfare because I had seen only one aspect of it, the ritual phase, which had been underway in 1961. I never had much success in getting the Dani to talk about the past. As a result, I understood only the fairly static, 10-year-long pace of the ritual phase....[The] secular phase, which punctuates the ritual phase every 10 years or so, is very different from the ritual phase, and does have considerable material effect on the Dani - populations shift, goods are destroyed, and so forth. Had I not returned for a third visit to the Dani in 1968, I would probably still now be propagating a badly incomplete version of Dani conflict (Heider 1979: 20-1).

Heider refers to secular warfare as a phase of Dani conflict: 'The cycle of Dani warfare is a years-long series of battles and raids between alliances of confederations, broken by a brief outburst of fighting which splits alliances and rearranges constituent confederations into new alliances, setting the stage for a new series of battles' (1979: 103). He also notes that the 1966 massacre was itself the culmination of long-standing grievances and signalled the breakup of an alliance between two confederations.

Heider recognizes that the 1966 massacre took place after pacification efforts that began in 1961 had successfully suppressed ritual warfare. But he plays down the importance of machetes as new killing weapons (Heider 1979: 45), noting that spears are 'a deadly jabbing weapon at close quarters' (Heider 1979: 56). According to Heider, the element of surprise attack is the key to success in secular warfare, and he traces the phases of ritual and secular war in the Dugum area back to the 1940s, prior to pacification, when another secular war took place in which a rout occurred and in which fields and homesites were abandoned (Heider 1979: 89).

The colonial government did play a role in the 1966 massacre, having established a police post in the area in 1961.³ Certain Dani factions had allied themselves with the police (Heider 1979: 6), and the government responded immediately to the massacre. But Heider contends that this should not obscure the pre-existing Dani pattern of alternating phases of war, the secular phase prefiguring ritual warfare. As he states:

It is impossible to make precise comparisons between the attack of June 4, 1966 and other such events. There is no reason to suppose that this attack differed from others in the history of the Grand Valley except in the details of police involvement and the use of steel bush knives instead of spears and bows and arrows. Both in form and in intensity it was probably typical of the violent phase of war which, together with the ritual phase, form the normal pattern of Dani warfare. But it is clear that this explosive phase of war differs dramatically from the ritual phase. Even though it lasts only days, compared to the years of ritual war, in many respects its effects are more far-reaching (1970: 121).

Heider also notes four other instances of secular warfare in this area, dating to well before effective contact took place (1970: 102, 121-2). Casualties were probably high in most of these wars (Heider 1979: 110).

For Heider, the 1966 massacre represented a continuation of pre-contact secular warfare in roughly the same form and intensity. Contact effects, including a government presence and the use of machetes, influenced the course and duration of this war, but they did not lead to an escalation from small raids to 'genocidal' war. While in some contact situations, warfare may increase in scale and intensity, the Dugum Dani in Heider's view do not represent such a case. It is difficult, however, to discern a trend towards escalation among the post-contact Dugum Dani since there was only one post-contact secular war. After 1966, pacification effectively suppressed all further warfare in the Dugum Dani area.

Post-contact warfare in the New Guinea Highlands

Because pacification efforts in the New Guinea Highlands followed shortly after other contact effects, the kind of escalation of warfare that occurred among the Jivaro, Iroquois and Maori – Blick's other cases – may not have had time to develop in full. Prior to pacification, there were areas in the Highlands where warfare did intensify, but in these cases the relationship between the trade in weapons and the escalation of war is somewhat different from what Blick suggests. For example, among the Miyanmin on the highland fringe, inter-group conflict did increase during the early contact period (Morren 1986: 294). Yet the Miyanmin were already involved in 'unilateral raiding and genocide' (Morren 1987: 264). Through these wars, the Miyanmin gained access to steel tools, but Morren reports that this was a by-product of warfare rather than a cause of it (1986: 294).

The Siane also intensified warfare as a result of contact, especially as a consequence of the indirect trade in steel axes. Between 1938 and 1945, three large wars occurred in which villages were burned and clans exiled, while only four smaller wars had occurred in the previous twenty-five years (Salisbury 1962: 118). Yet axes were important not so much as weapons of war but rather as tools that dramatically reduced the time spent in subsistence activities. This, Salisbury argues, allowed more time for other activities including war (1962: 118).

Among the Mae Enga, steel axes and machetes also became important trade items in the early contact period, although without apparent escalation in the scale of warfare. Machetes were favoured primarily as domestic and horticultural implements and were occasionally used in brawls. For serious warfare, the Mae Enga preferred light steel axes or 'tomahawks' which they regarded as 'more durable, better balanced, and hence more reliably lethal' (Meggitt 1977: 195). Yet there is no evidence of an escalation of war to genocidal proportions among the Mae Enga between 1900 and 1950.

Elsewhere in the Highlands, the early success of pacification in the 1930s and 1940s gave way to the return of inter-group hostilities in the 1970s and 1980s (Strathern 1984: 18). Yet, however serious this problem has been in some areas, there is little suggestion in the literature that warfare in the post-contact period has become genocidal.⁴ Typically, post-contact warfare has been brief in duration, broken up by mobile police or military units. While government forces, development programmes, increasing populations and other factors have dramatically

altered the political and economic dimensions of war (Strathern 1984: 24), some fieldworkers nevertheless find a certain continuity in warfare patterns.

For the Highlands group on which the some of the best documentation of pre- and post-contact warfare exists, Meggitt found that the central Enga after contact 'are still conducting warfare on much the same scale as they did in the past' (1977: 181). He notes that:

The main difference between past and present warfare concerns the duration and outcome of engagements, and this is directly attributable to the intervention of Administration forces. Traditionally, war between clans had its own 'natural' course of development, leading either to a stalemate, or, more commonly, to a partial or complete victory for the aggressors. The sequence of events might take weeks or months to reach its conclusion. Nowadays, depending on the numbers of combatants and of officers and police, outbreaks of fighting are usually contained within one to four days, as the authorities break up the contingents of warriors into smaller groups and arrest as many as they can (Meggitt 1977:168-9).

Among the Enga, continuity with pre-contact patterns of war includes the use of traditional bows and arrows as the major weapons. While contemporary Enga could use fletched rather than unfeathered arrows, metal instead of wooden arrowheads, and shotguns rather than bows and arrows, in fact they do not. As Gordon and Meggitt note:

To use shotguns and steel-tipped, fletched arrows, which would be available to many Enga men, would be to transform, visibly and publicly, the rules of warfare, creating highly deadly contests in which everyone would be at far greater risk (1984: 155).

The increased casualties would also undoubtedly provoke a strong government response. In this case as in others, there is little evidence for escalation of pre-contact warfare to genocidal proportions as a direct result of the weapons trade.

On the other hand, there is evidence of large-scale, pre-contact secular warfare in the Highlands. In the 1920s in the Hagen area, the greatest war in living memory 'was fought with much bloodshed; an entire group was routed and their land permanently lost' (Connolly & Anderson 1987: 157). In the 1940s, the Kapauku fought a war in which there were over 250 deaths (Pospisil 1958: 89). While most groups had far fewer casualties – among the Mae Enga, the largest pre-contact war led to 24 fatalities (Meggitt 1977: 109) – casualties on the Dani scale were not unknown.

Cultural ecology and warfare in pre-contact stateless societies

There is considerable debate about the explanation of pre-contact warfare in Highlands societies. Ecological explanations of warfare have been widely employed (Rappaport 1984; Vayda 1976; Meggitt 1977; Morren 1987), but there have also been a number of critiques of the ecological perspective (Koch 1974; Hallpike 1973; Sillitoe 1977, 1978; Feil 1987, and recently Vayda 1989; see Ferguson 1984 for a review). The Dani case has not been prominent in this debate, although as early as 1961 Carneiro suggested the importance of the Grand Valley for ecological explanations of war. Heider himself, while noting the ecological or material causes and effects of Dani warfare, favours holistic description and is reluctant to place causal emphasis on ecological factors.

Yet the Dani occupy an important position in the study of Highlands warfare, and not simply because of *Dead Birds*. The Dani represent the 'apogee' of agricultural intensification and political integration in all of the Highlands (Golson &

Gardner 1990: 409). If ecological explanations of warfare are applicable anywhere, they should be applicable here. For this reason, the Dani are worthy of closer attention.

The ecological perspective used here has its basis in cultural materialism and specifically in the cultural materialist approach to war adopted by Ferguson (1984; 1990b), Carneiro (1970; 1987; 1990) and Ross (1984). Warfare in stateless societies is an activity and a process embedded in larger ecological, social and cultural processes. The fundamental question is how these larger processes increase or decrease the likelihood of certain kinds of conflict, including war. Under what conditions does warfare become more likely than alternatives such as mediation, dispersal, or other forms of dealing with inter-group hostility? The investigation of infrastructural causes of war such as population pressure is vital to this perspective, but structural and superstructural causes have also to be taken into account. The perspective is primarily concerned with persistence and change in patterns of warfare, rather than origins per se.

The scale of conflict in stateless societies has been linked by advocates of the ecological approach to the *interaction* of such factors as technological level, type of ecological niche, population size and density, and population pressure on subsistence resources (Carneiro 1970; Harner 1975; Harris 1989; Johnson & Earle 1987; Johnson 1989; Vayda 1976). The simpler the technology, the fewer the environmental constraints, the smaller the population, and the lower its density relative to subsistence resources, the less complex the political organization and the smaller the scale of the warfare.⁵ Conversely, the more technologically complex the stateless society, the greater its environmental constraints, the larger and more dense its population, and the greater the pressure on subsistence resources, the greater the scale of its political organization and warfare.

The rationale behind this set of correlations is as follows. As technologically simple populations increase in size and density relative to subsistence resources in a circumscribed ecological niche, in the absence of a centralized political authority, conflicts increase and become more difficult to resolve by movement and mediation. In this context, larger political units with more effective war capabilities will tend to develop. Alternatives to war are still available, but the threat of war tends to encourage similar political and military responses by stateless groups in the same area, at least until one group is defeated. Even anthropologists sceptical of the ecological perspective seem to concur that in pre-contact New Guinea Highlands societies, ecological factors were important in the development of political complexity, if not of warfare itself (Strathern 1984: 111-12; Koch 1979: 202; Koch *et al.* 1976).

Cultural ecology and pre-contact warfare among the Dugum Dani

Why did large-scale warfare with much bloodshed occur among the Dugum Dani prior to European contact? The number of casualties suggests an important organizational aspect to Dugum Dani warfare. Although Blick designates the Dani as a tribal society, the largest political unit is the territorial alliance comprising up to five thousand people and composed of smaller units – also territorial – which Heider calls confederations (1979: 44). 'The confederation is the largest stable, peaceful unit, not usually split by war or feuds' (Heider 1979: 63); each

confederation may have from a few hundred to two thousand people living in neighbourhoods of dispersed compounds.

While still a stateless society without a powerful central authority, the Dani have a semi-stable supralocal political organization involving thousands of people. In fact, they have the largest political units in the New Guinea Highlands (Brown & Podolefsky 1976: 218). By contrast, the village-based Yanomamö have settlements normally of less than two hundred people, the largest village comprising close to four hundred (Chagnon 1974: 189). These villages tend to be very unstable and have no supralocal organization apart from temporary alliances. Dani alliances and confederacies are larger, more hierarchical, more territorially-based, and more stable. The scale of political units may be linked to the cultural ecology of the Grand Valley. Since the Dugum Dani were part of the largest and most dense population practising the most intensive horticulture in the New Guinea Highlands, large political units and large-scale pre-contact warfare were to be expected.

Using Heider's data, the specific ecological constraints under which the Dani live can be described in the ethnographic present (circa 1961). At an altitude of 5200 feet, the Grand (or Balim) Valley is more of a plain than a valley, roughly 28 miles long and 9 miles wide; inside its walls live 50,000 Dani. The valley's most impressive feature is the complex system of gardens that covers its floor. Since cultivation no longer requires much clearing and burning of forest, the major effort goes into turning over old sod and into digging the deep ditches that drain the cultivated area. The intricate gardens are a monument to the sweet potato, a plant that has about seventy named varieties and that makes up about 90 per cent. of the Dani diet (Heider 1979: 34).

A garden may take up to three months to prepare. Men, working in co-operative groups, do the heaviest work while the women do the lighter work. First, trees, roots and old grass are burned if necessary and old ditches are weeded out and excavated. Then a new series of trenches is dug with support walls from four to six feet deep. The ditches are fed by a small stream used for drainage and irrigation (Heider 1979: 38). Encircling the whole garden is a large ditch to protect the future crop of sweet potatoes from hungry pigs.

Sweet potatoes are cultivated along with yams, taro, tobacco, gourds, cucumbers, sugar cane and bananas. The sweet potato is, however, the major source of food for the Dani, and the labyrinthian pattern of the gardens is a result of the special needs of this single plant. Sweet potatoes are sensitive to drought and flooding. The balance between too much and too little moisture is handled by the Dani through labour-intensive drainage systems.

Soil and decomposed vegetable matter from the bottom of the ditches are heaped up onto the sweet potato ridges to provide fertilizer. The gardens are maintained on a long fallow cycle. After a number of years, when the ridges are depleted of soil nutrients, they are allowed to lie fallow and regenerate. While the gardens are in use, women plant, weed and harvest. Harvesting from any particular garden takes place over several months, after which it is left to the pigs for scavenging. Every family maintains several gardens concurrently so that there will be year-round yields of sweet potatoes.

The best land for gardening is on the broad valley floor. Here cultivation is most intensive and population densities are over 400 per square mile (Heider 1979:

43), an extremely high density for a stateless society and the highest recorded in the New Guinea Highlands (Brown & Podolefsky 1976; Brown 1978: 109).⁶ Higher up the mountain sides, intensive cultivation becomes impractical and more extensive methods are used. Most of the arable land is either in use or in fallow; some Grand Valley Dani are reclaiming swamp and, in a few cases, are paying for the occupation of land controlled by other groups. Compared with the highly intensive horticulture practised by the Dani and the Chimbu, gardens cultivated elsewhere in the Highlands need less labour and less preparation, cause less environmental degradation, and provide greater dietary variety (Clarke 1966: 357-8; Harris & Ross 1987: 64).

When viewed from an ecological perspective, it is apparent that the Grand Valley Dani occupy a rather narrow environmental zone outside of which they cannot support themselves at current population levels. Below about 4000 feet is the malarial zone, while above about 7000 feet misting from clouds limits this kind of Highlands horticulture. A frost line at 8000 feet makes cultivation at higher altitudes impossible and, outside the Grand Valley, other peoples including other Dani-speaking groups are already cultivating some of the best available land. As Heider notes, 'the Grand Valley of the Balim is unusual in the generally rugged Highlands of New Guinea and is comparable only to the Wahgi and Chimbu valleys of East New Guinea and the Wissel Lake region of West New Guinea in size and opportunity for dense population' (1970: 204).

In addition to horticultural limitations, the Dani are constrained by a reduction in the amount of wild game, and no longer rely on hunting for their major sources of animal protein. The only remaining wild animal resources in the valley are small rodents, bats, birds, crayfish and a few small marsupials, which, although hunted, are hardly enough to feed fifty thousand Dani. As Heider states, 'hunting and gathering is now almost inconsequential in providing food' (1979: 34). The reduction of wild animal protein within the valley has led the Dani to rely on the domesticated pig, now their major source of meat. There are no feral pigs in the valley (Heider 1979: 33).

For the Dani, as for most Highlands groups, pigs are an important source not only of protein but also of prestige because, as a scarce resource, their distribution can bring a man status. Almost every man tries to maintain a pig herd, which is looked after by his wives and children. The more wives and children a man has, the more pigs he can own and hence the more prestige he may receive when his pigs are slaughtered and redistributed on various ceremonial occasions. A man with too few pigs lacks prestige and meat, but too many can put a strain on the gardens since people and pigs are to some extent dependent on the same subsistence resource - sweet potatoes. Pigs also require a large amount of work for their maintenance and protection. Therefore few men have more than two dozen pigs at any one time (Heider 1979: 31).

Large pig herds are often vulnerable to theft since the larger the herd, the more difficult it is to guard. Because wild game is scarce and because pork is so highly esteemed, there are always men who are tempted to steal a wandering pig. As a result, pigs are the major source of conflict among the Dani, and thefts across confederation or alliance boundaries contribute to tensions that can erupt in war (Heider 1979: 36).

Phases of war

Most Dani activities are in some way connected with pigs, gardens and war, and daily life revolves around these central themes. Unmarried young men assist in the digging and preparing of the gardens, with their spears, bows and arrows nearby in case warfare should erupt. Older men may also help in garden preparation, but it is the younger men – the warriors – who occupy the watchtowers so critical to the defence of life and territory. Watchtowers overlook the frontiers where raids and skirmishes often take place. The men sitting in these 30-foot towers provide early warning against attack by the enemy.

Since warfare is a constant threat, the watchtowers are occupied for most of the day almost every day; only during important ceremonies are they left unmanned. It is within the context of the expectation of war that other Dani activities take place. Gardening activities are affected, for clearly the possibility of warfare means that land which is unprotected cannot be cultivated. Trade is also affected. Trade in salt and other commodities takes place throughout the Grand Valley and beyond during times of relative peace, but when war breaks out trade routes shift as new boundaries are established.

According to the Dani themselves, neither ritual nor secular wars are fought for territory or plunder. Ritual warfare is fought for revenge, in the hope that an enemy will be slain. Battles are fought to placate the ghosts of the slain who will be satisfied only when an enemy warrior dies, or failing that, an enemy woman or child. The belief in the need to appease the ghosts helps to perpetuate raiding and ritual warfare, providing men with an important motive to participate. But while ghosts may be one of the reasons for ritual war, their invocation does not adequately account for its scale. Why is it that among the Dani, recruitment for ritual warfare appears to be relatively easy, with hundreds of men quickly turning out at the battle front, while among the Yanomamö, who pride themselves on fierceness, it is often difficult to recruit sufficient manpower for a raid? Why are so many men needed, and why do most adult men participate? What might happen if Dani men did not move quickly to the battle lines?

In the context of these questions, secular warfare has important implications. It occurs only rarely, perhaps once every ten to twenty years between two alliances or confederations. Unlike raids and ritual warfare, secular warfare is fought for political power and military advantage: large numbers of people are killed; pigs are seized and consumed; gardens are abandoned and new boundaries are fixed; whole populations are displaced; new no-man's lands are established; alliances and confederations are reworked; and a new balance of power is established. Ritual motives and ghosts are not invoked in these struggles for power and resources.

Raids, ritual warfare and secular warfare may be viewed as phases of a single system (Vayda 1976), each waged in different circumstances and for different purposes (Heider 1979: 103). That is, ritual warfare must be seen alongside secular warfare in the context of the total system. As Heider states, 'a brief outburst of violence, the secular phase, sets the political stage for the years-long duration of the routine of the ritual phase of war' (1979: 88-9). These phases might be conceptualized as recurring rather than cyclical, with ritual war being the containment phase in an escalating progression of conflict.

Conflicts among the Dani usually begin at the individual level (Heider 1979: 87) and follow the principle of complementary opposition (Sahlins 1961). As they escalate within a confederation, the big man of that confederation mediates the conflict. If, however, there is a conflict between individuals of different confederations, confederation members side with each other and in opposition to members of the other confederation. Even the big men that head alliances have difficulty in mediating conflicts between confederations, and so grievances can mount until they reach a point where one confederation seeks allies to engage in secular war against another confederation. This structural problem involving different levels of political organization is summarized by Heider as follows:

If men from different and even ostensibly allied confederations have trouble, they each will be supported by their own confederation mates, and there is no effective alliance-wide system to adjudicate matters.

Although wars are on the alliance level, pitting all of one alliance against all of another, these grievances and unanswered killings are between opposed confederations. Thus the Big Men of the confederation can keep the war going, but no overall alliance high command can coordinate a peace for all its constituent confederations, each of whom, in a sense, is fighting its own war against those confederations of the enemy alliance which face it across the no-man's-land (1979: 107).

A confederation planning a major secular attack will enlist other confederations or alliances for support against its former, nominal allies. But since victory is rarely complete and territorial boundaries are shifted rather than eliminated, conflicts between opposed confederations tend to continue. As Heider comments:

The Dani explain the secular phase of war as the result of many unresolved trouble cases between confederations. The secular phase does not actually resolve these cases, but it is a way of exacting revenge and it is such a bloody event that it overwhelms the minor grievances of the past (1979: 108).

Beyond conflicts between confederations, there are secular conflicts between entire alliances. For example, when two alliances are at peace, 'people from each push into the no-man's-land between them to open new gardens. Then disputes over land do occur' (Heider 1979: 87). Whatever the perceived causes of secular warfare, the outcome is usually such that problems remain, and war deaths themselves are added to the grievances that contribute to the waging of ritual war and possible future secular war.

If ritual warfare affords the possibility of revenge and the placation of ghosts, it also requires an alliance or confederation to show its strength in terms of manpower. The organization and mobilization of manpower can be critical in this kind of warfare, since neither side has the advantage in military technology. The only way in which a rout can take place is if one side lacks a sound defence or reliable allies, and therefore becomes vulnerable to surprise attack. In this context, ritual war is primarily a low risk, military strategy designed to prevent secular warfare. Given the open terrain of the valley and the preparedness of the adversaries, battle line formations are expectable (Sillitoe 1978: 268; Ferguson pers. comm.). The low number of fatalities in ritual war is the result of using projectile technology in tandem with this formation.

Should a group fail to make a credible showing of warriors during the ritual phase of warfare, it may seem vulnerable to its nominal allies or enemies and become the target for an all-out secular attack (Meggitt 1977: 97; Peoples 1982:

295, Johnson 1989: 69-70). A group is also vulnerable when it finds all of its boundaries are war frontiers (Heider 1970: 122). The failure to mobilize sufficient manpower in ritual warfare could lead to imbalances in deaths between combatants, thereby encouraging secular warfare with its riskier and more deadly strategies.

Losing a secular war not only means loss of life and personal suffering, it also means the destruction and abandonment of valuable garden land and homes. The vanquished must seek food, protection and garden land from relatives elsewhere. The threat of these kinds of losses may provide some of the motivation behind the vigilance in the watchtowers and the willingness of most able-bodied men to enter into manpower-testing and secular phases of war. As the largest political unit, the alliance is responsible for manpower in the secular phase of war and is the maximal unit for protection of garden land. The most influential big men in the alliance are said nominally to control land, and are responsible both for directing alliance warfare and for the great pig feast that is held once every few years. Thus land, warfare and politics are closely interconnected.

The evolution of Dani society in the Grand Valley

This synchronic analysis of Dani cultural ecology and warfare suggests a diachronic developmental sequence for the Dani. While much work remains to be done on the prehistory of New Guinea, and although there is debate about the evolution of Highland New Guinea societies (Feil 1987; Strathern 1990; Golson & Gardner 1990), some broad trends can be outlined. The current Dani adaptation seems to be fairly recent and dependent largely on the introduction of the sweet potato and the use of domesticated pigs (Bulmer 1964; Watson 1977; Heider 1979: 32). Sweet potatoes were first domesticated in South America and were probably introduced into New Guinea no more than 450 years ago. Although the antiquity of horticulture itself in the Highlands is still in question, sweet potatoes provided the Dani and other Highland New Guinea peoples with a new staple, greater in yield and easier to grow at higher altitudes than crops such as taro that were already under cultivation (White & O'Connell 1982: 183; Golson 1977: 607; 1982). As Golson notes: 'it is obvious therefore that under climatic conditions like those of the present there would have been a ceiling on productive agriculture without the sweet potato which would have been appreciably lower than with it' (1977: 606). With the adoption of the sweet potato, population growth rates may have increased and a greater proportion of the forests in the Grand Valley would have been converted to arable land. In this sense, indirect culture contact, responsible for the original introduction of the sweet potato, was a major cause of the changing cultural ecology of the New Guinea Highlands.

At the same time, the expansion of the population reduced the amount of wild game in the valley, and the Dani became more reliant on domesticated pigs.⁷ Fortunately, not only did sweet potatoes provide more food for the human population, the garden remains made excellent pig fodder as well. So as the Dani came to rely more on sweet potato cultivation, they were able to cope with an expanding pig population. Expanding pig and human populations in turn led to further intensification of horticulture (Watson 1977).

In evolutionary terms, there may have been a shift to more intensive horticulture accompanied by a shift to domesticated protein. The sweet potato allowed the

simultaneous growth of both human and pig populations which, in turn, provided the impetus for more elaborate horticultural development. As intensification proceeded, land became more scarce and new forms of political organization arose to provide protection from war, to make war and to assure access to land. It is not surprising that the valley is divided into a number of large confederations and a dozen even larger alliances, each consisting of thousands of individuals and engaging in large-scale warfare.

Population pressure

Although most of the arable land in the Grand Valley is currently under some form of cultivation, Heider has stated that there is no lack of land; no 'overpopulation' (1979: 43-4). 'The Dani in their own statements never suggest land as a motive for war' (1970: 132). And yet in secular warfare, no-man's-land is annexed, large numbers of people are killed, and major population shifts occur. It would seem that land does have a relationship to warfare, for even if land shortages do not cause warfare, the annexation and use of no-man's-land, as well as the abandonment of land and the shifting of populations and boundaries as consequences of war, disturb both politics and subsistence. Peters, a missionary-anthropologist who worked in the Grand Valley from 1959 to 1964, summarizes the situation as follows: 'The primary purpose of a war is not to extend territory. This is a possible result when the enemy is driven out of his area, leaving behind more land for the victor' (1975: 77).

One reason why Heider argues against 'overpopulation' is that the Dani have a five year post-partum taboo on sexual intercourse. This long period of sexual abstinence has implications for population growth, for if child-bearing does indeed take place at five to six year intervals, the population growth rate may be very low. Most women do not have more than two children and Heider reports that only one of 170 married women in the Dugum neighbourhood had even four children (1979: 80). Peters concurs with this finding and adds the possibility of high infant mortality rates (1975: 30). If the Dani are reproducing at low levels, and given an almost 30 per cent. mortality rate from all kinds of warfare (Heider 1970: 128), then population growth may be negligible. Unfortunately, at present, no accurate data are available on actual Dani population growth rates in the Grand Valley.

Pospisil encountered a similar situation among the Kapauku, who also appeared to have a stable population (1958: 67), but he was able to demonstrate long-term population growth on the basis of indirect evidence. Thus, even though demographic data for the Dani are incomplete, there may still be evidence of long-term population growth or, more significant for the immediate history of Dani warfare, evidence of population pressure. The distinction between population pressure and population growth is important here. Population pressure does not necessarily presuppose population growth, and should rather be viewed in relation to the availability of subsistence resources. Diminishing soil fertility, periodic floods, frosts, droughts, or other natural and social circumstances are all capable of generating the kind of pressure that can lead to population shifts, new organizational developments or intensified conflict. There are hints of these kinds of problems among the Dani. Heider comments on flooding in some parts of the Grand Valley (1979:

33), and Peters witnessed a flood that 'ravaged' an area (1975: 69). Brookfield notes that 'it is reported that a short drought in the Baliem [Grand] Valley led to widespread alarm in 1957' (1964: 24). While for Heider the system appears stable, with 'no shortages of food' (1970: 60), Peters has noted that there are periods of 'relative food shortage' (1975: 66). Among the Ilanga Dani to the west, severe droughts and frosts have caused real food shortages and famine (Larson 1987: 89-90).

In certain parts of the Grand Valley, land is scarce, and is a source of conflict (Heider 1979: 87). Boundaries are fixed and sometimes contested. According to Heider, land is the third most common source of conflict after pigs and women (1970: 100-1). In the valley, swamp is being reclaimed, but this arduous task might be unnecessary if arable land were easily available through less labour-intensive methods. Furthermore, some alliances are receiving pigs for allowing people of another alliance to live in that area for protection, which presumably includes provision of access to land (Heider 1970: 86); again, there would be little point in this arrangement if land were available for the taking. Still another index of population pressure on land is that when there is peace, people may begin to cultivate the adjacent land that had formerly lain fallow as part of the no-man's land. Like swamp, this land can be brought into productive use. As Heider notes, 'after the secular phase of war, populations shift in order to open new protective no-man's-lands and to occupy old no-man's-lands' (1979: 111). Finally, at least some Grand Valley Dani leave the valley altogether as refugees from war. If land were readily available, this migration would hardly be necessary. The question, then, may not be whether population pressure exists among the Dugum Dani, but rather how it is related to warfare.

Warfare and population pressure among the Ilanga Dani

The work of the missionary-anthropologist Gordon F. Larson (1987) on the Ilanga Dani provides the most detailed historical inquiry into population pressure and warfare that is presently available for the Highlands. The Ilanga Valley is much smaller than the Grand Valley and lies roughly one hundred kilometres west of larger Dani-speaking areas. It was first discovered by Europeans in 1951 with temporary missionary contact commencing in 1953; in 1956 permanent contact was established. Larson himself was among the missionaries who, in 1957, witnessed part of a deadly secular war in which thirty-three people were killed. His work among the Ilanga Dani was conducted from 1956 to 1984.

At the turn of the twentieth century, the Ilanga Valley had only a small number of Dani-speakers relative to the more numerous, indigenous Damal-speakers. However, immigrant Dani successfully displaced the Damal by mid-century. The Damal practised less intensive horticulture on higher slopes at lower population densities, while the immigrant Dani with their intensive sweet potato horticulture moved onto the Ilanga Valley floor. The Dani population grew very rapidly and, within a relatively brief period of time, was in a position to make war on and forge alliances with the Damal. By the 1930s, Dani in the Ilanga Valley occupied parts of all areas that would later become entirely theirs. Damal speakers who survived thereafter did so by adopting the Dani pattern of subsistence and close settlement, as well as by allying themselves with the Dani.

Larson calculated that the Ilanga Dani population increased dramatically over several decades. He estimates that in 1910, there were roughly 650 Dani in the Ilanga Valley, but by 1961, the date of the first official census, the number had increased to 4100, and the Dani were easily the dominant group in the valley which had a total population of about 5200. This more than six-fold increase was due largely to immigration from the North Balim and Grand Valleys; almost half of the adult Ilanga Dani that Larson sampled were born in these distant locales (1987: 15).

Larson questioned Ilanga Dani about their reasons for moving from the larger valleys to the Ilanga Valley. Of the fifty-two adult men he interviewed in 1961, 56 per cent. said they immigrated as the result of warfare; many were refugees. Another 12 per cent. cited land shortages and 'overpopulation' (1987: 336-8). In both demographic and motivational terms, the Ilanga Valley provided a significant population outlet for larger valleys.

Yet the Ilanga Valley was not simply a refuge from warfare and land scarcity in valleys to the east. As its population grew, the valley developed its own system of warfare that came to resemble those of larger valleys, although alliances were smaller, consisting of about two thousand individuals each rather than five thousand as in the Grand Valley, and there were only three alliances in the Ilanga Valley compared to the twelve of the Grand Valley.

Ritual wars in the Ilanga Valley occurred every few years. Larson recorded twelve such wars between 1911 and 1960, averaging 3.7 months in duration with deaths ranging from 7 to 48, and averaging 23.8 per war. As suggested for the Dugum Dani, ritual war was a deterrent to secular war. Among the Ilanga Dani, this relationship was explicitly recognized by the people themselves. Larson states that 'ritual war always commences as formalized fighting to prevent what would otherwise become unrestrained violence and rampant revenge killing' (1987: 246). During a ritual war, two of the three alliances in the valley would assemble their forces at a stipulated battlefield, while communities within the third alliance would split ranks and join the other alliances to equalize manpower. As among the Dugum Dani, the number of killings in ritual war on each side was supposed to be equal or nearly equal; when equivalence was reached, a truce could be declared and reparations made. If, however, there was an imbalance in deaths, or if there was a failure to adequately compensate for deaths following a war, escalation to secular warfare could occur.

Two secular wars were recorded by Larson in which the vanquished were completely routed from the valley (1987: 174). The first occurred during the 1940s in which about 200 people were routed and an undetermined number of people were killed. In 1955, a second war began and was waged for over a year in a series of battles and raids. Of the defeated forces, 133 people were killed, as were another 35 among the victors. A whole alliance of over two thousand people, amounting to about a quarter of the Ilanga Valley's entire population, was routed and displaced in this war.

During periods of peace in the Ilanga Valley, Dani leaders would actively encourage immigration to provide additional labour for sweet potato cultivation. Increased production allowed more pigs to be raised and slaughtered for warfare indemnity payments and peace ceremonials between Ilanga alliances and

confederacies. In the many intervals of peace between 1911 and 1961, the population of the Ilanga Dani grew at an average of 9 per cent. a year, which, in turn, led to increasing conflicts and ultimately to war. Thus the short-term interests of Ilanga Dani big men often resulted indirectly in war rather than peace. And, just as among the Dugum Dani, warfare led to the displacement of defeated populations and the abandonment of land that was eventually occupied by the victors.

During and after war in valleys to the east, when peace reigned in the Ilanga Valley, people were drawn into Ilanga Dani territory; while during and after warfare in the Ilanga Valley, populations were displaced, moving in with local allies, or to the valley's periphery, or to sparsely settled areas outside the valley. Within the Ilanga Valley itself, the relationship between war and population pressure developed over time so that increasing population was accompanied by the formation of larger political units and by greater numbers of casualties in war (1987: 22). The more immigration there was into the Ilanga Valley, the greater was the likelihood of war. But, as Larson explains, the relationship of population pressure to warfare also involved not only population growth but population density, degree of territorial confinement, and geographical proximity to allies and enemies.

With population densities in some areas of over 400 people per square mile, the Ilanga Valley rivalled the Grand Valley. But according to Larson, population density by itself or in conjunction with population growth provided only a partial index of population pressure. In a study of the many conflicts between all confederations in the valley leading up to a war in 1961-62, Larson tested the hypothesis that the degree of territorial confinement and proximity to the enemy, in conjunction with population density, would determine the extent of violence, which would in turn determine the likelihood of warfare. Beyond the immediate causes of conflict – women, loss of life, property and land – Larson found that conflicts would not escalate without high degrees of territorial confinement, close proximity to enemies and high population densities.⁸

Larson convincingly demonstrates that within the Ilanga Valley, population pressure varied and conflict did or did not escalate depending on the mix of variables constituting population pressure. He also demonstrates that while the immediate causes of war were complex and cumulative, over the long term population growth in this circumscribed valley was the major underlying cause of the increasing scale of Ilanga Dani warfare (1987: 394). Was the situation in the Grand Valley similar? In its broad outlines, it may have been. Some time ago population certainly grew so as eventually to fill the Grand Valley, and, as population increased in this relatively circumscribed area, political units grew in size as did the scale of war. But growth rates in the Grand Valley seem to have diminished whereas in the Ilanga Valley, due to its recent settlement by Dani immigrants, they have not. Nevertheless, even without substantial population growth, the Dugum Dani have continued to experience population pressure in the form of high densities, territorial confinement and close proximity to enemies with fixed boundaries and limited access to new land. These factors, coupled with environmental crises such as floods and droughts, have led to situations in which conflict was less easily mediated and concluded at levels below warfare. Neither in the Dugum Dani nor in the Ilanga Dani case was warfare explicitly waged for land. Yet population pressure in

circumscribed areas made conflicts over anything – pigs, women, land – less easy to resolve and more likely to escalate to warfare.

Population pressure, warfare, and population dispersion in the Highlands

What light do these data shed on the much debated relationship between land shortage and warfare in the Highlands? Sillitoe (1977) addressed this question in a study of twenty-six New Guinea societies, using population density as the measure of land shortage, and taking the extent to which a group displaces – and then uses – enemy land as an index of whether warfare was waged for land. He found that most of these societies did not have high densities and most did not go to war explicitly for land. Sillitoe therefore concluded that the relationship between population density and warfare for land 'is an insignificant one and demonstrates that ecological explanations account for only a small number of wars which occur in New Guinea' (1977: 73). Sillitoe did not, however, test his assertion statistically.

M. Ember (1982), using Sillitoe's own data, demonstrated statistically that quite the opposite was the case: the higher the population density in New Guinea, the greater the likelihood that wars would result in acquisition of land (1982: 647). The strong relationship between the two variables⁹ offers comparative support for ecological explanations of Highlands warfare.

The underlying issue raised by these studies is whether land acquisition is a goal of war, or whether it merely arises as an effect of war (Ferguson 1984: 30). Warfare that has the acquisition of land as its motive is analytically quite different from warfare of which land acquisition is a systematic consequence. Among New Guinea Highlands groups where population density is relatively high, Ember's results indicate that warfare involving land acquisition is more frequent. And such acquisition may also be an explicitly recognized motive for war. Among the Mae Enga, where population density in some areas is over 300 persons per square mile, Meggitt found that 'when the Mae say that they commonly fight over land they not only mean it, they are correct' (1977: 14). Warfare proved to be an effective means of gaining territory. As Meggitt states:

In short, Mae groups that feel themselves to be in need of more land to maintain their members have good reason to believe that violence is a fairly effective means of acquiring territory. Given that the initiation of warfare generally in this sense pays off for the aggressors it is not surprising that by and large the Mae count warfare as well worth the cost in human casualties (1977: 14-15).

Not only did the Mae Enga recognize that they went to war for land and calculated the results, but also the additional reasons they gave for going to war, such as pig thefts, homicides and other offenses against enemy groups, often formed parts of a deliberate overall strategy of provocation that set the stage for war over land. On the other hand, in the cultural conceptions of the Dugum Dani and Ilanga Dani, no perceived causal relationship between land and warfare existed, although there was a systematic relationship between population pressure and warfare involving land.

While it is important to understand the motivation for war, this alone cannot account for the size of political units, the scale of warfare, or its consequences. Here the ecological perspective is more useful. Increasing population pressure on groups living in relatively circumscribed areas should lead to similar outcomes and

consequences that can be inferred even where we have no direct knowledge of motivation. Synchronic statistical tests across societies, such as Ember's, are one way of examining such relationships. Single-case developmental studies such as Larson's are another. And historical and archaeological reconstructions of settlement patterns are a third way of testing ecological hypotheses (Haas 1990). For example, Lacey's historical reconstruction of Enga settlement patterns indicates that the type of land was an important consideration, and that early settlements were sited on fertile soil. Lacey found 'a history of competition for better ecological zones and a progressive push into new territories in higher, less fertile, regions of these valleys....Quite often the most vigorously disputed grounds are situated close to the most fertile garden sites' (1979: 291). Lacey concludes that these movements 'could have resulted only from an increase in population and a rising demand for cultivable land' (1979: 292).

Over the long term, population dispersion and resettlement were among the most important consequences of Highlands warfare. These could result from total routing, but most wars did not lead to complete routs where an entire enemy population was driven off its land, even where warfare was explicitly waged for land. Moreover, the actual amount of land acquired by victors in complete routs was not large. Among the Mae Enga, of the forty-one wars fought for land between 1900 and 1950, only six resulted in complete routs (Meggitt 1977: 14); each complete victory allowed the acquisition of one to two square miles of the defeated clan's territory (Meggitt 1977: 2). Among the Ilanga Dani, who did not fight for land, but who acquired it nonetheless, two of fourteen wars fought between 1910 and 1957 resulted in complete routs. Yet in many cases, partial routing and the threat of war may have been sufficient to displace smaller, weaker groups to peripheral areas. And movement seems to have been quite common in response to war (Feil 1987: 85-8). Morren notes that warfare in the great Highlands valleys had an impact over large areas (1984: 172), while Feil argues that the dispersive effects of war were related to land scarcity and other variables (1987: 85-8).

Despite the relative circumscription of major population centres in the Highlands, land was available elsewhere, and big men did not have the kind of control over local groups, land, trade, or food storage that would prevent population movement (Johnson & Earle 1987: 186). The ability of defeated groups to disperse, to shift residence and to alter allegiances during and after warfare, effectively prevented wars of conquest and hence further political development in the Highlands. Although the Dani and some other Highlands groups resemble simple chiefdoms in certain ways, crucial differences between these societies and true chiefdoms have been noted by Johnson and Earle (1987) and by Carneiro (1987; 1990). Groups such as the Dani did have thousands of people in the maximal political unit on a permanent war footing; their fighting forces consisted of almost all adult males who, in some wars, inflicted large numbers of deaths. Yet victors did not incorporate and subjugate losers, nor did victors receive mandatory tribute. Nor were prisoners taken, with the exception in some cases of women and children.

Victorious Highlands groups sometimes annexed land but, if there was expansion, the acquired land areas tended to be small. Moreover, leaders did not have the power to force all men to fight or to inflict severe punishment on those who did not, just as they were unable to prevent conflicts between confederations from

escalating. While political centralization and coercive power did not develop in the Highlands, ecological conditions did contribute to political evolution beyond the local level and to the formation of larger supra-local units – what Carneiro terms 'recurring alliances' (1987: 761). These same conditions, however, also allowed for dispersion and therefore did not lead to the kind of political incorporation and organization found in true chiefdoms.

Conclusions

In this article I have attempted to place Dani warfare in a broader theoretical context. I began with an examination of Dani warfare in the context of culture contact. Blick has suggested that, as a result of the adoption of machetes, Dani warfare became genocidal in the post-contact period. Yet the warfare that Blick terms 'genocidal' was probably part of an indigenous system of warfare with interrelated phases that included raids, ritual battles and secular warfare. The particular killing in 1966 to which Blick refers did occur during the post-contact period, but Heider has noted pre-contact examples that led to large-scale death and population dislocation. Heider does not view the 1966 killing as an escalation of earlier patterns; rather 'in form and intensity it was probably typical of the violent phase of war' (1970: 121).

The Dugum Dani case remains problematic because there are insufficient historical data from the Grand Valley to determine the precise nature of secular warfare in the pre-contact period. Heider himself has noted the difficulty of precise comparisons and has called for a study that will elucidate both pre- and post-contact warfare patterns (1979: 89). Nevertheless, the data on pre-contact warfare that are available support an ecological explanation for warfare among the Dugum Dani. The diachronic data on Ilanga Dani warfare and its relationship to population pressure are even more compelling. Both the Dugum Dani and the Ilanga Dani material support the broader proposition that increasing population pressure on subsistence resources, in stateless societies inhabiting relatively closed ecological niches, can lead to greater political complexity and larger-scale warfare. This proposition does not preclude the influence of additional variables. Nor does it preclude other perspectives on warfare in stateless societies; it may indeed be compatible with them (see Netting 1974; Kelly 1985; Vayda 1989).

While a plausible case can be made for the indigenous nature of Dani warfare and its ecological basis, the ecological perspective on warfare in the New Guinea Highlands has not fared well in some of the recent literature. In his comprehensive work, *The evolution of Highland Papua New Guinea societies*, Feil states that although ecological explanations of warfare were dominant in the 1970s, they have now been effectively criticized (1987: 66). He concludes that, in the Highlands, 'battles were waged for a variety of reasons and within a wide range of environments and ecological conditions, and there is no very good correlation or causality between population density, scarcity of land, intensity and scale of conflict, casualties or the dispersal of groups and usurpation of land' (1987: 66). Yet Feil seems to accept earlier criticisms of ecological explanations without providing an independent review of the evidence that would support his conclusion.

New data are now available from recent, ecologically-oriented ethnographic studies of warfare in the Highlands and highland fringe (Larson 1987; Morren

1984; 1987). New statistical material (M. Ember 1982), together with promising theoretical developments, should stimulate further work in this area. It is true that the data are often imperfect and the issues complex, but the problem of explaining Highlands warfare is still open to empirical resolution. Analysis of pre-colonial warfare among the Dugum Dani, the Ilanga Dani, and other New Guinea Highlands societies suggests that a cultural ecological approach may yet provide valuable insights into warfare in stateless societies.

NOTES

I am grateful to Karl Heider for his very helpful comments on an earlier draft of this article. I would also like to thank Tracy Ehlers, Charles Piot, Terry Hays, Paula Brown, Aaron Podolefsky, Brian Ferguson, Robert Carneiro, George Westermark, Dennis McGilvray and the anonymous reviewers of *Man* for their comments.

¹ Since I have no first-hand knowledge of the Dani, I am relying primarily on the published work of Heider (1970; 1976; 1979; Gardner & Heider 1969; see also Matthiessen 1962; Peters 1975; Ploeg 1979; 1988), the unpublished dissertation of Gordon Larson (1987), as well as the work of other New Guinea ethnographers.

² Secular warfare has been noted as part of the indigenous pattern of war among a number of New Guinea groups (Berndt 1964; Langness 1972; Blick 1988); however 'what is uncertain are the exact circumstances in which it occurs' (Blick 1988: 665).

³ On the precise nature of contact influence, see the exchange between Father Jules Camps (1972) and Heider (1973). Father Camps views the role of the central government and earlier alliances differently from Heider.

⁴ Studies discussing the resumption of warfare after pacification in the Highlands include Brown (1972), Meggitt (1977), Westermark (1984), Podolefsky (1984) and Feil (1987: 273-76).

⁵ This does not mean that interpersonal violence is absent from low-density, stateless societies or that there is no war (see Knauff 1987).

⁶ Although Heider provides the figure of 440 persons per square mile (or 272.8 per square kilometre) for the Dani (1979: 43), in his 1970 monograph he states that the actual figure could be considerably lower.

The Dugum neighborhood's 350 people use about two square kilometers for dwelling and gardening. These figures give a population density of 175 persons per square kilometer. For the Grand Valley as a whole, figuring about 50,000 people living in about 315 square kilometers, one gets nearly 160 persons per square kilometer. (However, the population figure is only a guess and may be off by 50 per cent.)

But what of the several square kilometers of forest behind the Dugum settlements that provide rooting grounds for pigs, lumber and vines for houses, minor food from game and pandanus, not to mention shelter for ghost houses? Even without proving that the forests are indispensable to the Dugum Dani, it is obvious that they are used. If the immediate forest area is to be calculated, the population density of the Dugum Dani could well be about fifty persons per square kilometre (1970: 59-60).

Even with these disparate estimates, the Dani still have a high population density by New Guinea Highland standards, and there is no question about their high level of agricultural intensification.

⁷ Morren argues just the reverse, stating that:

All evidence points to the fact that agricultural practices would not be expanded and/or intensified were it not for the need to support larger and larger pig herds....The role of agriculture has been exaggerated. Rather it is the expansion and intensification affecting the availability of pork (the most likely source of complete protein and fat) that must command our attention (1977: 310).

He provides evidence from the Miyanmin, the Tsembaga Maring and the Raiupu Enga. Morren's argument has been criticized by Vayda and McCay (1977: 415-6). For present purposes, we can simply note that this debate is unresolved.

⁸ After permanent contact was established in the Ilanga Valley, there were three ritual wars, in 1962, 1975 and 1977. Warfare persisted but did not break out as frequently as before contact (Larson 1987: 34). Casualties from these three wars were within the range of those for pre-contact

ritual wars; for example, in 1977 there were twelve deaths, all the result of arrow wounds. There were no secular wars in the period following permanent contact.

⁹ In another quantitative study of warfare designed to test ecological hypotheses, the Embers (1990) note that while there is a strong correlation between population density and warfare in the New Guinea Highlands, this correlation does not hold for a cross-cultural sample of 220 societies probably because density alone is usually not an accurate measure of population pressure across different environments and different subsistence types. The authors do report that the threat of famines or natural disasters is highly correlated with warfare.

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Department of Anthropology, University of Colorado, Hellems Building, Campus Box 233, Boulder, Colorado 80309-0233, USA

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