Bridge populations in the spread of HIV/AIDS in Thailand

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Objective: To determine the extent to which men provide a bridge population between commercial sex workers (CSW) and the general female population in Thailand.

Design: Sexual network and serological data were collected from a systematic quota sample of low income men and truckers during 1992 in three Thailand provinces. Completed sample size was 1075 men aged 17–45 years and 330 truckers.

Methods: Sexual network information was used to identify those men who have sex with both female CSW and non-CSW partners (the 'bridge population'). A new method was used for calculating the partner acquisition rate and to establish the potential number of women exposed to HIV via inconsistent condom use among the bridge population.

Results: Approximately 17% of men and 25% of truckers can be included in the bridge population. These men are more likely to be HIV-positive and to have had at least one other sexually transmitted infection in the past year (odds ratio, 2.2 and 3.4, respectively). Consistent condom use with CSW is less than 30%, and is less than 1% with non-CSW partners. As a result, 30 women in the general population were potentially exposed to HIV per 100 sexually active men in the last year: nine women each additional year. Younger men and truckers expose almost twice as many women to HIV; more female peers than wives are exposed.

Conclusion: Bridge populations may be as important as 'core groups' for the spread of HIV into the general Thai population. Young men and women are strategic intervention targets because they have more partners, are more likely to be in bridging networks, and are more receptive to condom use.

AIDS 1996, **10**:1265–1271

Keywords: Networks, behavior, transmission, heterosexual, survey data

Introduction

The HIV epidemic in Thailand is relatively young in comparison to the epidemics in Africa, Western Europe and North America, but it is spreading rapidly and appears to be moving beyond the initial high-risk populations. The first AIDS cases were diagnosed in 1985, and surveillance data have revealed successive waves of HIV infection moving into populations of drug users and homosexual men, commercial sex workers (CSW), army recruits, men in the general population, and women in antenatal clinics [1,2]. The spread of HIV outside the initial high-risk groups distinguishes the Thai epidemic from the epidemics observed in Western industrialized

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Sponsorship: Supported by the National Institutes of Health, grant 1HD28306 and Family Health International AIDS Behavioral Research Project, funded by the United States Agency for International Development.

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Date of receipt: 15 September 1995; revised: 30 May 1996; accepted: 3 June 1996.

countries, and has led some analysts to speculate that the epidemiology of HIV in Thailand may eventually come to resemble that in sub-Saharan Africa.

Thailand is particularly vulnerable to pervasive spread of HIV due to its commercial sex industry. Whereas mathematical modelers have shown that 'core groups' such as CSW play a disproportionate role in the spread of sexually transmitted disease (STD) [3], transmission beyond the core group depends on the patterns of mixing between the core and other members of the population [4,5]. Thai men purchase sexual services on a regular basis: nearly one-half of all Thai men report a recent commercial sex partner (CSP) [6], well above the 0.4–3% reported by men in the West [7,8]. Men who have both CSP and non-CSP may therefore play a critical bridging role for HIV transmission in Thailand, linking a low prevalence population of spouses and other non-CSP to a high prevalence population of women who work in the commercial sex industry [9].

In this study, we report the results of a behavioral survey designed to identify the composition of sexual networks and measure the extent of possible HIV exposure to women in the non-commercial sex population from male partners who also have CSP.

Subjects and methods

The analysis is based on data from the Behavioral Research on AIDS in Thailand (BRAIDS) project. This project collected data on sexual behavior, networks and blood samples for 330 male long-haul truck drivers (truckers), and 1075 low-income men aged 17–45 years. Truckers were sampled separately because other studies have shown this group to be at high risk for HIV infection [10]. The sample of low-income men was chosen to establish the potential for spread beyond the initial high-risk groups, as low-income men are the primary clients of CSW in brothels, the type of commercial sex establishment found to have the highest seroprevalence of HIV [11]. The sample was stratified into three provinces of north-eastern and central Thailand — Saraburi, Udon Thani and Bangkok — representing semi-urban and urban settings. Truckers were interviewed in Saraburi only, at the waiting areas around the two largest cement factories in the country. During several week-long field visits, each trucker waiting in the lot to pick up a load was approached and asked to participate in the survey. Systematic data on response rates were not collected, but estimates from the field staff suggest about 60% of the truckers agreed to be interviewed. The low-income men were sampled in Udon Thani and Bangkok only. Low-income communities were selected from the registry in each region, and a quota sample stratified by age and educational attainment was drawn from each. The interview response rate was recorded at 42.9% in Bangkok, and estimated at about 80% in Udon Thani. Interviewing was carried out from February to December 1992. Primary data were collected using structured interviews, with additional qualitative data from focus groups and in-depth interviews.

Respondents were asked to report the number of sexual partners in the following categories: wives [major and minor (*Mia Noi* wives are traditional second wives, although are not legally recognized)], other non-CSP [fiancée, girlfriend, 'playgirl' (casual partners with whom sexual relations are expected), and other female partners], and CSP. They were also asked to report over different time-frames (last week, last month, last 6 months, and lifetime). The categories of partners were established during qualitative focus group interviews that preceded the survey. Data on condom use was obtained by asking the respondents how often they had used condoms with each type of partner during the last 6 months.

Serological samples were drawn with a filter-paper technique [12] for the trucker subsample and the respondents from Bangkok. Respondent consent was obtained at the time of the interview; the response rate was 94.5% for truckers, and 63.8% for the Bangkok men. Men who refused to be tested had demographic attributes similar to tested men, but were slightly less likely to be married, to report risky behavior (such as lifetime number of CSP and inconsistent condom use), or to be in the bridge population. Blinded serological testing was conducted at the Virological Division of the Department of Microbiology in the Faculty of Medicine of Siriraj Hospital (Mahidol University, a World Health Organization Collaborating Center on AIDS). All samples were initially screened by particle agglutination (Fuji Rebeo, Tokyo, Japan) and all positive samples were confirmed by Western blot (Diagnostics Biotechnology, Singapore). For quality control, subsamples of filter papers were reanalysed at Johns Hopkins University, Baltimore, Maryland, USA (enzyme-linked immunosorbent assay, Genetic Systems, Seattle, Washington, USA; Western blot, Cambridge Biotech, Rockville, Maryland, USA).

STD history was established by self-report. Respondents were asked about the last time they had syphilis, gonorrhea, chancroid and herpes, and where they had sought treatment. Persons reporting any of these STD in the last year were coded as having a 'recent' STD.

The quota sample of men appears to be reasonably representative of the lower income strata of the Thai male population. The age breakdown of the BRAIDS community male sample is nearly identical to the Thai census (data available from M.M. on request). Using several different indicators, there is no evidence that high-risk persons were either excluded from or overrepresented in the sample. Risky sexual behavior was at levels that are equivalent to other more representative samples of Thai men [6]: over 25% of the sample men reported having multiple sex partners in the last 6 months, with 5% reporting 10 or more. The BRAIDS sample men

reported lower levels of consistent condom use than reported in government surveys, but this may be due to the more accurate measures provided by the BRAIDS survey instrument [13]. The HIV prevalence in the sample of Bangkok men was 1.3%, which was slightly higher than the 1992 prevalence of 0.8% found in the national sentinel survey of blood donors [14].

Exposure rate calculations

The primary objective of this study is to estimate the potential number of women in the general population exposed to HIV by men who have both CSP and non-CSP. Three factors determine this potential exposure: the fraction of men who have both CSP and non-CSP in the same time interval (the 'bridge population'); the fraction of these men who use condoms inconsistently with both CSP and non-CSP; and the rate at which these men acquire, and thus potentially expose, additional non-CSP.

The bridge population was defined as men who have had both CSP and non-CSP in the last 6 months. Basing the estimate on the last 6 months is fairly conservative, because more men would be likely to have each kind of partner if a longer time interval had been chosen (e.g., an additional 10% of men reported a CSP in the last year, and almost all of these men also had non-CSP).

The number of female non-CSP potentially exposed by each man in the preceding 6 months was determined by calculating the number of non-CSP of bridge population men who used condoms inconsistently with both partners (equation 1):

$$N^1 = \left(\sum_{i=1}^{I} n_i c_i \right) pc_p \qquad (1)$$

where n_i is the number of non-CSP of type i reported in the last 6 months (see Subjects and methods for types of partners); $c_i = 1$ if condom use is inconsistent with this type of non-CSP and zero otherwise; $p = 1$ if respondent reported any CSP in the last 6 months and zero otherwise; and $c_p = 1$ if condom use is inconsistent with CSP and zero otherwise. [This method may slightly overestimate the number of exposed non-CSP if men reporting inconsistent condom use with one type of partner (e.g., girlfriends) use condoms consistently with one girlfriend but not with another. The potential error is however small, as consistent condom use is effectively zero with wives and very low with all other types of non-CSP.] N^1 indicates the number of non-CSP exposed in the first 6-month interval for the calculation.

In general, the number of new partners acquired in the next 6-month interval will not be equal to the number reported in the previous 6-month interval. For example, if a man reports one wife in the preceding 6 months, this does not mean that he has one new wife every 6 months. This is a basic problem with standard survey data on sexual behavior collected in specific time-frames (last month, 6 months, 1 year), and is similar to the prevalence/incidence issue in disease surveillance. Relationships have variable duration, and it is necessary to model this duration explicitly to establish the rate of partner acquisition. Below, we describe a new method for estimating partner acquisition rates from cross-sectional lifetime summaries.

We modelled the rate of partner acquisition as a function of the cohort-specific cumulative lifetime total number of partners reported. Lifetime partner totals were found to vary both by respondent age (which also represents birth cohort here) and by number of years that the respondent had been sexually active ('sexual activity cohort'); age at first sex ranged from 7 to 35 years (median, 16 years; interquartile range, 15–18 years). The model thus estimates the lifetime total as a function of an age (birth cohort) effect and a sum of the rates of new partner acquisition for men in each sexual activity cohort (equation 2):

$$y_{ikl} = \alpha_i + \sum_{j=1}^{k} \lambda_j + \epsilon_{ikl} \qquad (2)$$

where y_{ikl} represents the lifetime total partners for person l in sexual activity cohort k and birth/age cohort i. The parameter α_i represents the age/birth cohort effects, λ_j is the sexual activity cohort effect for the jth year of sexual activity, and ϵ_{ikl} is the error term. The model specifies that men accumulate partners for each year that they are sexually active at annual rates given by λ_j, so by k years of sexual activity they have accumulated the sum of the rates from the first to the kth year. In addition, there is an additive increment (or decrement) to this total representing the effects of their age/birth cohort, as some cohorts may be more sexually active over their lifetimes than others. A generalized linear model is used for estimation, using a mixture distribution for the errors having a point mass at zero and a gamma distribution for the positive values. (Although the form of the model is linear, the distribution of the dependent variable is heavily right-skewed, violating both normal and Poisson assumptions.) The estimates for the positive values were obtained from the *glm* routine in the statistical package S-plus [15] using a linear (additive) link and gamma distributed errors. Separate estimates were again obtained for wives and for other non-CSP.

The resulting estimates for rates of non-CSP acquisition for each sexual activity cohort, λ_k, are then used to calculate the number of new non-CSP potentially exposed per additional 6-month interval (equation 3), using the same type of calculation as in equation (1):

$$N_k^+ = \left(\sum_{i=1}^{I} \lambda_{ik} c_i \right) pc_p \qquad (3)$$

where λ_{ik} represents the rate of acquisition of partners of type i for persons in sexual activity cohort k. N^+ indicates the number of new non-CSP potentially exposed

Table 1. Frequency of commercial sex partners (CSP) and non-CSP reported in the last 6 months, mean number of partners reported, and consistency of condom use by subgroup and age.

		CSP			Non-CSP		
			Of those reporting any			Of those reporting any	
Age (years)	n	Reporting any (%)	Mean (median) reported	Inconsistent condom use (%)*	Reporting any (%)	Mean (median) reported	Inconsistent condom use (%)*
Low-income men							
Total	982	29.74	4.1 (2)	72.26	75.66	1.6 (1)	97.04
17–24	364	39.56	4.0 (2)	63.19	64.29	2.4 (2)	91.88
25–29	221	35.75	4.5 (2)	79.75	77.83	1.3 (1)	98.26
30–39	293	20.14	3.9 (1)	81.36	81.57	1.1 (1)	100.00
40–45	104	9.62	3.3 (3)	90.00	94.23	1.2 (1)	100.00
Truckers							
Total	327	33.33	6.7 (2)	73.39	89.60	1.5 (1)	100.00
< 24	36	61.11	5.5 (2)	72.73	75.00	1.7 (1)	100.00
25–29	61	44.26	8.0 (2)	66.67	77.05	1.3 (1)	100.00
30–39	147	29.93	5.1 (2)	72.73	95.24	1.5 (1)	100.00
40+	83	19.28	11.0 (2)	87.50	95.18	1.5 (1)	100.00

*Percentage of male respondents who do not use condoms consistently with this type of partner.

in the next 6-month interval (for long-term extrapolations, age effects would also have to be added).

Risk factors for HIV and STD were analysed using t tests and odds ratios. For t tests involving the number of CSP, the analysis was based on the logged numbers, as the distribution of the unlogged numbers was severely right-skewed.

Results

The basic patterns of contact and condom use with CSP and non-CSP for the different groups of men can be seen in Table 1.

About one-third of both low-income men and truckers report at least one CSP in the last 6 months. The fraction is much higher for the younger men, particularly young truckers, of whom over 60% reported a CSP. The median number of CSP in the last 6 months among men reporting any is two (mean, four). Inconsistent condom use with CSP is the norm, with nearly three-quarters of the men in both groups reporting some unprotected contacts. Consistent use is more commonly reported by younger men, especially among non-truckers, but the levels are still well below 50%.

Non-CSP are more common among both groups of men, with 65–95% reporting at least one non-CSP in the last 6 months. The pattern is strongly age-graded: younger men are less likely than older to report a non-CSP, but if they do, they tend to report more of them. Older men are more likely to report spouses as their non-CSP, whereas younger men are more likely to report girlfriends and other non-spousal partners. Inconsistent condom use with non-CSP is nearly universal. As with CSP, younger men are the consistent users, but even in this group less than 10% report consistent condom use.

For men to form an effective bridge between the two populations of women, it is necessary for them to have both CSP and non-CSP in the same time interval. The composition of men's reported sexual networks over the last 6 month interval is reported in Table 2.

Table 2. Sexual network composition in the last 6 months by subgroup.

	n (%)	
Network type	Low-income men	Truckers
No bridge	817 (83.2)	245 (74.9)
No partners	157 (16.0)	10 (3.1)
Wife only	445 (45.3)	195 (59.6)
Other only	63 (6.4)	2 (0.6)
Wife+other	25 (2.5)	11 (3.4)
CSP only	127 (12.9)	27 (8.3)
Bridge	165 (16.8)	82 (25.08)
Wife+CSP	78 (7.9)	50 (15.3)
Other+CSP	66 (6.7)	14 (4.3)
Wife+other+CSP	21 (2.1)	18 (5.5)
Total	982 (100.0)	327 (100.0)

CSP, Commercial sex partner.

During this interval, most men do not report both types of partners: over three-quarters of men report sexual networks that do not provide a bridge (although not all of these men are monogamous). About 17% do report CSP and non-CSP (25% among truckers). In this bridge population, the most common pattern is to have both a wife and a CSP.

To quantify the continuing exposure of women in the general population two other factors must be established: the fraction of men in the bridge population who use

Table 3. Number of wives and other non-commercial sex partners (CSP) at risk per hundred sexually active men in last 6 months, and per additional 6-month interval by subgroup and age.

	Last 6 months			Per additional 6-month interval		
Age (years)	Wives	Other non-CSP	Total (95% CI)	Wives	Other non-CSP	Total (95% CI)
Low-income men						
Total	8.0	16.1	25.4 (19–32)	0.4	4.0	4.4 (0.8–8.0)
17–24	5.0	30.2	37.4 (23–52)	0.1	9.0	9.1 (3.2–15.1)
25–29	12.2	15.4	29.0 (17–41)	0.5	1.0	1.4 (0.0–4.9)
30–39	9.6	3.1	13.0 (8–18)	0.7	1.3	2.0 (0.4–3.6)
40+	5.8	4.8	10.6 (3–19)	0.5	0.6	1.0 (0.1–2.0)
Truckers						
Total	18.4	19.9	38.2 (27–50)	1.1	3.3	4.5 (0.0–9.3)
17–24	19.4	44.4	63.9 (26–101)	0.4	19.1	19.5 (5.0–33.7)
25–29	13.1	19.7	32.8 (10–56)	0.7	2.3	3.4 (0.0–8.0)
30–39	23.1	18.4	41.5 (23–60)	1.5	1.0	2.5 (0.0–6.8)
40+	13.3	12.1	25.3 (7–44)	1.0	1.5	2.5 (0.8–4.1)

CI, Confidence interval.

condoms inconsistently with both CSP and non-CSP, and the rate at which additional non-CSP are acquired and therefore exposed to HIV.

Overall, 27.1% of the men in the bridge population reported consistent condom use with both partners. The fraction is lowest among those whose non-CSP is a wife (21.1%), and highest among those with other, non-spousal non-CSP (36.2%), with those reporting all three types of partners falling in the middle (28.2%). Taking condom use and contact rates into account, the number of women in the non-commercial sex population exposed to potential HIV-transmission is presented in Table 3.

The estimates represent the potential number of women exposed per 100 sexually active men in the population. For every 100 sexually active men, 25 women were potentially exposed to HIV in the last 6 months (38 for truckers), and an additional four women will be potentially exposed in the next 6 months. These numbers are roughly additive, so we may estimate that over the course of 1 year, an average of 30 women would be potentially exposed per 100 sexually active men (43 for truckers).

Age- and group-specific patterns of partnership and risk are clearly visible in Table 3. Younger men are consistently more likely to expose non-spousal partners, and to expose greater numbers of them: five wives compared with 30 other non-CSP in the last 6 months (19 wives compared to 44 other non-CSP for truckers). Non-spousal partners thus make up 70–90% of the women exposed by the younger groups in the last 6 months, and well over 90% of the number of new women expected to be exposed in the next 6 months. The higher rates of exposure generated by younger men are due both to their higher rates of engaging in commercial sex (Table 1), and to their higher rates of acquiring new non-CSP (Table 3): compared with the overall men's mean of just over four new women exposed, young men expose nine new women (19 for truckers). Most of the new women they expose to HIV are girlfriends and other casual partners, and not wives. By contrast, the two older groups of men expose substantially fewer women, and wives comprise about one-half of those exposed.

Although wives might have been expected to comprise the majority of the women exposed given the network composition findings in Table 2, this turns out not to be case. More non-spousal than spousal partners are exposed for almost all groups of men in the last 6 months. The one exception to this pattern is among 30–39-year-old truckers. The higher predicted number of new wives exposed by this group appears to be due to the influence of several outliers — men who report over eight wives in their lifetime.

Truckers expose relatively more women to the potential for HIV transmission than men in the general low-income population. The rate at which truckers expose both their wives and other non-CSP is higher than other men in all age groups. This is due mostly to the higher rates of commercial sex reported by truckers, as their rates of new non-CSP contact are about the same as for other men. Among the youngest group of truckers, however, the higher rates of exposure are also due to higher rates of new non-spousal partner contact.

Differential rates of STD and HIV infection among men provide evidence that the potential exposure established here is an important indicator of actual risk. Commercial sex is a significant risk factor for HIV and other STD in this population of men. About 10% (n = 126) of the men in the sample reported at least one STD in the last year. Among these men the mean number of CSP in the last year was 15.9, compared with 3.4 among men with no recent STD ($t = 6.93$; $P < 0.001$). A total of 15 men tested positive for HIV: eight men and seven truckers (2.5% of the tested sample; 1.3% and 2.3% of Bangkok men and truckers, respectively). Among HIV-positive men, the mean number of lifetime CSP was 47.1, compared with 35.1 for HIV-negative men ($t = 4.39$; $P < 0.001$). In addition, men in the bridge population have higher rates of infection. The incidence of STD in

the last year was 21% for bridge population men and 7% for others [relative risk (RR), 3.5; 95% confidence interval (CI), 2.4–5.2; $P < 0.001$]. The prevalence of HIV was 4.3% for bridge population men and 2.0% for others (RR, 2.2; 95% CI, 0.7–6.6; $P = 0.15$). Bridge men are thus exposed via commercial sex, and in turn expose their non-CSP.

Discussion

This study has provided a quantitative estimate of the number of women outside the commercial sex industry who are potentially exposed to HIV by male sex partners who have unprotected sex with CSW. About 17% of men are in this 'bridge population', 73% of whom use condoms inconsistently with both types of female partners. As a result, for every 100 sexually active men, 30 women in the general population are potentially exposed to HIV in the last year, and about nine will be exposed in each additional year. Commercial sex is a significant risk factor for recent STD and HIV infection among men, and men in the bridge population are more likely to be infected than others. Together these figures establish that bridge populations can be as important as 'core groups' for the spread of STD, and that there is significant potential for HIV to spread beyond the initial high-risk groups in Thailand.

The rates reported here represent the potential for HIV exposure, rather than actual rates of exposure. At the time of this survey, HIV prevalence among the men in the bridge population was 4.3%, so a rough guess of the actual annual rates of non-CSP HIV exposure at the time of the survey is $0.043 \times 30 = 1.3$ women per 100 sexually active men, well below the potential established here. However, the higher rates of STD and HIV in the male bridge population indicate that these men will contribute disproportionately to the future spread of HIV.

Although the emphasis in this study has been on the risk that commercial sex poses to men, it is important to note that this risk is not one-way. The women who work in the commercial sex industry are not the origin of HIV infection, nor do they pass it among themselves: they are typically infected by their male clients, and these clients usually have multiple CSP. Of all women, CSW are at the highest risk of contracting HIV from men.

The patterns of risk and exposure suggest three forms of targeted intervention. First, it makes sense to target younger men to promote safer sex. Younger men already report higher rates of condom use with CSP, and are the only group reporting consistent use with non-CSP. There is some evidence (and logic) to support the idea that it is easier to establish safer sex patterns at the onset of sexual behavior than it is to change behavior. Because younger men expose the greatest number of non-CSP, a change in behavior in this group could have large impact on potential HIV transmission. Targeting younger men is thus an efficient and effective strategy for intervention.

Second, it makes sense to target men who are employed as truckers. Truckers are more likely to report commercial sex at all ages, more likely to report both CSP and non-CSP in their sexual network, and they expose substantially higher numbers of women in the general population on a per capita basis. Here, perhaps, it might be possible to utilize the occupational culture of truckers to popularize the consistent use of condoms.

Third, it is important to target safer sex skills to young women outside the commercial sex industry. The findings here indicate that female peers (non-spousal non-CSP) are exposed in greater numbers than wives. Most of the exposure is created by the younger men, and it can be assumed that their female partners are also young. It is critical, therefore, that these young women be informed of the risk they are being exposed to and be given the skills to negotiate safer sex. Both married and unmarried women are clearly at risk here, and the needs of both groups must be addressed. The greater frequency of exposure among unmarried women, however, and the greater likelihood that they in turn could infect others, suggests that this population is a more critical link in the system of HIV transmission.

Finally, these data provide some basis for evaluating the impact of condom use and other potential intervention options in the Thai HIV epidemic. If the government campaign for '100% condom use' with CSP begun in 1991 were to be successful, it would be an effective strategy. But these data suggest that 2 years into the campaign, fewer than 30% of men report consistent condom use with CSP. This is similar to levels found in other studies of male clients [2,16], although substantially lower than the 90% or more suggested by governmental studies of female CSW [13,17]. If future studies find that consistent commercial condom use among men has risen, it will be important to establish whether the levels have risen uniformly for bridge and non-bridge population men. On the basis of data here, however, the policy cannot be considered an effective single strategy for preventing HIV transmission between CSP, or an effective way to prevent transmission across the bridge to other women.

Policies aimed at reducing the level of commercial sex activity may also need to be considered, but the results here strike a cautionary note regarding possible substitution effects. The frequency of sexual contact with female peers is already much higher among younger men, many of whom have already had more female peer sex partners in their lifetime than older men. There are both Western and indigenous influences on the younger population which could be expected to contribute to a weakening of norms against pre-marital and extra-marital sex with non-CSP. Under these conditions, a reduction in commercial sex activity could be offset by an increase in

sexual activity among non-CSP, particularly in the younger age groups. Unless condom use increases among non-CSP, a change of this sort could actually increase HIV transmission in the population. Policy changes thus need to be evaluated in terms of intended and unintended outcomes, and research on partner-specific sexual behavior patterns must be continually updated in order to provide accurate information for evaluation and planning.

Acknowledgements

The authors would like to acknowledge the contributions made to this project by Anthony Pramulratana, Uraiwan Kanungsukkasem, Regina McNamara and Annette Bernhardt.

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