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Chapman, Barbara Anne

A MEDICAL GEOGRAPHY OF ENDEMIC GOITER IN CENTRAL JAVA

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A MEDICAL GEOGRAPHY OF ENDEMIC GOITER

IN CENTRAL JAVA

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN GEOGRAPHY

DECEMBER 1982

By

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I can name here only a few of the people who generously assisted and supported me during the research and analysis for this dissertation.

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Monetary and material support were provided by several institutes of the East West Center, namely, the Food Institute, the Resource Systems Institute, and the Environment and Policy Institute, and a Foreign Language and Area Studies grant.
Conventional public health efforts for the eradication of endemic goiter focus on iodine supplementation. However, the growing literature on active goitrogenic chemicals in vegetables and the awareness that many impoverished third world populations depend on local resources for their diet suggests that actively goitrogenic diets must be considered early in the goiter survey stage. Yet few surveys of goiter include even a diet survey. The objective of this research is to re-examine the etiology of endemic goiter in a particular place as a basis for public health intervention. The approach is novel in that it examines dietary sources of iodine and goitrogens for a single goitrous community in Central Java. The medical geographic approach to the case study highlights the relationship of people to environment as a factor in disease causation.

The results of the investigation are as novel as its approach. The goitrous case study village has a moderate continuous supply of iodine via a longstanding food exchange system with the coast of Java. Three preserved seafoods bear iodine into the region. Yet the goiter prevalence is 62 percent. Among the vegetables in the diet, 35 have
been found to be goitrogenic in other contexts. An analysis of the patterns of consumption indicate that the most commonly eaten vegetables are those grown in the village. The poor majority of the village eat large quantities of cassava, cassava leaves, papaya leaves and various legumes. The better-off minority purchase equally goitrogenic vegetables, such as cabbage or carrots and have largely abandoned the dried seafood. A previously unknown symptom of community-wide deficiency in taste ability for salt and bitter goitrogen solutions is affecting the total eating pattern of the community.

In short, the case study village, already a recipient of iodine supplement efforts is clearly one where the endemic goiter has a large component of active goitrogens in the diet. Prophylaxis based entirely on the hypothesis of absolute iodine deficiency can be only partially successful, since several of the goitrogens cannot be overridden by excess iodine.

A recommendation is made for government health planners and agencies to carefully investigate the possibility of goitrogens in the diet at the time of the initial goiter survey. A goiter prevention policy should then be developed for each community which includes an appropriate emphasis on iodine supplements and diet modification.
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CHAPTER I

INTRODUCTION

Abstract
Endemic goiter is a disease caused by a complex interaction of people and environment. Effective prophylaxis can be planned only upon an understanding of these interactions. This case study of one village in Java is used to alert public health planners to the importance of non-iodine factors in endemic goiter. The medical geographic approach generates new discoveries regarding the ecological causes and consequences of endemic goiter and points the way to more fruitful research and public health interventions.

Objective

The presumption that iodine deficiency is the sole cause of endemic goiter has limited the effectiveness of research and public health efforts for over 50 years. It is so strongly held that iodine shortage is often presumed from the presence of endemic goiter. Prophylaxis programs costing many millions of dollars have been based upon this presumption. The usual approach to the study of endemic goiter establishes rudiments of environment considered relevant and the medical descriptions of the population afflicted. To a large extent, goiter research since World War II has elaborated the search for signs and symptoms in the goitrous population, and has taken the etiology for granted. The detail on either pole depended on the
training of the researchers. Geographic studies of the problem, on the other hand, have consisted largely of correlation of geographic co-incidence between environmental factors and disease distributions. Commonly the scale of the studies is that of whole states or an entire watershed. Despite the presumption that iodine shortage is the only cause of goiter, there have been at least 35 anomalous studies that could not attribute the goiter prevalence to an absolute lack of iodine in the environment.¹

This study is novel in several aspects. For a single goitrous community in Central Java it examines sources of dietary iodine, and does not make the common assumption that the presence of endemic goiter denotes iodine shortage. It also closely examines dietary goitrogens as a factor in goiter etiology. Lastly, it argues that the pattern of human behavior, that is cultural behavior, is critical in the interrelations between man and his environment, and therefore is a factor in environmental health. To accomplish this examination of man-environment relationships, the study was conducted in one community over a period of 22 months. I employed some formal surveys, but especially observed and recorded the daily aspects of community life, marketing, cooking, eating, and gaining a living. Explanations for the goiter endemias in iodine sufficient areas usually suggest active goitrogens from vegetables in the diet. Yet goiter studies hardly ever include diet or human behavior as etiological factors in spite of clear evidence that relevant factors are carried by a multitude of dietary items allocated by complex sets of cultural rules. In any potentially goitrous community, there are choices to be
made among the goiter-relevant environmental factors at the community, the household, and the individual level. One of the greatest enigmas about the etiology of goiter, then, is the role of human adaptive behavior in goitrogenic environments.

Goiter is a multi-factor situation which can only be alleviated when the complexities of the interaction of people with their environment is known. To elucidate this people-environment interaction and make it useful for goiter prophylaxis planning I chose a case study approach.

Operational Objectives

The larger objective of the research is to re-examine the etiology of endemic goiter in a particular place as a basis for public health efforts. Within this larger objective two sub-objectives have been isolated:

1. To establish the parameters of the goiter-relevant environment, particularly the availability of iodine and goitrogens to the population.

2. To describe the cultural choices within the above environment that pattern iodine and goitrogen flows at the community, household and individual levels which determine the prevalence of goiter.

More specifically, the research seeks to elucidate the following aspects of the food system of one goitrous community:

   a. Are iodine or goitrogen-bearing foods imported into the community?

   b. Are iodine or goitrogen-bearing foods produced within the community?
World Distribution of Endemic Goiter

Figure 1.1

Source: Howe, G.M., 1977
c. Does food processing modify iodine or goitrogen content or change food acceptability?

d. Are there differences in access to resources, community taste preferences and cultural ideas about food that affect the distribution of iodine and goitrogens in the community?

Rationale

Goiter is a well studied, but highly prevalent, disease in the Third World today (Figure 1.1). It virtually disappeared from Northern Europe and North America after the introduction of iodized salt in the third decade of this century. Kelly and Snedden\(^2\) reviewed the world goiter situation in 1960 and estimated that over 200 million suffered from it. Today that estimate would be five times too conservative.

The Effects of Endemic Goiter

A series of research and laboratory reports by nutritionists and biochemists in the early years of the twentieth century\(^3\) established the role of iodine as a raw material in the production of thyroxine by the thyroid gland. The thyroid, a bi-lobed gland (see Figure 1.2) at the base of the neck, traps and concentrates iodine from the circulating blood supply. Later it releases into the body's circulatory systems several forms of thyroid hormones which affect a wide spectrum of growth and metabolic functions. Table 1.1 lists the great diversity of signs and symptoms the body exhibits when thyroxine levels are improper. Generally, people living under endemic goiter conditions might be expected to suffer from some of the signs of thyroid hormone deficiency, such as dry skin, intolerance to cold,
Table 1.1

Signs and Symptoms

of Thyroid Hormone Deficiency and Excess

<table>
<thead>
<tr>
<th></th>
<th>Excess</th>
<th>Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolism</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Muscle</td>
<td>Weak, tremor</td>
<td>Weak, hypotonia</td>
</tr>
<tr>
<td>Sweating</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Body weight</td>
<td>Decreased</td>
<td>Increased</td>
</tr>
<tr>
<td>Growth</td>
<td>Rapid</td>
<td>Dwarfism</td>
</tr>
<tr>
<td>Tissue changes</td>
<td>Exophthalmos</td>
<td>Myxedema</td>
</tr>
<tr>
<td>Temperature</td>
<td>Heat sensitive</td>
<td>Cold sensitive</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Normal-low</td>
<td>Elevated</td>
</tr>
<tr>
<td>Serum cholesterol</td>
<td>15 ug</td>
<td>less than 2 ug</td>
</tr>
<tr>
<td>Serum PBI</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Pulse pressure</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Diarrhea</td>
<td>Constipation</td>
</tr>
<tr>
<td>response</td>
<td>Nervousness</td>
<td>Irritability, deafness</td>
</tr>
<tr>
<td>CNS response</td>
<td>Hyperactive</td>
<td>Slow</td>
</tr>
<tr>
<td>Reflex</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Cerebration</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Drug tolerance</td>
<td>Flushed, increased sweat</td>
<td>Dry, scaly cold</td>
</tr>
<tr>
<td>Skin</td>
<td>Fine, soft</td>
<td>Dry, brittle</td>
</tr>
<tr>
<td>Hair</td>
<td>temporary loss</td>
<td></td>
</tr>
</tbody>
</table>

Source: Carlson, L.D. and Arnold, C.L.H. 1970, p.27.
The Position of the Normal Thyroid

Figure 1.2
swollen tissues (myxedema), and of course, the compensatory swelling of the thyroid glands themselves which may hamper circulation and breathing if they reach an unusual size. This most obvious manifestation of the shortage of thyroxine is a compensatory growth response triggered by feedback mechanisms between the thyroid gland and the pituitary gland. The pituitary gland monitors thyroxine levels in the blood. When these levels drop, the pituitary chemically orders increased production of thyroxine, involving a build-up of glandular tissue and blood vessels in the thyroid glands. Initially, the added production may compensate for the hormone deficiency. The commonly used grades or sizes of goiter refer only to the size of the thyroid glands and are at best only a general indicator of hormone deficiency. Grade OA is normal. OB is enlarged, but not visible when the head is in normal position. The examiner must palpate for it. Grades I, II, III are progressively larger and can all be detected by the alert layman. Somewhat arbitrarily, a goiter prevalence rate of ten percent or more is considered endemic.

An enlarged thyroid, therefore, may or may not indicate impaired thyroid function for the individual, but it indicates that some deficiency of thyroid hormones is being detected by the pituitary. Severe deficiencies can result in hypothyroidism in the goitrous individual, or cretinism, or deafness in the offspring of goitrous mothers. Frequently, in addition to a high prevalence of goiter, a portion of the population suffers an irreversible neuromotor syndrome called cretinism. Cretinism is the most severe aspect of endemic goiter. This is a cluster of signs, not all of which appear in
every cretin or in every community. The signs include deafness, mental retardation, dwarfism, epiphyseal dysgenesis, and ataxia (see Table 1.2).

The diagnosis of cretinism is complicated by the apparent clustering of these diverse signs into two basic types. The "nervous" cretin exhibits deafness, awkward gait, normal height, and squint while the "myxedematous" cretin tends to be of less than normal height and exhibits many of the classic signs of hypothyroidism. Mental retardation and clinical hypothyroidism are the two most common traits of both types (Table 1.2).

The causes of these different types of cretinism are unknown, but probably they are the result of thyroxine deprivation at some important early stage of development, possibly before birth. Problems of definition and diagnosis make the interpretation of the prevalence of cretinism for any particular area of endemic goiter a difficult task. Reports vary from as little as one percent from Idjwi Island in Eastern Zaire to as high as eight percent in rural Ecuador.

Only in the last decade did scientists recognise that the neural damage resulting from endemic goiter is not restricted to the overt cretins in the goitrous population. Recent research efforts in Ecuador and Indonesia have discovered evidence of impaired intellectual function in the "normal" or non-cretinous segments of goitrous populations. One study contrasted the performance of children whose mothers had been given iodine injections early in their pregnancy to children whose mothers had not received iodine. Those
### Characteristics of Endemic Cretinism

#### Table 1.2

<table>
<thead>
<tr>
<th></th>
<th>Western New Guinea</th>
<th>Eastern New Guinea</th>
<th>Equador</th>
<th>Brazil</th>
<th>Italy</th>
<th>Nepal</th>
<th>Northern Congo</th>
<th>Eastern Congo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence (%)</td>
<td>5.5</td>
<td>2.5</td>
<td>7.1</td>
<td>1</td>
<td>1</td>
<td>5.9</td>
<td>0.3</td>
<td>1.0</td>
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<tr>
<td>Absence of goiter</td>
<td></td>
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<tr>
<td>Epiphyseal dysgenesis</td>
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<tr>
<td>Thyroid failure</td>
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<tr>
<td>Dwarfism</td>
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<tr>
<td>Clinical hypothyroidism</td>
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<td>Mental retardation</td>
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<td>Neurological defects</td>
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<td>Normal thyroid function</td>
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<tr>
<td>Deaf-mutism</td>
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<td>Goiter</td>
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<tr>
<td>Normal height</td>
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</table>

Source: De Lange, et al., 1972
children whose mothers received iodine performed substantially better on a battery of intellectual tests. A second study in the same area of Ecuador found a visual-motor defect in 17 percent of the non-cretin children. Querido found 19 percent of the non-cretinous children in a village in Java scored below the 10th percentile on the Raven test, while in a non-goitrous control village, only 6.6 percent scored that low. These somewhat surprising results indicate that the neurological damage in goitrous communities extends far beyond the few conspicuous cretins, including perhaps as much as one fifth of the population.

Thus the effects of endemic goiter are in no way limited to the cosmetic problem of a swollen neck. In addition to the long recognised problem of a small percentage of overt cretins, there are substantial proportions of goitrous populations whose physical dexterity and mental acuity is irreversibly retarded. This problem burdens developing countries where changing technologies increasingly demand dexterity and intelligence. Endemic goiter is a problem they cannot afford to ignore.

Associations and Etiology of Goiter

Early in the twentieth century, Western countries applied the discovery of the role of iodine shortage in goitrogenesis by supplementing common foods, usually salt or bread, with iodide. These
efforts coincided with a dramatic decline in the prevalence of goiter and cretinism. Today, in developing countries where the most serious regions of endemic goiter occur, similar approaches are being tried, but with little consideration for the differences in social systems, expertise, transportation networks, storage, economy and resource bases.

In fact, there is evidence that cultural practices and economic events have affected the course of endemic goiter, particularly when these events affect the access of communities to food resources. Endemic goiter disappeared in the span of a few years from a Mexican village when a new road permitted the importation of a greater selection of dietary items and increased social mobility. By contrast, a multitude of iodine deficiency symptoms appeared for the first time in the highlands of New Guinea when increased contact to the outside world led to changing salt sources in the early 1960's.

Evidence has been accumulating over the last 20 years that simple iodine deficiency is not a sufficient explanation for the etiology of endemic goiter in some regions. A recent review lists 35 references to endemic goiter attributed to dietary factors other than iodine deficiency. Simple iodine availability, usually determined by sampling drinking water, does not always predict the prevalence of goiter. Epidemics of goiter erupt in places where it has previously been absent. After 15 years of iodine supplementation of an endemic goiter valley in Colombia, the prevalence of goiter has declined only from 52 percent to 30 percent. Some evidence points to goitrogenic factors in the drinking water.
Because of these unexplained research results and the uneven success of iodization programs in developing countries where rapid economic progress does not accompany the programs, goiter has again become a medical mystery, stimulating a search for environmental associations as clues to the etiology of a disease which is incompletely understood. Several geographers have speculated on the causes of the uneven distribution of goiter. Pyle postulates four explanations:

1. An absolute environmental shortage of iodine.
2. An excessive presence of other minerals in the water such as calcium or fluoride competing with iodine for uptake by the thyroid gland.
3. A high intake of the Brassica (Cruciferae) family of plants.

Learmonth, another geographer, advances some familiar theories for the uneven appearance of goiter over the earth:

1. Northern hemisphere goiter often coincides with soil in recently glaciated areas.
2. Leached soils in high rainfall areas may account for some of the tropical goiter.
3. Drinking water containing excessive calcium from a limestone catchment area.
4. A diet heavy in goitrogenic plants could account for goiter less easily explained by the others.

Briefly summarized, the associations posited to explain the occurrence of goiter are: 1) absolute iodine shortage due to the youth of the soil, for example, because of recent glaciation, volcanism, or erosion, and 2) relative iodine shortage. In the latter case, there are active goitrogens in the diet which restrict the use of available iodine in spite of local iodine supply.
One such class of anti-thyroid agents acts to block the uptake of iodine by the thyroid. Among these are: cobalt, calcium, or fluoride; and also compounds such as perchlorate or thiocyanate which occur in such food plants as cassava. The second class of goitrogens blocks the production of iodine-containing hormones within the thyroid. These thiouracil compounds, found widely in many cultivars of the Cruciferae, Umbelliferae and Compositae families, cannot be overridden by supplemental iodine and as such, cause a difficult public health problem.

Especially revealing are several lines of micro-level research which indicate that the concentrations of iodine and goitrogenic anti-thyroid compounds in a plant corresponds very well to the composition of the soil supporting it.\textsuperscript{21} Despite the essential nature of iodine for animal metabolism, higher plants do not appear to utilize it. The great majority of plants neither concentrate nor dilute iodine from soil, but merely reflect it. This, perhaps, explains the absence of iodine from the indices of several well-known soil science texts.\textsuperscript{22,23} Secondly, the iodine content of soil is derived from its organic material and is relatively unrelated to the parent rocks. Consequently, mature soils with a long history of supported biomass tend to be richer in iodine than are undeveloped soils. Iodine content and nitrogen content are highly correlated.\textsuperscript{24} The mechanism for this process is the absorption of iodine from rain through the leaves of plants.\textsuperscript{25} A third relevant line of inquiry is the antithyroid activity of Cruciferae under different growing conditions. The goitrogenicity of cabbage\textsuperscript{26} varies directly with the amount of sulfates provided in the growing medium. Rats fed high
sulfate cabbage develop goiters, while those fed cabbage grown on the lowest concentration of sulfate do as well as controls on a normal diet.

To sum up current thinking, researchers now consider goitrogenic substances in food and water supply as possible contributors to endemic goiter. However, in international public health practice and goiter prophylaxis efforts in developing countries, people have been slow to act on this change of thinking regarding the etiology of goiter. There is understandable inertia to spend limited public health funds for anything other than the standard iodine supplements. A re-consideration of the thrust of goiter prophylaxis in Indonesia is in order.

**Presentation of Research Results and Recommendations**

After a brief description of the field methods, the highland Central Javanese community setting is dealt with in some detail, for medical geography is above all a consideration of disease in the context of a particular place and people. Chapter four is devoted to tracing the sources and distribution of iodine in the village diet. Chapter five depicts the much more complicated sources and distribution of dietary goitrogens to the community. Some of these are imported and are relatively expensive by local standards, while others are locally grown and inexpensive. An analysis in chapter six compares the heretofore separate flows of iodine and goitrogens and presents conclusions and recommendations.
The iodine prophylaxis already carried out in the case study village has corrected the effects of dietary goitrogens that can be overridden by excess iodine, leaving a residual effect of the other goitrogens in the diet. Recommendations based upon the findings in this research include an education campaign to focus on the reduction of goitrogenic vegetables in the diets of pregnant and nursing mothers, all infants, and all girls to the age of 20.

A more general measure is the recommendation to consider broader systems in planning campaigns against human disease. Human occupation of an environment is far from a passive co-incidence of people and an environment. Systems of managing the environment have developed over centuries involving choices of food plants, organization of systems of production, distribution, and consumption. As a result, the flow of nutrients in human food chains is as much a social process as it is a physical process. In the case of endemic goiter, iodine or goitrogens may enter the human food system from water, food or medicines, but only some of the available iodine and goitrogens will become distributed in the population in culturally patterned ways. Patterns of consumption may vary geographically, seasonally, or by the social and economic role played by individuals and families within the community. Because some of the factors involved in endemic goiter cannot be overridden by supplements of iodine, the system of goitrogenesis in particular places must be studied in some detail before programs of amelioration can be planned.
References


CHAPTER II

METHODOLOGY

Abstract
Several operational objectives are defined within the major goal of re-examining the etiology of endemic goiter in a specific Third World setting. This chapter describes methodological approaches and problems encountered in sufficient detail to enable the reader to appreciate the difficulties encountered in the course of fieldwork, the specific tailoring of the study to the rural Javanese culture, and to evaluate the resulting data. The model of cultural ecology as a template for data collection is introduced and finally the simplification of food categories for relevance to the problem of endemic goiter is described.

Statement of Operational Objectives
I proposed to re-investigate the etiology of endemic goiter in a particular Third World setting having recognised the limits of the model of iodine deficiency as the exclusive basis for preventing endemic goiter in developing countries. The highlands of central Java
present a situation where all of the etiological factors in question are present. There is economic underdevelopment with its usual poorly developed rural infrastructure, a high prevalence of endemic goiter and a diet that includes a high proportion of goitrogenic plants. I assessed iodine and goitrogen supply in the village diet with formal surveys and other less formal investigational procedures. Specifically the operational objectives were as follows:

1. To inventory the supply and describe the consumption patterns of iodine-bearing foods in the goitrous community.
   a. To monitor the import of iodine bearing foods into the community
   b. To describe the regulation of consumption across economic levels and throughout the year
   c. To evaluate the loss of iodine caused by food processing
   d. To evaluate the equity of intra-household distribution

2. To inventory supply and describe consumption patterns of goitrogenic foods.
   a. To monitor goitrogenic foods grown in the village and those imported.
   b. To describe the regulation of consumption across economic levels of households.
c. To assess the effect of household processing technologies on the goitrogenicity of the foods.
d. To assess equality of intra-household distribution of goitrogens.

The inventory of iodine and goitrogen supply in the diet was purposely measured at more than one scale of analysis. Measurements taken at the level of the total village could have, for example, misrepresented the availability of iodine at the individual level.

Field Methods

Background Data

Reconnaissance. By mid-1976, the time of my arrival in Indonesia, some information regarding the severity of endemic goiter was available for central Java. From 1975, local departments of health throughout Indonesia were advised by their national health agency to be alert for the presence of endemic goiter. In central Java, at the initiative of Dr. Djokomoeljanto of the Universitas Diponegoro Medical School, two members of each subprovince health center attended training in goiter diagnosis and completed a goiter survey in their respective areas. Based on the unusually high goiter rates that they discovered, and especially on the evidence of cretinism from several areas, the Central Javanese Department of Health planned a trial distribution of iodized salt to three areas judged to vary in accessibility. The measure of accessibility was
based largely on distance to an asphalt road. I decided to conduct my research in one of the three targeted areas. After visiting all three sites, I chose the Banjarnegara area largely for political reasons. My research was welcomed enthusiastically there, and the medical staff and subprovincial staff had an established record of cooperation with medical projects.

With the help of two college students who spoke the local dialect of Javanese, the Indonesian national language and some English, I moved to the villages to begin my investigation. In this early phase when I was acquiring the languages and discovering the rudiments of village life, data gathering was at a basic level. Because there were no extant maps or a consistent household number system, I constructed cadastral maps for six hamlets, and assigned house numbers. In the process I gained an idea of the range and variety of household resources that might affect consumption. I mapped and sampled the drinking and cooking water and sent the samples to an agricultural laboratory in Yogyakarta. Additionally, I began the task of collecting, pressing and recording names and recipes for the myriad of edible plants available locally in gardens and markets. Eventually these samples were identified with the help of an Indonesian botanist and several authoritative botanical works in libraries and private collections.¹²

Census. Some months later I conducted a household census in all six hamlets with a research team temporarily expanded to four. Census information fell largely into two categories, that of economic resources available to each household and that of indicators of localness or attachment to the immediate area. Part of the assessment
of economic resources is based on a simple checklist of houseform and possessions likely to be displayed in the front rooms where most of the interviews took place. Household heads and other household members were asked about animals owned or cared for, land rights and use as indices of resources in a primarily agricultural village. Other indicators of household resources were the more conventional socio-economic information: sex and age of each household member, educational level, and kinds of jobs worked.

Place of origin is an important factor in establishing whether the observed 62 percent goiter rate is a product of this place or, in part, an imported product of some other place. For each household member we recorded birthplace and length of residence. We also asked destinations of trips made by household members within the last year and about extended family members who live outside the hamlet.

After a pretest in a neighboring village and some revisions to the questionnaire, the census was conducted house to house over a six week period spanning the Moslem fasting month in 1977 (roughly August and September). Each of the four interviewers was equipped with four items: a sketch map of the hamlet, a calendar showing the convergence of the Javanese months and Julian calendar dates, a dated history of local memorable events to help establish ages, and a stack of blank census forms. Each interviewer was assigned a block of about ten households to interview before midday prayers. I circulated among the interviewers to observe technique and to discover and correct any misunderstandings.
Food Availability

The units of study or levels of data gathering were dictated by the organizational reality of the community. Individuals act not only as individuals, but as members of conspicuous groups: households for work and food preparation and consumption, and hamlets or villages for interactions with the outside world. To increase our understanding of the distribution and consumption of iodine bearing and goitrogenic foods, data gathering was carried out at each of these somewhat apparent levels of organization: the village, the households, and the individual.

Village-level Food Availability. On two days out of the five-day Javanese market week there was a bustling vegetable market at the entrance to the village. Vegetable vendors revealed that the source of the cruciferous vegetables and most of the other produce was the next eastern subprovince, Wonosobo. Gradually, the informal questions developed into a formal checklist of vegetable types, amounts, prices and points of origin of the common vegetables at the market. I continued the survey as time permitted for 17 months, compiling a record of volumes and types of vegetables sold for 127 market days. Prices and amounts of salt and sea products I gathered periodically at the local provisions stores.

Household Consumption Patterns. Surveys at the household level were designed to reveal the effects of varying household resources on the processing and allocation of the goiter-relevant foods. I surveyed all of the households in one of the six hamlets for garden
holdings and varieties planted. The hamlets are densely packed with houses, but most yards contain a few vegetables, spices or medicinal plants. Obviously, one source of food is local vegetables which never pass through the market. A garden survey in each of 123 households of a single hamlet in April, 1977, reflects use of locally gathered vegetables when they are relatively abundant, that is, in the middle of the rainy season. The detail of the garden survey revealed fruit tree holdings and non-commercial vegetable plantings that no other method illuminated.

A household diet survey was indicated as an index of the frequency of consumption of local or imported sources of goitrogens or iodine-bearing foods. However, a combined household larder record and weighing of salt conducted over a three-day period early in the fieldwork elicited 33 percent exaggerations. Clearly diet survey techniques used commonly in the West need modification to produce reliable data in Java. The standard Western techniques of larder record, weighing, or recall make ethnocentric assumptions about the food system which render them less successful in non-western contexts. I devised a method to minimise the "survey formality," the Javanese tendency to achieve status by reporting only high status foods, and to minimise forgetting. In ten months of participant-observation, I had accumulated a wealth of fieldnotes on Javanese food beliefs and behaviors. This information was invaluable as a basis for devising a workable diet survey method. Food and eating situations carry heavy burdens of culturally defined meaning in Java. If you are observed with food, whether raw or cooked, you must offer part of it to your observer. This axiom of generosity produces predictable reactions.
Excessive public generosity with food results in the use of food offers to express generosity no matter how hollow. The converse, hoarding, surreptitious consumption and extreme gluttonous measures to avoid being seen eating are also found. Additionally, most foods can be ranked for their associated status. Higher status foods are generally more expensive, imported into the village or at least purchased, while lower status foods tend to be grown locally. They have low market value and may be directly gathered from the local environment. People with high status should be served food of equally high status and are presumed to consume only the best foods. It is a source of embarrassment for a low status individual to be caught eating low status foods by a high status individual.

Ten months of conspicuous public consumption of steamed cassava had not dispelled the idea that I dined on roast beef, cake, and cheese, as Dutchmen were supposed to. This complex of food beliefs, plus the tendency to justify low status snacks as not really "food" but just something to fill the stomach while waiting for real food, challenged the probability of a successful conventional diet survey. Not only would the one-on-one observation and weighing of individual meals be culturally repugnant, but the association of many common foods with low status might encourage imaginative reporting of unseen meals.

I improved the quality of the dietary information by making two visits in two days of each of the three seasonal surveys, developing a personal gift-giving and joking relationship with each of the 43 households and focusing on the reporting of complete recipes. A 20 percent sample of two of the hamlets stratified by differences in
economic resources was based on my earlier census. The goal was to get an indication of the effect of the seasonal round on the consumption of relevant foods through a sustained friendly relationship, encouraging people to be relaxed and honest in reporting the food they were eating.

To preserve continuity, I and the same research assistant made each of the 258 visits, pointedly joking about the stains still visible on my hands from gathering taro leaves and the high cost of coconut milk in America. We arrived unannounced at the midmorning cooking time the first day of the survey and explained to the cook that we were interested in the eating habits of the household. Using their categories for types of foods, we asked general questions regarding foods they were eating in this season and the meal pattern of the household. Then we asked for complete recipes of the day's cooking, including the spices and oil. Initially the cooks seemed to have difficulty focusing on the questions which asked specifically what they had eaten for breakfast. They much preferred to answer in the ideal rather than answer that they drank tea with sugar and snacked on steamed cassava root. Initially they answered, "Well, if we like something, we eat it and if we don't, we won't." We circumvented this tendency to generalize by asking the cook for detailed recipes within hours of the time she cooked. We told her to remember any guests or household members who ate out for this day and the next since we would return the following evening to complete the food register for the two days. My impression after closely observing the entire survey is that the data still underreports some low status foods, cassava roots in particular, but that the method of eliciting
recipes soon after preparation provides an adequate basis for evaluating the frequency of consumption of foods involved in goitrogenesis. Since portions are largely dictated by custom, the pattern of individual variation in consumption was assumed to follow that rigid pattern.

**Household Processing.** In rural Banjarnegara, as in all human communities, vegetable and animal material defined as human food is highly modified before consumption. These modifications can potentially change either the acceptability or content of goiter-related foods. Procedures likely to cause a chemical or physical change in the amount or availability of iodine and goitrogens received special attention. Continuous residence in the village and familiarity with many of the cooks afforded repeated opportunities to observe, interview and record with camera and notes the various complicated processing involved. I focused on household level activities where foods were processed for household consumption or for resale. In particular, local customary definitions of what was refuse and what was consumable were carefully observed, as were the plant parts included in the preparation of snacks, duration of soaking, sun drying, baking, or frying.

**Individual Consumption Patterns.** The supply system at the community and household levels notwithstanding, it is the individual who ultimately eats. Therefore, several methods were directed at the individual scale to aid further understanding of the complex of factors affecting iodine and goitrogen consumption by individuals in
the endemic goiter community. One group of goitrogenic chemicals occurring widely in the Cruciferae family are the thioureas. The ability to taste these bitter chemicals is inherited separately from other taste abilities and has been associated with varying risk of nodular goiter and reduced neuromotor coordination in endemic goiter communities. One of the field methods executed shortly after my arrival in the community assessed the population's ability to sense measured salt solutions and solutions of these goitrogens using a volunteer sample of 547 men, women, and school children. I used a field modification of the widely used Harris and Kalms technique. Fifteen months later, after a public health mass injection of the population with iodized oil (Lipiodol), 411 of the original volunteers were retested using the same technique and solution concentrations.

A scaling exercise explored individual's vegetable preferences resulting from the interplay between ability to taste and culturally directed patterns of vegetable consumption. A subsample of 50 school children who had taken both the taste tests scaled a collection of snapshots of vegetables common in the village. The exercise sought frequency of consumption and tastiness ratings on a seven point scale. I used school children because adults in the village with little exposure to two-dimensional representations could not associate the color snapshot with the object, for example, cabbage, despite the frequency of consumption. A bonus with this school sample is that children were much more frank about their food dislikes than adults.

My two year residence in the village accompanying the more formal survey procedures suggested new questions relevant to the process of goitrogenesis which could be included in the surveys, and provided a
basis for evaluating the data gathered by survey and generated data which could not have been gathered by formal means.

**Cultural Ecology: Model for Data Gathering**

This research grew out of several years study of what has generally been known as cultural ecology. This school of thought, developed in anthropology, holds that cultural variety—the multitude of technologies, organizations for work and play and even religious and philosophical beliefs—is not just decorative or interesting in itself, but serves a "higher" evolutionary purpose as suggested by Darwin. All human activity is ultimately held to be "adaptive" or functional in keeping the particular population alive, maximizing their harvest of consumable minerals and energy from their environment. A considerable number of cultural ecology studies have focused upon disease as one of the important environmental challenges man must meet not only with a biological response, but also a complex cultural response. Although there is wide agreement throughout the cultural ecology literature that culture is adaptive in the biological sense, that the capacity for culture has enabled the phenomenal growth of human population, our ability to explain the process of adaptation, or exactly why any particular cultural adaptation is successful, or measuring the degree of success is still very unsatisfactory. In short, there is no overarching theory or model a cultural ecologist shares with his fellows. The commonalities among the subset of biocultural studies as delineated by Bennett, Osborne and Miller are:
1) The focus is upon specific individuals and populations as a unit.

2) There is a multidisciplinary frame of reference.

3) They study specific human behavior, not generalized norms or averages.

My study shares most of the above mentioned characteristics. I observed and documented a particular place, a particular population and a cultural adaptation to a local disease hazard, endemic goiter. My background in cultural and biological anthropology and medical geography heavily influenced the choice of data and the methods used to retrieve it. The study methodically investigates cultural behavior patterns relating to the distribution and consumption of goiter-relevant foods at three levels of generalization, the village as a whole, the households varying by resources, and individuals. I included an assessment of the role of potential genetic adaptation to some of the disease factors by including formal taste evaluation for several of the relevant chemicals.

Man is able to co-operate with others of his spicies to a degree unknown to other animals. By importing and exporting commodities, he mitigates the limits of any particular environment. Herein lies the fallacy of simple coincidence mapping of disease and mineral abundance in a single area. Man also selects and rejects items from the wide range available in the environment and distributes these chosen items very unequally throughout the population by attributing unequal values to them. The medical geographic approach utilized here incorporates
much of the above mentioned character of a cultural ecological study while maintaining several time-honored approaches in geography. As with other geographic studies of place, this study has considered details of people-environment interactions in the particular place and it has integrated data and literature from several different academic spheres within a single area to attempt to explain the unique etiology of endemic goiter in the highlands of Central Java.

Formal Food Categories, Area of Origin: Research Tools

A community receives most of its supply of minerals from food. Certainly, in the western world, even for rural populations the source of food is far from exclusively local. But much more traditional communities in developing countries have long participated in extra-local food and goods exchanges with other areas, thus diversifying their resource environments. It is unwise in a disease study to assume that a traditional population is restricted to its own local area for mineral and food resources.

The relevant foods in this case study were categorized by both botanical family and area of origin in order to specify their contribution to endemic goiter. I included vegetables in the study based on their inclusion in a botanical family whose many members have been implicated in goitrogenesis in other studies. The three most commonly implicated families are: Cruciferae, Umbelliferae and Leguminosae. Area of origin as a second classifying device indicates the iodine or goitrogen contribution the food will make, seafoods reflecting their iodine-rich environment and goitrogenic vegetables
varying in goitrogenicity depending on the mineral composition of the particular soil they grew on. In Indonesia little soil mineral analysis has been done and what information there is must be extrapolated from other areas.

**Conclusion**

This study re-examined the etiology of goiter from the perspective of cultural ecology using an analytic case study approach to a particular goitrous community where the suspicious factors were present, notably, low mobility, underdevelopment, poverty, and a diet rich in cabbage and other goitrogenic vegetables. Early efforts in the field were those that required minimal language and cultural skills, such as cadastral mapping, garden surveying, and market surveying. The most delicate social surveying such as census and diet were left until a considerable amount of participant observation had taken place. Doing research in a cultural context other than one's own necessitates patience and investment of much time and effort. The 22 months spent in the goitrous highland community was an invaluable resource of experience with which to understand and interpret the quantitative data.
References


CHAPTER III

THE RESEARCH SETTING

Abstract
This chapter describes the geographic setting of the case study village establishing it as one of many similar villages rimming the Dieng Plateau in Central Java, Indonesia. As such, discoveries regarding the etiology of goiter in the case village can be extended to villages of this type. The context of goiter here is rural poverty and population density resulting in general under-nutrition. Infrequent travel and heavy dependence on the local area of recent volcanic origin limit nutrient resources to foods produced or purchased locally. An appreciation is developed for the multi-faceted nature of goiter causation to be found in the interrelationships of the people and their environment.

Indonesia: A Population and its Health

The Third and Fourth Indonesian Five Year Plans\textsuperscript{1,2} cite health and population among the greatest problems they have to solve. Despite a decade of concerted population control efforts, the
relatively youthful population of over 140 million has a very high fertility potential and continues to grow at a rate of 2 percent per year\textsuperscript{3}. The quality of life in this fifth largest populated country on earth is hazarded by continuing problems of malnutrition. Four of the health problems identified had their basis in under-nutrition.\textsuperscript{4} These are goiter, generally believed to be caused by iodine deficiency, xerophthalmia, a blindness caused by severe vitamin A deficiency, anemia caused by iron shortage, and protein-energy malnutrition. On a basis of spot surveys, each is believed to have high prevalence over the archipelago. As in many developing countries, Indonesia's infrastructure and services, including nutrition and health services, were until the early 1970's concentrated in the capital city. Since then, much progress has been achieved in staffing rural health centers with dedicated doctors, nurses, dentists and nutrition educators. Despite the improvements, however, the most recent five year plan reiterates the need to deal with these nutritional problems.

Of course, the health problems of Indonesia are the direct result of larger economic and population and resource ratio problems. Sixty-five percent of the population lives on Java, creating rural densities in Central Java of over 700 per square kilometer. The sparsely populated outer islands create 94 percent of the foreign exchange through mineral and oil exports.\textsuperscript{5} This resource and population disparity in addition to the diversity of languages and traditions create tensions in the archipelagic nation.

Nutritional deficiency diseases such as goiter are more than an indicator of underdevelopment. They may themselves impede development. Greene, for example, has described the vicious circle of
poverty and discrimination which maintains goiter and cretinism in a population of the Bolivian Andes. The ethnic image of stupidity and uncoordination, perhaps based upon observation of goiter and cretinism, maintains the Indios in poor paying jobs, insuring they will not be able to buy the next generation's way out of the disability.

Malnutrition is a pervasive problem in Indonesia. Small body size, for example, is taken for granted. Children's growth rates and achieved adult heights are commonly used as indices of nutrition. Rose and Gyorgy observed that the contemporary growth curve of Javanese males is comparable to that in Japan at the turn of the century. Of course, with improved diets after World War II, Japanese growth patterns and achieved height have changed dramatically.

A nation wide survey for nutritional blindness conducted at the same time as my research found 3.2 to 9.6 cases of active corneal disease resulting from vitamin A deficiency per 10,000 throughout the archipelago. The author estimates that over 800,000 new cases of vitamin A related eye disease develop each year in Indonesia. Most are pre-school children and many will become permanently blinded.

Thus, although endemic goiter will be isolated here for analysis, the reader should not forget that the context of this one nutritional problem is the more general problem of insufficiency of all the nutrients, that is, not enough food.

Infants and children are particularly susceptible to the irremediable damage caused by insufficient calories, protein, vitamin A, and iodine, since their needs per unit of body weight are so much higher than adults' needs. Therefore, the identification of nutrition
improvement as a development goal in Indonesia's most recent five year plan where one chapter is entitled: "Staples and Nutrition Improvement"², is a hopeful first step in breaking the vicious circle of ill health and poverty.

Unfortunately, the recent program to eradicate goiter in Indonesia is based on the premise that it can be eradicated by technological means, that is by iodine supplementation, entirely divorced from changes in cultural behavior and the general state of the economy.⁴,⁹ A major theme in this research report is that isolation, a dependence upon a local area for food, customs and unequal access to resources are all involved in the cause of endemic goiter in the highlands of central Java and probably elsewhere in the Indonesian archipelago. Efforts toward the elimination of goiter would better be based on a model of disease causation which approximates more closely the etiology of the disease.

Dutch doctors and public health personnel surveyed for goiter extensively in the first quarter of the twentieth century and, on the basis of the evidence of a serious endemic situation, they implemented an iodized salt program in 1927.¹⁰ This salt program has been largely ineffective since World War II. Although there is still a salt iodization plant in Madura, iodized salt is sent to the regions only on request. When Soewondo investigated in 1964 there were no such requests.¹¹ His study documents the degree to which for 30 years following the Japanese invasion with the foment of the struggle for independence and the economic and political difficulties of the young republic, the goiter problem became invisible.

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Nevertheless, since 1970, there has been a resurgence of interest in endemic goiter in the archipelago. Jumadias, and colleagues surveyed 7,000 school children from 99 villages throughout Java, Sumatra and Bali and found that between 60 and 90 percent of all primary school children had first and second grade goiter. A subsequent study indicated that the prevalence rates found in this survey were probably underestimations of rates in the general population. In the highly endemic situation in the well known classic goiter area of east central Java, where total population prevalence was contrasted to the prevalence in school children, goiter prevalence peaked in the 30-40 age group with 97.5 percent prevalence.

Since 1975, under the direction of the Department of Health and with the supervisory and professorial skills of Dr. Djokomoeljanto, several members of the health team from each subprovince in Java and many from the outer islands have attended brief seminars at the medical school in Semarang in the techniques of conducting goiter and cretinism surveys. The heightened awareness of these newly trained surveyers to the problem has caused a virtual explosion of information about the prevalence of endemic goiter in Indonesia. Early reports indicated that it was concentrated mainly in mountainous districts, far from the sea, but upon closer examination, communities suffering from severe goiter and cretinism have been found within a few miles of the south coast of Central Java. In December, 1978, Dr. Djokomoeljanto convened the first Indonesian goiter conference, and invited doctors and health workers from many areas of the archipelago to gather and exchange information on the subject. He perceived that the information explosion about goiter prevalence had far outstripped
the progress of its analysis. The meeting produced numerous reports on pockets of recently discovered goiter, examination of secondary community symptoms such as deafness and other neuromotor development problems and follow-up studies of several small prophylaxis projects. It was a fine stimulus to further research and public health efforts.

Although dated, the map of goiter discovery sites from Dr. Djokomoeljanto's dissertation, seen in Figure 3.2, gives some indication of the extent of endemic goiter in Indonesia. Virtually no island is unaffected.
The Village Site

Access

Prigi, in the sub-province of Banjarnegara, is one of a thousand peasant villages located on the periphery of the Dieng Plateau (Figure 3.3). This 2,100 meters high, geologically active and sparsely inhabited area is in the center of densely populated Java. The villages in question are located a little lower, within the altitude range of coconut cultivation, whose products constitute one of the major trade items exchanged with the higher Dieng area for their more temperate produce. Soil in the plateau is very fertile, but the extreme cloudiness and cool temperature limit the production of the usual Javanese crops. Limited iodine and high sulfur in the relatively new volcanic soils is not a barrier to crop growth. In fact, the soil is an optimal medium for the cruciferous crops the area is known for. Cabbages, potatoes and carrots are in great demand and increase rapidly in price as they are shipped to distant coastal cities. But the robust health of the cabbage fields belies the health of the human populations in the Dieng Plateau and surrounding villages. Cabbage consumption becomes a part of the general problem of iodine deficiency disease. The Prigi study will be used as a detailed example of the health problems resulting from the settlement of this iodine deficient and cabbage abundant area. By understanding the food choices of Prigi's population we can explore some unique aspects of the etiology of endemic goiter there.

The six hamlets of Prigi lie on the steep slopes of the Serayu River valley at an altitude ranging from 350 to 500 meters above sea
Central Java Showing the Dieng Plateau and Research Site
Figure 3.3
level. The Serayu River originates in the Dieng Plateau to the north and flows rapidly at Prigi in its southwest course to the sea. The river has cut the steep valley which provides slopes for rice terraces and permits the gravity-flow irrigation system. This area has not benefitted from the year-around agriculture made possible in other areas of Banjarnegara by the medium-sized dams and irrigation works built under the Dutch. From the narrow asphalt road which crosses the river lush irrigated rice terraces are visible. The Serayu river also serves as a constant reminder of its source-land, the cool temperate Dieng Plateau where rich young volcanic soils produce a complex of temperate vegetable crops so important to the diets of tropical villages, like Prigi, which circle the Plateau.

Prigi lies 17 kilometers from Banjarnegara, the small sleepy capital of the subprovince of the same name. Although technically under the administration of Banjarnegara, Prigi's orientation, in various respects is 30 kilometers to the northeast, to the bustling market town of Wonosobo, collection point for the temperate climate crops grown in the plateau. Wonosobo is also the departure point for domestic tourists who come to see the lavender lakes and steaming geysers. Prigi's affiliation with the subprovince to the east can also be read in the house styles, or marriage patterns, but it is most apparent in the diet.

The narrow asphalt roads of Java travel mostly east and west and were originally built for another age of horses and bullock carts. Between Prigi and the north coast with its very large cities of Jakarta, Semarang and Surabaya, the foci of modernization, lies the
The impassable Dieng Plateau region. The Indian Ocean is only 50 kilometers to the south, but three mountain ranges away with no asphalt roads. Access to this rural interior of Java is still difficult, time-consuming and dangerous. With the introduction of small Japanese trucks in the 1970's, transport east and west has become more rapid if more dangerous, while north-south traffic is as difficult as it was 80 years ago. In the second decade of this century, the Dutch administration directed the construction of both a railroad and the narrow asphalt road following the winding path of the Serayu river. These remain the only means of access to the outside world for the population of Prigi. However, the role of each has changed in the 80 years. Until the late 1960's the railroad was the primary means of transporting agricultural produce and people. The road was largely the domain of people on foot, riding a bullock cart or aboard the occasional touring car. Since 1970, small Japanese trucks and motorcycles have revolutionized the transportation of people and produce. The train is a single car, usually empty, that puffs past the village morning and evening. All produce arrives or departs Prigi via the road.

Effective distance from Prigi to the iodine-rich sea is considerably greater than a map of the island of Java indicates. The closest seaports which could potentially supply Prigi with sea products are Cilacap on the south coast and Semarang on the north. The direct distance is roughly 50 kilometers to either the Indian ocean or to the Java sea. However, the absolute distance does not reflect the difficulty of travel over single-lane rutted roads clotted with the many kinds of vehicles traveling at breakneck speed. The
real distance in hours is approximately four, and five and one half hours, respectively. Thus the marketing of fresh sea products to the interior of Java is still impractical. Seafoods available in interior Java are still the traditional dried, salted and fermented forms. Canned and frozen sea products are still not widely available in Indonesia and, in any case, could not be afforded by the mass of interior peasants.

Water Quality in Prigi

Several investigators have pointed to excessive calcium and certain microscopic life forms in drinking water as contributors to endemic goiter. For this reason, water quality must be considered in the sources of the high goiter rates found in interior central Java. Drinking water supplies of the villagers are a combination of springs, wells, and surface waters. Preference is clearly the spring water. A particularly valued spring is fitted with a bamboo pipe and the water transported as far as a mile for domestic use. Surface waters are used only if there are no springs or wells. A point high above the dwellings will be chosen because it is believed to be pure, and a similar system of bamboo pipes constructed. The system represents considerable investment in construction and maintenance, for in this climate the bamboo pipes must be replaced every six months. Wells are considerably more expensive than either of the previous methods and are dug only by wealthy households. Occasionally the well will be used communally by the cluster of neighboring houses.
In Prigi, samples were drawn from a representative number of the water sources of the village both in June and again in September of 1977, for analysis at the laboratory of the NUFFIC Gadja Mada Serayu Valley Project in Yogyakarta. These samples were drawn at the end of the rainy season (June) and at the end of the dry season (September), respectively. During the dry season sampling, between one third and one half of the water sources in the village were found to be dry, and mineral concentrations in the remaining sources can be expected to be highest. Only mineral content can be reported, for the NUFFIC lab did not test for biological factors. Calcium levels ranged between 2.5 and 15 parts per million, equivalent to the lower extremity of the range discovered by Miller in water from a variety of rock types. For a subsample of the sites, both fresh and boiled samples were collected and tested on the presumption that customary treatment of the water might affect the mineral content. The water is always boiled in an aluminum or copper kettle and stored in a pottery or plastic container. Many variables increased slightly with household treatment, among them pH, electrical conductivity, SiO₂, K, Na. Proportions of CO₂ decreased. This decrease in a carbon compound suggests that the common red precipitate observed in stored boiled water was a carbonate, possibly including calcium. Calcium levels, therefore, are not excessive in fresh water samples and can only decrease with boiling and storage. Excess calcium from drinking water, implicated in endemic goiter elsewhere, does not appear to be implicated in the high goiter rates here.

Biological factors in the water are one of the more speculative contributors to endemic goiter mentioned in Chapter I, but cannot be
ruled out. Although food is predominantly cooked and water is universally boiled and made into tea, dishes are washed in fish ponds behind the house which serve more as dump sites for human wastes of all kinds than as sites for fish cultivation. Glasses freshly dipped in the fishpond may be filled with cooled tea, insuring the recycling of intestinal parasites. Thus although excess calcium from drinking water is an unlikely cause of endemic goiter in the area, biotic factors in food and drinks may be a contributing factor.

Endemic Goiter

Goiter prevalence is high in the Banjarnegara-Wonosobo area. Generally the goiters are of the diffuse rather than the nodular type, and are observable only as considerably thickened necks. The people of the area consider thick necks normal and apply the disease term, gondok, only if the goiter has produced conspicuous or odd shaped lobes. Goiters in the highland Dieng region are commonly of this more dramatic form, indicating more severe endemic goiter there.

A survey of Prigi and a neighboring village by the Department of Health in mid-1976, in anticipation of distribution of iodized salt, provided uncommonly good statistics on the goiter endemic in Banjarnegara. Population prevalence of goiter grade OB and larger is 62 percent in Prigi. Prevalence is unequal between the sexes. Some 90 percent of females of all ages exhibit a goiter size OB or larger while only 30 percent of the males surveyed had such goiters. Of the large, conspicuous sized goiters (grades I, II, and III) 36 percent of the women suffered from them while only 7 percent of the men had
goiters in these grades. This disparity in the prevalence between men and women is common the world over, for women have higher frequency of all kinds of goiter. The same survey discovered 42 cretins in Prigi's population of 2,590. However, many of these individuals may have been mentally and physically defective for reasons other than iodine deficiency. Based on extended residence in the village and considerable acquaintance with all hamlets, I estimate the maximum number of cretins in Prigi at no more than ten.

The data from this simple survey were not recorded by area. However, one of the public health nurses who conducted the survey told me several months later that he was puzzled over his impression that there was less goiter in the upland hamlets, but more cretinism there. This observation would be an anomaly but for my suspicion that there was considerable misclassification of other developmental defects such as deafness and mental retardation due to other causes under the label of cretin. This is to be expected with a team not expert at diagnosis of cretinism, a task which still challenges the experts. We are left, then, with his impression that goiter was less prevalent in the upland hamlets. The total prevalence of 62 percent goiter in Prigi is far over the ten percent level required for the definition of endemic goiter.16

External Contacts

Immigration. The existence of the severe endemic goiter in Prigi has been established; it remains to discover its sources. The population of the village is largely indigenous with only 11 percent
of male household heads born outside the village and its immediate neighboring hamlets. Only 4.2 percent came from outside the dialect area. The percentages of foreign derived female spouses is even lower. Only eight percent came from outside the immediate village area and two and one half percent from outside the dialect area. This reflects the difficulty of travel to distant areas which held true until very recently. Another aspect of difficulty of travel is that dialect boundaries are close together in Java. I found different terms were used for food and furniture items only 30 kilometers from Prigi. Thus the population of Prigi is fairly homogeneous genetically. Its high prevalence of goiter cannot be explained by immigration of goitrous people from other areas.

Mobility. Despite the recent availability of transportation via passenger trucks along the road, most residents of Prigi travel to Wonosobo or Banjarnegara cities, distances of 15 and 7 kilometers respectively, at most once or twice a year. Except for the village elite who send their children to junior high school in nearby towns, a more distant journey would be the event of a lifetime. The life of Prigi residents is lived very close to home, and any food and water consumed is obtained within the village. Despite this major sedentary pattern, there is a new, as yet minor, trend for teen-agers of both sexes to seek temporary work as maids and factory workers in distant urban areas of West Java.

Telecommunications. Radios and television sets operated in the village by rechargeable car batteries provide another mode of
communication. The census recorded 138 radios, 13 tape-recorders, and 8 television sets in the village of 520 households. These devices expose the villagers to one of the most influential forms of education known—product advertising. The low percentage of households which own a television set does not represent the exposure of the population to that medium. In December, 1976, there were only two television sets in the village. Their owners were considered so elite that most people were hesitant to ask to watch the set. But by November, 1978, the number of households with television sets had grown to eight. The new owners were more democratic than the earlier ones had been. Large crowds occupy their front rooms beginning at 5 p.m. when the single station from Jakarta begins transmitting via satellite to the entire archipelago. Until the transmission ceases at 11 p.m., crowds of sarong-swathed young people will gaze through their front-room windows at unmodified transmissions of "Hawaii Five-O" and cartoons such as "Mighty Mouse" and "Daffy Duck." Only the commercials are certain to be in Bahasa Indonesia, the national language. Young people are the most likely to absorb the messages since they have had exposure to Bahasa in their brief stays in the elementary schools in the village.

Radio programming received in village central Java is extremely diverse in language and country of origin. Most common are Indonesian broadcasts using Bahasa Indonesia or Bahasa Jawa, or a mixture of the two. However, many European language programs are beamed to Indonesia from Australia, Russia, China, and France. Radio programs also carry substantial advertising.
The Village Economy

Land Ownership

Since the village encompasses land ranging from 350 to 500 meters above sea level, in an area roughly 30 square kilometers, the slope is steep and much of the agricultural land, irrigated or not, is in terraces. A variety of land use types in the village are based upon water supply and history of land modification. Well-watered terraces are devoted to rice production. Since irrigation is a simple gravity flow system through carefully maintained mud channels, the best riceland (sawah pengairan), which can be planted twice in a year, is predominantly at the lowest border of the village, presenting a view from the road of verdant rice fields. Other terraces higher up the slope are planted to rice in the rainy season, but to dryland crops such as peanuts or maize in the dry season. Kebon and tegal are two land use types never planted to rice. Kebon is a garden near the house of the owner and planted to a mixture of highly valued tree crops for export, such as coffee, cloves, coconut, fruits, and mixed vegetables. These kebon present the classic picture of a mixed-level forest garden. Tegal, by contrast, tend to be farther from the houselot and these plantings show less variety and structural complexity. Usually cassava, maize, and beans are the crops on these drier plots.

Farming is the single most important economic activity in the village. Access to the land is through ownership, rental or a variety of share-cropping arrangements. Although fifty percent of all household heads indicated farming as the major source of their
livelihood in the census I conducted, the figure falls to 35 percent if the criterion is farming of one's own lands as the major source of income. The distribution of land ownership in the village is highly inequitable. All wet riceland (sawah), and kebon, the most lucrative land parcels, are owned by less than one quarter of all households. Even these figures do not reflect the great chasm between the small elite group and the mass of the village population. Many underreported the area of land they owned. Certainly 90 percent of the households own less than half a hectare of wet rice land. The elite ten percent of households owning more than half a hectare of sawah also plant more than a hectare of kebon to profitable export crops. By contrast 64 percent of the households owned tegal and 35 percent owned ricefields which can only be planted once a year because of their lack of irrigation. In these land holdings the parcels are very small.

Land Fragmentation

Although the hamlets are nucleated, and houses are very close together leaving wide expanses of fields, fragmentation of agricultural lands is intense. In a land use survey I conducted in one hamlet, stratified by house-type, the poorest households owned an average of 1.6 parcels of land in addition to any houselot they had. Fragmentation increases with wealth as far as the second most affluent group, which had an average of 5.7 plots of land worked by a single household. The most elite have not only the best land, but it tends to be in fewer parcels, since the average worked in this group was only 3.6 (see table 3.1).
Table 3.1

Parcels of Land Owned Exclusive of Houselot

<table>
<thead>
<tr>
<th>Economic Level of Household</th>
<th>Household Sample (n)</th>
<th>Average Number of Land Parcels per Household</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elite</td>
<td>6</td>
<td>3.6</td>
</tr>
<tr>
<td>Upper Middle</td>
<td>6</td>
<td>5.7</td>
</tr>
<tr>
<td>Middle</td>
<td>25</td>
<td>2.4</td>
</tr>
<tr>
<td>Lower middle</td>
<td>56</td>
<td>1.9</td>
</tr>
<tr>
<td>Poor</td>
<td>20</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Non-agricultural Income

Despite the overwhelming importance of agriculture as the economic base of the village, most houses have some income that is not strictly agricultural, and only half of the household heads reported agriculture as their major source of income. Nevertheless, non-agricultural activities are not conspicuous in the village, so it remains to be seen how the 65 percent of households who do not claim farming of own lands as their major income source make a living. Only six percent of household heads work at a job such as elementary school teacher or bank teller, where regular wages can be expected as remuneration. This group commute to work every day in nearby population centers. Another 7.8 percent claimed a skill such as carpentry, stonemasonry, or barbering. These activities are carried out in the village on a contract basis, the payment not infrequently being in goods or services. The single largest group (13 percent) labelled themselves in the work category the Javanese call buruh, literally suggesting they would do anything, any work. Often the
buruh is followed by a modifier narrowing somewhat the range of work that might be done. The 11 percent who claimed to have no work probably also belong here, as do many who may have temporarily found a job. At the time of the census, the buruh group was largely involved in exploiting common resources by investing their time and muscle. Many carried heavy baskets of river stones and sand slung on a pole over their shoulders, products destined for household renovations ordered by the central provincial government. Others were illegally harvesting national forests for firewood or building materials, both village exports.

I suggest these major sources of income for households as an indicator of the kinds of economic activities common in the village. In fact, the income of most households is a patchwork of efforts ranging from washing a rich man's cow to selling the tailfeathers of a duck to an itinerant buyer from a shuttlecock factory. Although women tended to see their activities as non-economic and thus underreported them, 29 percent of spouses of household heads reported involvement in the household-based processing and peddling of snacks. Another 18 percent work in agriculture, largely in the backbreaking transplanting, weeding and harvesting of rice. This figure must reflect a recent reduction in traditional jobs for women in agriculture by the introduction of two new items of technology in rice agriculture, sickles and the motor-driven rice mill. Both of these innovations occurred within the last decade concurrently with the introduction of the new IRRI rice varieties. Traditional rice varieties are still harvested by women with the aid of a tiny hand knife, one panicle at a time. The new varieties, now a majority, are
harvested by men or boys using a sickle and are threshed in the field by beating on a rock placed over a piece of plastic sheeting. Rice hullers have all but replaced the hand pounding of rice. Only a few women mentioned rice pounding as an economic activity. At many houses, the discarded rice pounders lie out in the backyard junk pile. Secondary sources of income for household heads, their wives and other workers in the household were caring for animals—usually a single cow or a gaggle of ducks, peddling prepared snacks, and of course, buruh.

The top ten percent of the households are excessively elite by village standards by virtue of owning the only productive property in the village—the good land. Households that have poor land or none at all must survive by supplying labor and time in the form of prepared food or river stones to the 15 percent of households that are surviving nicely with their professional or agricultural endeavors.

The Agricultural Calendar

Because of reliance on the gravity-flow irrigation system, the rhythm of Prigi's agricultural events strongly reflects the rainfall pattern. The average monthly rainfall data reveal a distinct dry season between June and October. The agricultural calendar in turn affects the economics of consumption of all kinds, including diet.

The climate is generally classed as "Am", a humid tropical climate, originally occupied by a rain forest despite a dry season. The nearby Dieng Plateau area is classed as "Cf", temperate with precipitation in all months. This sharp climatic change has important agricultural implications for the villages of the Dieng Plateau and those nearby. Prigi is one of hundreds of villages
ringing the plateau just within the permissible climate and altitude for growing coconuts and rice. Above that altitude the economic crops are tobacco, cabbages, maize, potatoes and onions. The sharp distinction between their products makes villages in these two climatic types mutual trade partners, each one highly valuing the other's products.

The Javanese use several calendrical traditions in addition to the Gregorian calendar. Some of the traditional calendars reflect the agricultural cycle and the climate it is based upon. One such is the manggal system which divides the year into 12 unequal sections called manggal which ranges in duration from 23 to 43 days (Figure 3.4). The manggal are closely attuned to the amount of rainfall and the seasonal prevalence of rice pests. Accompanying the manggal cycle are directions for agricultural preparations which anticipate the seasonality in rainfall and pests. For example, it is important when planting rice to plan to avoid harvesting the 11th and 12th manggal in order to avoid insect pests and to avoid ripening the fourth manggal because of bird predators. The system is attuned to the events in the larger solar system as well as local climate. June 22 and December 21 divide manggal. Thus the calendar can be read as a cultural map of the behavior of the Javanese farmer whose agricultural success and very survival depends on his ability to anticipate the seasons. Harvests and thus prosperity in this largely agricultural village are strongly seasonal and availability of produce for local consumption and for sale hinge on rainfall.
Average Monthly Rainfall Pattern of Java

Figure 3.4
The Two Hamlet Types

The six hamlets of Prigi can be divided into two types based on their ease of access to the outside world and their resource base. The lowland hamlets closest to the river benefit from the gravity flow system which channels the runoff from the uplands to the lowlands and permits the growing of sawah year round. These lower hamlets too are closer to the road and have for long had more direct communication to the outside world than the upland hamlets. The village administration is located here as are the only two elementary schools. As might be expected, the educational level is higher in the four lower rice-based hamlets as is the number of residents who commute to nearby offices to work for wages. The upland hamlets are by every index more conservative and are more impoverished looking. The upper hamlets have little sawah, even during the rainy season. Their drier lands are planted in maize and cassava. The non-agricultural jobs are gathering coconut sap and the making of coconut sugar, plus the harvesting of sago palm starch. The houses are more traditional and less likely to be painted. Here in the conservative upland hamlets, the traditionnal rural music, dance and martial arts are still valued and practiced. People are more likely to use the traditional midwife than to seek a public health nurse when the journey is an hour on foot.
before one can board a bus. Children from the upland hamlet based on cassava rarely attend school because their parents say the journey to school is too long and it is rumored there are evil spirits near the schoolhouse.

Table 3.2

Economic Levels of Households Defined

<table>
<thead>
<tr>
<th>Hamlet types</th>
<th>1976-1977 Agricultural productivity in Rupiah*</th>
<th>House type</th>
<th>Consumables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ia</td>
<td>Rp150,000</td>
<td>cement floor, brick walls</td>
<td>television, motorcycle</td>
</tr>
<tr>
<td>Ib</td>
<td>Rp 30,000–150,000</td>
<td>wood house</td>
<td>large animal, radio</td>
</tr>
<tr>
<td>Ic</td>
<td>Rp30,000</td>
<td>bamboo walls</td>
<td>wood bed, table</td>
</tr>
<tr>
<td>Upland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIa</td>
<td>Rp25,000</td>
<td>wood, glass windows</td>
<td>large animal, radio</td>
</tr>
<tr>
<td>IIb</td>
<td>Rp15,000</td>
<td>bamboo walls</td>
<td>wood bed, table</td>
</tr>
</tbody>
</table>

*In January, 1978, $1 U.S. was equal to 411 Indonesian Rupiah.

Thus within the same village administration there are really two lifestyles, the more modern "connected" rice-based agricultural hamlets in the lowlands near the road and the backward and poorer cassava and maize based hamlets in the uplands whose water is diverted to lowland sawah in all seasons.
Throughout this report, the economic levels in the village will be divided into five categories, three in the lower rice-based economy and two in the dry upland economy. The two lower levels of the rice hamlets do not correspond in their resource use or in their consumption habits to the two economic levels in the upland. Extremes of wealth are greater in the lowland rice-based hamlets than in the upland. The five economic levels are based on statistics of land and possessions derived from a total household census I conducted in 1977. Table 3.2 is a breakdown of the agricultural productivity and owned items that distinguish the five levels.

Occasionally economic and behavior patterns of two of the economic levels coincide, but overall, their interaction with the goiter-relevant environment differs significantly.

Consumption Patterns

Although rice, coffee, cloves and fruit are major exports from the village, their consumption by the population is restricted by the poverty of 85 percent of the households. These items are prestige foods and operate at the level of the ideal diet, to be achieved only at feasts (selametan). They are consumed on a regular basis only by the elite. The bulk of the population drinks tea, and alternates cassava and maize with rice for the staple in their meals. Only seasonal harvesters consume small quantities of fruit.

Dried fish and spices, a variety of vegetables, soybeans, canned milk, sugar and oil are imports that must be purchased. This limits their consumption by the poorest of the population. However, the status of these foods is mixed and depends upon the perspective of the particular stratum considered. The fermented soybean cakes (tempeh),
are eaten universally. For the rich, consumption of soybean cake is neutral and a matter of course; for the poor it is a luxury, and its high status dictates that it is allocated very carefully within the household. Dried fish, on the other hand, is an expensive high status food to the poor, but a low status food to the rich, who choose to eat more expensive local chicken, beef and egg protein most seasons of the year.

Food shortage is noticeable in the slow growth rates of children both of pre-school and elementary school age. Adult body sizes are short and spare, a result of food shortages over the last 50 to 70 years. Very thin children and adults were occasionally singled out to me with the comment they were *segar*, meaning fresh or filled out. This suggests that they are distinguishing finely among levels of gauntness. Alternatively, the few people in the village who carried any degree of body weight were regarded as beautiful and necessarily of high status.

One of the most frequently expressed worries by parents of all economic classes is that their toddlers will beg for expensive foods their parents cannot afford. Thus child training consists in part of convincing the child never to admit hunger or desire for food. This early childhood experience underlies the adult rituals of hosting and guesting wherein the host repeatedly urges his guest to consume the offered sweet tea and snacks while the guest, no matter how hungry or thirsty he may really be, refuses vigorously the requisite number of times.

These comments and observations are offered to suggest some implications of national data which indicate that after several
five-year plans that have emphasized rice sufficiency, food production does not meet even effective demand. Indonesia is the world's largest rice importer. The latest five year plan suggests developing a more diverse staple base, including maize, sago, and cassava, and a variety of tubers to feed the millions of Indonesians present and future. Clearly goiter is only one of many and perhaps not even the most serious of the food-related problems for Indonesia. After separating out endemic goiter for special attention, I find it necessary to return endemic goiter to its context as one of a number of nutritional problems, before any lasting solutions can be sought.
References


CHAPTER IV

VILLAGE IODINE SUPPLY

Abstract
Three types of traditionally preserved iodine-bearing seafoods are imported into interior central Java. Thus, despite their distance from the sea, goitrous highland villages are not absolutely iodine deficient. Although seafoods must be purchased, the middle and poor resource households eat them more consistently over the year than the elite households. Within the households, the cooking process generally conserves iodine, but women, infants and children, whose iodine needs are higher are less likely to consume seafoods than the higher status elderly and males. The island-wide seafood importation scheme is an ancient response to an iodine-deficient area. Although the system imperfectly allocates the iodine at the household level, the Dieng Plateau and surrounding area should be virtually goiter free.

Introduction

Non-iodine causes of endemic goiter are the primary concern of this research. However, discussion of the adequacy of iodine nutrition in this goitrous community is a necessary background to understanding the action of the goitrogens. It is an unspoken rule in endemic goiter studies that iodine shortage may be presumed from high goiter rates. Iodine sufficiency must be proven. In many studies of endemic goiter, low iodine in the environment is presumed from the
high rate of goiter alone. Alternatively, urine samples may be assayed for iodine content, an individual's iodine intake then derived from output. Urine samples were taken in Prigi by the Department of Health in early 1976 before iodization of the area began, but because of the incomplete laboratory facilities in Indonesia, they have not been analysed. In any case, the interpretation that iodine excretion in the urine reflects iodine intake has been challenged. A clinical study of hospitalized children in Mexico found fecal excretion of iodine much higher than expected and showed no consistent pattern between intake and excretion.¹

In lieu of a direct laboratory method of assessing iodine availability, I developed a method of recording the areal sources of food that came into the village. Thus estimation of iodine supply in the diet is based upon knowledge of iodine distribution in soils, and a literature survey of the range of iodine content of foods in combination with a village survey of food sources. This chapter will evaluate the quality of the iodine supply at three levels of the village system: the whole village, the households which vary by economic resources, and individuals.

Although the iodine content of particular foods varies widely in published analyses, a rule of thumb is that iodine concentration in land plants and animals reflects the iodine concentration of the area of origin.²,³ Except for a few unusual "concentrator plants" such as spinach (Spinacia oleracea), land plant concentration of iodine tends to correspond to the concentration of iodine in the soil medium.⁴,⁵ While most terrestrial plants average less than one part per million dry weight of iodine,⁶ marine plankton and red and brown algae
concentrate iodine from 30 to 1,500 parts per million, many times the concentration in seawater. Ocean fish contain about 100 times more iodine than other meats, and several times more than freshwater fish or anadromous fish that spend a part of their lifecycle in the sea.\textsuperscript{7,8} Table 4.1 documents considerable variety of iodine concentration within seafish. The emerging picture is of the great mineral richness of seafood in contrast to other sources. The sea is a reservoir of iodine nutrition for man.
Table 4.1

Average Iodine Content of Common Seafoods

<table>
<thead>
<tr>
<th>Sea Food</th>
<th>Iodine content(μg per 100 μg fresh weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Marine fish</strong></td>
<td></td>
</tr>
<tr>
<td>Sole</td>
<td>16.3</td>
</tr>
<tr>
<td>Sea bass</td>
<td>25.0</td>
</tr>
<tr>
<td>Sardines</td>
<td>28.4</td>
</tr>
<tr>
<td>Mackerel</td>
<td>37.1</td>
</tr>
<tr>
<td>Halibut</td>
<td>52.0</td>
</tr>
<tr>
<td>Herring</td>
<td>52.0</td>
</tr>
<tr>
<td>Sea perch</td>
<td>74.2</td>
</tr>
<tr>
<td>Cod</td>
<td>146.3</td>
</tr>
<tr>
<td>Haddock</td>
<td>318.0</td>
</tr>
<tr>
<td><strong>Anadromous fish</strong></td>
<td></td>
</tr>
<tr>
<td>Sea trout</td>
<td>32.0</td>
</tr>
<tr>
<td>Salmon</td>
<td>34.1</td>
</tr>
<tr>
<td><strong>Fresh-water fish</strong></td>
<td></td>
</tr>
<tr>
<td>Carp</td>
<td>1.7</td>
</tr>
<tr>
<td>River bass</td>
<td>3.9</td>
</tr>
<tr>
<td>Lake trout</td>
<td>3.1</td>
</tr>
<tr>
<td>River perch</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Shellfish</strong></td>
<td></td>
</tr>
<tr>
<td>Crabmeat</td>
<td>30.8</td>
</tr>
<tr>
<td>Oyster</td>
<td>57.7</td>
</tr>
<tr>
<td>Clam</td>
<td>78.3</td>
</tr>
<tr>
<td>Lobster</td>
<td>102.0</td>
</tr>
<tr>
<td>Shrimp</td>
<td>130.0</td>
</tr>
</tbody>
</table>

Source: Chilean Iodine Education Bureau, 1952, Table 6.
Estimates of the amount of foods required to keep an adult male free of goiter according to 1955 daily recommendations of 100 micrograms of iodine, are given in Table 4.2. The recommended daily intakes have recently been revised upward by 50 percent. In effect this increases the amount of food required to achieve the recommended dietary allowance. Modest amounts of seafood meet the iodine allowance. In real diets, of course, iodine sources are a composite of many foods. Iodine is conserved by the ability of the thyroid to absorb it in excess when it is available and by other conserving processes in the body which recycle iodine after thyroxine has been broken down. Table 4.2 is based upon North American food samples which reflect unusually high levels of iodine in meat, eggs, and milk because cattle and chickens are fed fishmeal. Yet, the pattern is clear. Vegetables are generally poor sources of iodine, as are most land derived foods, while foods originating in the oceans, the iodine sink of the geochemical cycle, are rich in iodine. The Dieng Plateau and surrounding areas are recent volcanic soils and therefore likely to be very low in iodine. Foods grown locally in Prigi or imported from the surrounding area will supply little or no iodine. Therefore, in lieu of laboratory facilities, I have used source area as an indicator of the iodine contribution of each food in the diet.
Table 4.2
Approximate Quantity of Common Foods Needed to Supply 100
Micrograms of Iodine

<table>
<thead>
<tr>
<th>Food</th>
<th>Pounds of fresh product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables, fruits</td>
<td>10.0</td>
</tr>
<tr>
<td>Cereals, grains, nuts</td>
<td>8.0</td>
</tr>
<tr>
<td>Meat, fresh-water fish, fowl</td>
<td>6.0</td>
</tr>
<tr>
<td>Milk</td>
<td>4.0</td>
</tr>
<tr>
<td>Eggs</td>
<td>2.0</td>
</tr>
<tr>
<td>Marine fish</td>
<td>0.3</td>
</tr>
<tr>
<td>Shellfish</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Source: Astwood, 1955, p 56.

Seafoods in Central Java

Communities throughout the highlands of Central Java are relatively distant from the sea. People in these communities, dependent on the food production from the volcanic, low iodine soils, face the threat of diseases resulting from a deficiency of iodine. The pattern of seafood processing, importation, marketing and consumption found in Central Java today suggests an adaptation to iodine shortage. It is unlikely, for example, that the architectural complexity of the Hindu temples (800 AD) in the Dieng Plateau, 3,000 meters above sea level and 40 kilometers from the study village, could have been created by a grossly iodine deficient population. The burden of cretinism and lowered coordination would have been too great.
Inland settlements today are supplied with several iodine-bearing sea products in a circular exchange (Figure 4.1). Coastal settlements receive inland fruits, vegetables and starchy staples in return for preserved seafoods. The population of central Java at 740 people per square kilometer is much denser today than in the past and urban development of the north coast is further advanced. But this coastal-inland exchange continues to supply the highlands with iodine.

The seafood products regularly imported from coastal environments to the interior of Java today are these: sea salt (garam); salted fish fillets (greh); trasi, a fermented fishpaste usually mixed with banana or other starchy filler, and two kinds of very fine dried fish product, one a small shrimp and the other shredded fish flesh. This last composite category, rese, I will refer to as fish flakes. Two seafoods wrongly credited with a role in the rural Javanese diet are fish sauce and seaweeds. Fish sauces are consumed in the larger cities of Java, but are rarely seen in rural areas. Seaweeds were harvested during the Japanese occupation, but never achieved popularity as a food.
Cross-Section of Java Through Banjarnegara

Coast to Interior Food Exchange

Figure 4.1
A cautionary word is in order regarding the Javanese view of their dietary practices. For just as American consumers do not eat calories or linoleic acid, but bagels, french fries, and malted milks, neither do the Javanese recognise or operate with the category created here, iodine-bearing foods. The Javanese do recognise large goiters, have a term for it, gondok, and have noted that women more frequently suffer from the condition than men. But their explanation for the origin of the condition ranges from "frequent anger" to complications arising from the process of women "bearing down" during childbirth. Goiter is not associated with a nutritional deficiency nor does seafood play a part in the traditional treatments. A 15-year-old girl, diagnosed as having a grade I goiter in the village survey, subsequently combined her doctor's iodine drops prescription with visits to a traditional practitioner in her father's natal village. The traditional healer contradicted the diagnosis of goiter saying that this was an "ordinary neck disease" which he treated by periodic massage.

Iodine supply to the inland communities is complicated by the economic and cultural channeling of each of the preserved seafood products. Each of the seafoods is perceived, prepared and consumed according to longstanding cultural values, including taste, status, and appropriateness with accompanying foods. We cannot know the true distribution of the iodine or the efficacy of this traditional iodine supply system until we know these details of its distribution. I will consider each seafood in turn for its value as a source of iodine dependent on its original iodine content. Having established its
potential iodine contribution I shall examine the effects of cost on its distribution among the economic levels in the village and the results of in-household processing and distribution upon its value as an iodine supply source in the highlands communities. I will consider seafoods generally under two headings: (1) salt, and (2) other seafood products.

Salt

Under Dutch colonial administration, salt production was a state monopoly. Produced and collected along the shores, it was distributed via various regional warehouses or gudang garam. Shortly before World War II, a portion of the salt processed on Madura, an island north of Java, was iodized specifically as a prophylaxis against the widespread endemic goiter in the archipelago, but the war destroyed the operation. The independent Indonesian government followed the rudiments of the old monopoly system until 1957 when "peoples salt", that made by smallholders along the coasts, was allowed to be made and sold legally. This legitimized a situation which had developed in the absence of a strong centralized salt production system during the decade of the 1940's including the political and economic upsets of Japanese occupation and the war of independence. Despite recent imports of pure salt from Australia for iodization in the campaign against goiter, natural sea salt was still virtually the only salt in use in rural Java in 1978.

Most of the salt in Indonesia is produced with traditional dehydration techniques as a dry-season crop in coastal brackish-water fishponds. Salt produced this way contains 20 percent impurities of
minerals other than sodium chloride. These other minerals are predominantly magnesium, calcium and potassium salts plus iodine in very small amounts. Modern salt processing eliminates these compounds, and produces a product high in pure sodium chloride, less hygroscopic and consequently easier to store and transport. Despite the relatively high concentration of iodine in the sea, sea salt, including that produced by traditional means, contains very little iodine.

From production centers along the north coast, salt is transported inland to the larger towns which act as redistribution centers to the rural villages. The "Banyumas" area, roughly the valley of the Serayu River and including the study village, is known throughout Java for its preference for salty food. Indonesian researchers have postulated that poverty causes excessive salt consumption since chili and salt constitute the only taste interest in a poor man's monotonous diet. However, the unusual salt preference of the Serayu River basin and elsewhere in highlands Java may have a more complicated origin. Research has shown that laboratory rats deprived of iodine exhibit an increased salt preference, a situation which can be corrected by administering thyroxine, the organically bound form of iodine produced by the thyroid gland under conditions of normal iodine availability. The association of preference for high salt concentrations and endemic goiter has never been suggested for goitrous human populations, but here in highland central Java is evidence suggesting that man may experience the phenomenon in common with other mammals.
When salt consumption was recently compared in goitrous and non-goitrous villages in Central Java, the per capita salt consumption was 2.8 times more in the goitrous villages.\textsuperscript{15} In contrast to a usual salt intake estimated between 5 and 15 grams per day\textsuperscript{16}, salt consumption in the goitrous villages is excessive (Table 4.3).

\begin{table}[h]
\centering
\begin{tabular}{|l|c|}
\hline
Village & Grams of salt \\
\hline
Goitrous village & 23.6 \\
Normal village & 9.2 \\
\hline
\end{tabular}
\caption{Daily Per Capita Salt Consumption in Java}
\end{table}

Tests which I conducted in Prigi in early 1977, before the beginning of the iodization program, show that the taste sensitivity for salt solutions is far lower in the goitrous Javanese sample than the values usually discovered (Table 4.4). The only comparably insensitive group were an American sample over 60 years of age, whereas the Javanese sample is relatively young and includes many school children.

This population-wide taste discrimination deficiency for salt may be functionally related to the observations of increased salt consumption. Studies combining detection and preference do not necessarily show any relationship between ability to detect a chemical in weak solution and suprathreshold taste preferences.\textsuperscript{17}
<table>
<thead>
<tr>
<th>Authors</th>
<th>n</th>
<th>Threshold values (mM)</th>
<th>Methods/Special Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richter and MacLean, 1939</td>
<td>53</td>
<td>Mean 2.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range 1.2-10.3</td>
<td></td>
</tr>
<tr>
<td>Cooper, Bilash and Zubeck, 1959</td>
<td>100</td>
<td>Means 5.5, 6.2, 8.0</td>
<td>samples aged 15-21, 30-44, 45-49, 60-74, 75-89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21, 17.2</td>
<td></td>
</tr>
<tr>
<td>Furchtgott and Willingham, 1956</td>
<td></td>
<td>Mean 7</td>
<td></td>
</tr>
<tr>
<td>Wotman, Mandel, Thompson and Laragh, 1967</td>
<td>31</td>
<td>Mean 4.05</td>
<td>31 hypertensive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median 2.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range 2.7-10.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Mean 1.87</td>
<td>20 normals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median 1.37</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range 0.7-5.4</td>
<td></td>
</tr>
<tr>
<td>Fisher, Griffin and Kaplan, 1963</td>
<td></td>
<td>Median 12</td>
<td>Harris and Kalmus with mouthrinse</td>
</tr>
<tr>
<td>Chapman #1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>401</td>
<td>Mean 22.5</td>
<td>Harris and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median 12.8</td>
<td>Kalmus with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range 0.2-200</td>
<td>mouthrinse</td>
</tr>
<tr>
<td>Chapman #2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>401</td>
<td>Mean 19.06</td>
<td>Harris and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Median 12.8</td>
<td>Kalmus with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range 0.2-200</td>
<td>mouthrinse</td>
</tr>
</tbody>
</table>

<sup>a</sup> Based upon field tests in February, 1977.

<sup>b</sup> Based upon field tests in June-July, 1978.
However, the impaired ability of the villagers I tested to find any difference between water and salt solutions corresponds to the discovery that goitrous villages in Java consume an excessive amount of salt and suggests a causal relationship. Another explanation of this phenomenon is that salty tastes are highly preferred, as discussed by Contreras\textsuperscript{18} and Nachman and Cole.\textsuperscript{19} My threshold detection test sought recognition and thus is not a basis for conclusions about hedonic evaluations. However, village cooks added salt to their cooking until they could taste it, far beyond my tolerance level. They acted as if salt was a good taste and complained that my cooking had no flavor. The diminished taste sensitivity for salt affects overall food behavior.

A partial explanation for the insensitivity of Prigi's population to the taste of salt came with the opportunity for a retest. Iodine availability appears to play an important role in the diminished taste capabilities for salt taste detection (Table 4.5). After the Indonesian Department of Health conducted a campaign of iodized oil injections, the reservoir of iodized oil in the upper arm of all children and women of childbearing age insured them a continuous iodine supply for four to five years. The mean detection ability after the injections was 19.06 mM in contrast to a much higher mean of 22.5 mM before the injections. A t-test for paired samples, appropriate here since the subjects are being compared against their own performances 15 months apart, found a t-score of 9.11, statistically significant with P less than .001.

The tradition of importing sea salt from the coasts of Java into the interior is probably not an important source of iodine because of
the low iodine content. However, the relationship of decreased taste sensitivity for salt is a little-recognised symptom of endemic goiter.

Table 4.5
Sensitivity to Salt Before and After Iodine Shots

<table>
<thead>
<tr>
<th>Salt Solution</th>
<th>Concentration*</th>
<th>Percentage Before shots</th>
<th>Percentage After shots</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2nM</td>
<td>0.0%</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>0.8nM</td>
<td>3.0%</td>
<td>3.8%</td>
</tr>
<tr>
<td></td>
<td>3.2nM</td>
<td>22.5%</td>
<td>31.5%</td>
</tr>
<tr>
<td></td>
<td>12.8nM</td>
<td>58.5%</td>
<td>48.0%</td>
</tr>
<tr>
<td></td>
<td>50.0nM</td>
<td>13.5%</td>
<td>13.8%</td>
</tr>
</tbody>
</table>

Note: Tests with the same 401 subjects in the goitrous study community, before (February, 1977) and after (June, July, 1978) an iodized oil shot campaign.

*Solutions progressively quadruple in concentration. A small percentage of the sample could not detect a flavor in the highest concentration.
Other Seafood

In addition to salt, three kinds of preserved ocean fish imported into highland communities contribute significant amounts of iodine to the diet. An evaluation of the efficacy of this indigenous iodine supply system requires a detailed understanding of the economic, technical, and cultural factors governing the allocation of ocean fish.

Fishpaste. The practice of fermenting fish is apparently old. At the beginning of the 19th century, Sir Stamford Raffles described the process of fermenting fish he observed along the north coast of Java. The process is much the same today.

Trasi ...is prepared in many situations along the northern coast, but is mostly required for the consumption of the interior. It is prepared from Prawns or shrimps, and extensive fisheries for the purpose are established in many parts of the coast. The shrimp being taken are strewn with salt, and exposed to the sun till dry; they are then pounded in wooden mortars, dressed and formed into masses resembling large cheeses: in this state they constitute an article of trade, and are distributed through the country. The putrescent fluid remaining after the expression strongly impregnated with the odour of the shrimps, is evaporated to the consistence of jelly, and affords a favourite sauce called petis.20

The fermentation process involves extensive drying and the final product is mixed with red dye and cut with a starchy filler such as banana or cassava. The final product is much like cheese in consistency. A slightly cheaper and less valued product is made from small fish rather than shrimp. These products keep well. Despite a
very strong odor they are highly desired as the third ingredient for
the standard relish of salt and hot chilis ground in the Javanese
kitchen equivalent of the mortar and pestle, the *nyelok*.

**Salted Fish.** Many kinds of partially dried, salted and smoked
fish are prepared by fishing villages along the north coast of Java.
However, only the cheapest, small salted fish are imported into the
rural hinterland. The end-products are hygroscopic and much effort is
taken to re-dry them in the sun by the middlemen who transport them
inland. At midday the sidewalks of the small towns which serve as
redistribution centers for the trade of these products are lined with
mats for drying fish, forcing pedestrians to walk in the streets.

**Fish Flakes.** In Java, several kinds of fish are dried without
salting. Tiny shrimps are one such sea product treated by sun-drying.
Small cheap fish are also shredded and dried without salt. The
literature says little about these unsalted seafoods.

Precise evaluation of the iodine content of the preserved
seafoods of Java is made difficult by the absence of information on
their composition. *Trasi* is a contributor of high amounts of vitamin
B12, usually deficient in vegetarian diets\(^{21,22}\), but its contribution
of iodine can only be estimated. Seafoods are a rich source of
iodine. Any iodine loss in the process of sun drying or salting is
slight and takes place in the original steps of the process when
liquid escapes from the flesh.\(^{23}\) Unlike the condition of iodine in
seawater, the iodine in fish is bound organically into the tissues.
It is not, therefore, volatile. The iodine concentration of the fish
flakes and the dried salted fish must, therefore, exceed the concentration in the original fish. Only in the case of trasi, which is mixed with a starchy filler, would the iodine content be less. The cheaper form of trasi found in rural areas are those with the highest level of admixed starches. Iodine content in the fishpaste, then, may be reduced by one half.

These three iodine-rich preserved ocean products, fishpaste, fish flakes, and salted fish are imported into the highlands of Central Java, an area of iodine deficiency. It is a cultural adaptation to an environmental challenge—the shortage of a mineral necessary for healthy community life.

**Summary.** Thus far the data indicate that a response to iodine shortage in the highlands operates at the level of the island-wide commodity exchange, pulling ocean products into the highlands. Iodine is certainly available in the highlands. Whether it is carefully processed and equitably allocated to members of the population remains to be examined below.

**Effect of Household-level Processing on Iodine Content**

Household processing before consumption may affect the iodine content of the fish, but little information is available on traditionally preserved and dried products. I will extrapolate from published data on the loss of iodine in normal cooking of fresh fish, and examine in some detail the Javanese kitchen technologies applied to the dried seafood products. From these we can derive an approximation of the iodine loss after purchase. Like the middlemen,
the purchaser may continue to dry the fillets and flakes, preventing loss to mold either by sunning it at midday or by storing it in the woven spice basket in the kitchen near the fireplace. As previously mentioned, the fillets are occasionally soaked briefly and then redried before cooking to reduce the extreme saltiness. The practice was restricted to the middle- or upper-income groups and is somewhat rare and inconsistent even in these groups. Thus iodine loss is minimized. The residents of Prigi fry fillets if there is money to buy oil, or, if there is no money, they bake them directly on the coals. Loss through either of these processes for fresh fish approaches 20 percent. However the dried fillet placed on the coals scarcely bubbles; no juices fall into the fire, affording no chance for iodine loss. Any iodine lost during frying is conserved in the larger cooking pattern in which the Javanese cook uses and re-uses oil in the pan until one or another of the foods cooked will have absorbed the "lost" iodine. Almost all of the iodine borne by the fillets can be expected to be consumed.

The use of fish flakes in seasoning vegetables can be compared to boiling experiments, during which over half the iodine escapes into the water or kuah. The equitable and careful distribution of the water from vegetables, justified by the belief that there is a health promoting essence of food in the boiling water, effectively distributes iodine from the fish flakes to all the household members.

All iodine in trasi is consumed since it is not cooked, but merely warmed by the coals on a banana leaf and then ground in with the other relish ingredients on the spice grinder. Individuals help themselves to the highly salty spicy mixture directly from the spice
grinder, usually cleaning it completely by the last meal of the day. Of course the strong flavor of the relish prevents its consumption in any large quantity.

All in all then, household processing causes little or no loss of iodine from the fish products. Through the consumption of the boiled water and the re-use of oil for frying, the iodine is eventually consumed.

Effects of Household Resources on Iodine Nutrition

As with all foods imported to the village, the consumption of seafood products is limited by the necessity of paying for them. Unlike local produce, they cannot be raised locally or borrowed from a neighbor's garden. We might, then, expect strong economic patterns in iodine nutrition.

Since salt consumption is universally heavy in the community, but unlikely to contribute significantly to iodine intake because of its very low iodine content, this analysis will concentrate on the other seafoods eaten in the village, fishpaste, salted fillets and fish flakes.

Fishpaste

Villagers consume *trasi* as a hot salty dip for various cassava cakes or mixed with rice on the plate. Little or no water is added in preparation and resulting *sambal* is not cooked. Thus there is no opportunity for further loss of iodine in household preparation. Nor is the relish transferred from the grinding dish, but instead family members serve themselves. The distribution of iodine in this form is
dependent on personal taste preference for salt and chilis. A few families never prepare sambal.

Generally trasi use is more common among the upland and lowland poor (Table 4.6), and is consumed more frequently in the upland cassava and maize staple hamlet than in the lowland rice hamlet. Certainly the expectation that poverty would decrease its consumption is not found with trasi. The wealthiest households in the survey, the elite of the rice-growing lower hamlet, use trasi the least. This corroborates their statements that associate fishpaste consumption with traditional habits. The cassava and maize hamlet is most consistent in trasi use. Projection of the data for February and June surveys suggests that most households would use it at least once every two days.

Table 4.6

<table>
<thead>
<tr>
<th>Hamlet</th>
<th>Household Sample (n)</th>
<th>October</th>
<th>Percentages</th>
<th>February</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite (a&amp;b)</td>
<td>13</td>
<td>30</td>
<td>0</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>poor</td>
<td>15</td>
<td>20</td>
<td>40</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Upland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite</td>
<td>7</td>
<td>0</td>
<td>43</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>poor</td>
<td>7</td>
<td>14</td>
<td>57</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

Source: Diet survey with 43 households, a stratified random sample in two hamlets. Use is defined as occurrence in the menu during the two-day diet survey each season. Elite (a) and Middle (b) economic levels are combined here since their patterns of consumption are similar. Definitions of economic levels are given in chapter 3, pages 58-60.
Salted Fish

The salted fillets of ocean fish are an expensive high-status item to the poor and a symbol of low status to the elite within the same village. Nonetheless, this salty contribution to the rice plate is considered tasty by everyone. The fillet may be washed and re-dried before cooking to reduce the salt content, but mothers in middle and poor income families are more likely to cook it as it comes from the store. In all but the most affluent households 100 grams of the dried fish must last the family meals for an entire day. The extreme saltiness of the fillets is used consciously as a device to limit individual consumption. If the fish were washed, the meagre allowance would be more apparent because "everyone would eat too much," as the cooks reported.

The diet survey records salt fish by frequency in the daily menu since amounts varied only slightly and the amount an individual can eat is highly limited by the saltiness of the product. Frequency of salt fish consumption is high in all economic classes and in both hamlets. At all economic levels half of the houses have salt fish on the menu in a two-day period in every season. Wealth increases the frequency of fillet consumption despite the local association of dried fish products with low status rural characteristics (kampongan) and backwardness by the rice hamlet elite. The only indicators of this low status is the decrease in frequency of consumption among the elite rice hamlet households over the year from the peak in October. Through the seasonal progression of October, February, June represented in the diet survey, wealth is increasingly available in
the village owing to harvests of several crops. With enlarging incomes the elite of the rice hamlet replace salt fish with other more expensive side dishes such as locally produced eggs, chickens and beef. These replacements do not carry any notable amount of iodine because of their local production in a low iodine area. The other economic groups including the moderately well-off elite of the cassava and maize hamlet maintain their consumption of salt fish over the year. Patterns produced by season, economic level and modernizing attitudes are slight. The major interpretation of Table 4.7 must be that dried salted fish fillets are a very common dietary item at all economic levels in all seasons.

Table 4.7

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite (a,b)</td>
<td>13</td>
<td>85</td>
<td>54</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>poor (c)</td>
<td>15</td>
<td>57</td>
<td>47</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Upland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite</td>
<td>7</td>
<td>85</td>
<td>71</td>
<td>71</td>
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</tr>
<tr>
<td>poor</td>
<td>7</td>
<td>45</td>
<td>57</td>
<td>57</td>
<td></td>
</tr>
</tbody>
</table>

Notes: See notes to Table 4.6.

Fish Flakes

Rese, consisting either of sun dried shrimp or fish flakes dried without salting is not used as a food, but as a condiment in the vegetable side dishes. The flakes and spices and the soluble iodine are suspended in the soupy portion known as kuah. As such, the fish
flakes escape the taboos and social pressures applied to the trasi and the fried fish.

The two-day diet survey in three seasons reveals that the use of fish flakes is highly dependent on wealth (Table 4.8). In fact, this is the only seafood for which the pattern of consumption for the middle-income group is closer to the poor than the elite. The elite of both the rice and the cassava/maize hamlets use the flakes frequently in all seasons. All other economic classes use them much less frequently. Within the last eight years they have almost completely substituted a new commercial product, monosodium glutamate (MSG), for the fishflake condiment.²⁵ For all but the elite of the village the potential iodine benefits of fish flakes have been subverted by economics and advertising. Monosodium glutamate, in addition to being a cheaper substitute with taste enhancing properties, is seen as having the additional attraction of bestowing modernity upon the user.

Table 4.8
Fish Flakes Use by Economic Level

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite (a)</td>
<td>5</td>
<td>60</td>
<td>80</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>poor (b&amp;c)</td>
<td>23</td>
<td>43</td>
<td>43</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Cassava/maize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite</td>
<td>7</td>
<td>78</td>
<td>43</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>poor</td>
<td>7</td>
<td>28</td>
<td>43</td>
<td>43</td>
<td></td>
</tr>
</tbody>
</table>

Notes: see notes to Table 4.6.
Household Seafood Scores

Thus far I have considered the distribution patterns of each seafood product individually, because the indigenous logic of processing and distribution is unique for the individual product, not for the iodine-containing food category. The approach up to now leaves in question the possible cumulative seafood consumption in the households. For example, although one group of households has frequent trasi and fish flake consumption, they may rarely eat fillets. In reality, the daily household menus use the three products in every possible combination. Wide disparity in resources available to the households in Prigi suggests that consumption of seafoods, all of which must be purchased, will follow a pattern dictated by economics. To gain an estimation of the true relative consumption of iodine bearing foods across the economic levels, I devised a formula taking much of the former discussion into consideration. The formula contains load factors weighting each of the seafood products according to a careful evaluation of the preceding discussion. Even so, the "scores" derived in this fashion can only be used as a relative indication of the iodine consumption of each of the economic levels.

\[
\text{Iodine score} = (\text{fish flakes} \times 1) + (\text{fishpaste} \times .165) + (\text{fish fillets} \times 5)
\]

The formula was applied to seafood consumption data gathered in 2-day diet surveys October, February and June of one year with a 20 percent stratified random sample of households in two hamlets of the study village. The two hamlets represent the two different ecologic
bases in the village: the lowland rice hamlets and the upland cassava and maize hamlets.

In October, the beginning of the pajeklik, or hunger season, in Java, the average consumption of seafoods reflects economic level almost precisely; the elite of the rice hamlet consume the most seafood, followed by the middle level of the cassava hamlet (Figure 4.2). The poorest households cluster at approximately a seafood score of 4.0, fully two points lower than the middle-level of the upland hamlet. However, the elite of the rice hamlet virtually abandon seafood products for the rest of the year, and their average consumption drops to below the averages for any other economic group in either hamlet in February and June. The upper class of the cassava and maize hamlet maintain their consumption of seafoods between 4.5 and 6.0 for the entire year for the most consistent heavy consumption of iodine bearing foods. The three lower groups of households in both hamlets, on the other hand, vary only slightly around their original score of 4.0.

The inability of the three poorer classes to raise their consumption above a score of 4 reflects the economic constraint on their ability to buy imported seafoods. But for the elite classes of each hamlet, competition from other protein substitutes complicates the pattern for two-thirds or more of the year. This dramatically reduces the iodine consumption of the elite group of the lowland rice hamlet. The middle-level group of the cassava and maize hamlet show this pattern in less striking fashion when they reduce their seafood
Average Household Iodine Scores

Figure 4.2
score by one whole point between February and June. This is the result of the June wedding and party season, when local protein sources of higher status are prepared more frequently.

Comparison between the recommended daily allowance of 150 micrograms of iodine and the foregoing iodine scores reflecting frequency of consumption of iodine bearing products is possible only on an impressionistic basis. Some good estimates of the true iodine content of these foods is high priority research. However the evidence accumulated here suggests that the supply of iodine to Prigi must approach the recommended allowance.

Summary. Beyond the intricacies of varying patterns of seafood consumption, there is evidence of a year long moderate supply of iodine-containing foods to all of the economic levels in the village. A possible exception is the elite of the rice hamlet in the spring wedding season. The traditional coastal-inland iodine importation scheme is shown to be effective down to the level of the poorest household. This is an unexpected finding in a village suffering a 62 percent rate of endemic goiter.

This ancient coastal-inland exchange is relatively fragile. During the economic depression of the 1930s, for example, much less trasi was imported into the highland because inland populations lacked the resources to buy it.\textsuperscript{26} Also, informants in Prigi remembered that salt became very expensive during the ten years of military action beginning with World War II and ending with the Dutch recognition of Indonesian independence. Thus political or economic fluctuations have disrupted the delicate systems of production, transportation and distribution of seafoods throughout this century.
Intra-household Distribution of Seafoods

Despite the failure of the elite in the rice-based hamlets to take full advantage of seafoods, and despite the economic constraints on the poorer households in both hamlets, an unusually consistent consumption pattern for seafood has been documented for this highly goitrous community. Unexamined, as yet, is the matter of intra-household distribution. After seafood products are cooked, who has priority to consume them?

As might be expected by their unique forms and uses each sea product is consumed differently. The fish paste, is used exclusively in a chili relish which is dipped at will depending on the personal taste preference for salt and chilis. In practice, children under ten rarely opt to use the relish because they do not like hot food. Adults, on the contrary, almost universally like hot chilis and prefer high salt concentrations. Pregnant and nursing mothers are prevented from consuming tabooed chili-hot and fishy foods, including the chili and fishpaste relish. The strength of adherence to this taboo is a matter for speculation, since it is hard to believe women who enjoy chili and fishpaste the rest of the time will be able to endure nine months without it. However, even partial subscription to this taboo will reduce iodine supply to mother and child at crucial times in the child's development.

In any two day period throughout the year the salty fish fillets are used by over half the households in every economic category. However, distribution among the members of a household may not be as
equitable as it is through time and economic disparity. For the great mass of people, salt fish maintains its high status. Its pattern of allocation within the household is preferentially to those of high status—male adults and the elderly of both sexes. This tendency is reinforced by taboos on fish products to pregnant and nursing women and infants to the age of one year. Again, a rigid interpretation of these trends may lead to inappropriate and extreme conclusions. In past diet studies in Java the father of the household is recorded as being served "first". In my observations, it was usually the toddlers, waiting around in the kitchen who got to sample the day's cooking while it was still warm and tasty. On several occasions I observed, this included giving small fried salt fish to a toddler—clearly ahead of its father who would not return from the fields until nearly two in the afternoon.

Because they are suspended in the soup of vegetable dishes, fish flakes escape many of the taboos and social pressures applied to trasi and salt fish fillets. In fact, the water of all cooked foods is believed to contain certain strength-giving properties. Therefore, it is liberally ladled onto the rice portions of children. This will be done for children who are considered too young to eat the side dish itself. Thus, between the ages of one and three, a child's diet might consist largely of rice with the water ladled over it and occasional starchy snacks or bananas. Other members of the household also ladle the spicy water over their rice and comment on its health-giving properties. No vegetable or its water is discarded. Thus the soluble iodine from fish flakes is rather equally distributed to the various ages and sexes within the household. Belief in the beneficial
properties of vegetable waters continues, despite the exchange of MSG for fish flakes, especially in the poorer households. In its traditional form, the equal distribution of the soup must have been an effective iodine supply especially for the vulnerable groups, pregnant and nursing women, and infants and children, for whom fishpaste and fish fillets are less equally distributed.

Conclusion

A strong positive cultural response appears to be compensating for the relative scarcity of iodine in the highlands environment. Local foods produced on soils of relatively recent volcanic origin contribute little or no iodine. Although much more research should be done to assess amounts of iodine retained in the initial processing of seafoods along the shore, traditional transportation storage and within-household processing techniques conserve the iodine for consumption, it appears that significant amounts of iodine-bearing seafoods are being imported into the highlands village throughout the year. Seafoods are consumed at consistently high levels throughout the year by 90 percent of the village population. Only the minority elite in the lowland rice hamlet prefer to substitute local high-status protein products for salted fish.

Amounts of iodine delivered to individuals are difficult to specify for the many reasons cited. However, considering the small amounts of iodine necessary to prevent goiter and conversely, the richness of seafood as a source of iodine, the area should be goiter free.
Negative aspects of the local food system, from the perspective of guaranteeing iodine consumption, are the taboos on fish fillets by pregnant and nursing mothers at precisely the times of high physiological requirements, the replacement of fish flakes by MSG in the middle and poorer households and the trend in the elite households toward replacement of low-status seafoods with higher status local proteins.

Thus the adaptation to low local iodine availability is strong at the village and household level, but flawed at the individual level. The system produces the iodine-rich products along the seashore, transports them long distances across the width of Java, markets them, and insures their entry to all economic levels in the village. But the distribution system fails to a degree to guarantee that they will be consumed by children and women of childbearing age, those members of the population whose physiological needs are the greatest.
References


CHAPTER V

THE GOITROGEN LOAD

Abstract
A systematic search for goitrogens in the diet of Prigi, the case study village, is justified because of the high rate of goiter there, in spite of a continuous iodine supply from the imported seafood. Among the vegetables grown or imported into Prigi, thirty-five are goitrogens. Increasing wealth makes possible the purchase of more of the costly imported vegetables, but the poor rely heavily on two local goitrogenic foods, cassava and papaya leaves. Traditional cooking and processing techniques reduce but probably do not eliminate the goitrogenic chemicals. Rules for food distribution, such as the small portions of vegetables considered proper, moderate the consumption of goitrogens. However, certain prescriptions, such as the belief that bitter papaya leaves promote breast milk or cure malaria, expose mother and child to goiter and cretinism respectively. A high rate of impaired taste ability, symptomatic of the endemic goiter itself, reduces individual capacity to refuse toxin-bearing foods. Analysis of household diet data reveals that increasing wealth enables people to consume both larger amounts and more variety of food resulting in a more goitrogenic diet.

Introduction

The continuous iodine supply documented for the highlands of central Java was unexpected in light of the 60 percent goiter rate found in a 1976 survey. This anomaly suggests that dietary goitrogens may play an important etiologic role.
Vegetable genera most often implicated in goiter causation are those of the Cruciferae (cabbage), Leguminosae (bean) and Umbelliferae (carrot). In addition to these groups of cultivars, the members of which frequently contain one or more goitrogenic chemicals, plants such as papaya, bamboo and cassava also contain goitrogenic chemicals.¹,²

Goitrogens implicated in other endemic goiter areas bring about their effects in one of three ways:

1) Elements similar to iodine in the periodic table of elements, such as lithium or chlorine, prevent the uptake of iodine at the thyroid by competing with iodine. Another means is the binding action of soybeans to reduce effective iodine absorption during digestion. For a more complete explanation of the action of goitrogens see appendices 3.1 through 3.5.

2) A second type of goitrogen prevents the production of thyroxine in the thyroid gland after the iodine has been absorbed. Goitrogenic chemicals in this category are the thiocyanates and cyanides carried in cabbages, papaya sap, and cassava roots and leaves.

3) A third mechanism of goitrogenesis is peripheral, or external to the thyroid. Thyroxine may be successfully produced in the thyroid after iodine is absorbed, but through mechanisms not well understood, some chemicals such as

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goitrin, also found in Cruciferae and Umbelliferae, reduce the effective use of thyroxine in the body.

There is disagreement regarding the effectiveness of excess doses of iodine to counter the effects of the above goitrogen types. However, most authorities believe that large doses of iodine can counteract the effects of types one and two. The action of type three cannot be overridden by excess iodine. More detail about the actions of the different types of goitrogens can be found in Appendix 3.

Available Vegetables

There are two sources of fresh vegetables in the village: those grown in local gardens and those imported from outside the village. Those imported are marketed at the single local market or at the several tiny front-room stores in each hamlet. A survey of villager's annual travel histories revealed that with the exception of the elite households, people live their lives almost exclusively within the village and its agricultural lands. They travel to the small rural towns 20 kilometers in either direction only for important reasons, such as taking a sick child to the public health nurse. Consequently, food obtained and consumed in the village is the major source of goitrogenic vegetables.
Marketed Vegetables

In addition to the island-wide exchange with coastal areas for seafoods, Prigi is involved in a small scale food exchange with the cool vegetable and tobacco producing region. The Dieng Plateau (Figure 5.1) is too high for the cultivation of either rice or coconuts, but instead grows a complex of crops that are termed "Dutch" or "Chinese" by the Javanese. In fact, the cultivation here of the many varieties of cabbage, cresses, potatoes, beans and maize originally domesticated in the American and Asian mainlands reflects over a thousand years of exchanges with the outside world. The Dieng Plateau exports fresh vegetables to all the major coastal cities in central Java and heavily influences food availability to the goitrous interior. Proximity suggests that the cabbage products of the Dieng Plateau should be present in large amounts in the periodic fresh vegetable markets of the surrounding lower villages. Such proved to be the case.
Cross-Section of Java Through Banjarnegara

Rim Village to Dleng Plateau Food Exchange

Figure 5.1
A market is held at the entrance to Prigi in the early morning of two out of every five days of the traditional Javanese market week. This small market featured only two vegetable merchants and a dry-goods outlet selling oil, sugar, flour, and a variety of dried spices and salted fish. Total volume passing through the market is small by outside standards, but since few villagers shop outside the village, this is a major portal for non-local produce contributing to the iodine and goitrogen supply.

Despite the small size of the market, 42 different fresh fruits and vegetables were sold over the survey period of 17 months. Of these, over half (Table 5.1) are suspected or proved goitrogens. Seven belong to the Cruciferae genus, 11 to the Leguminosae, three to the Umbelliferae and 2 to the Allium genus. Additionally, a number of the dried spices sold are Umbelliferae seeds.

Goitrogenic vegetable sales are highest in the dry season, between April and November. On an average market day 115 kilograms are sold, or nearly three-quarters of a kilogram of goitrogenic vegetables for each household (Figure 5.2). Early in the rainy season, December through February, the volume is much less. In this season not only are local free vegetables abundant, but villagers have
Table 5.1

Goitrogenic Vegetables in Prigi Market

<table>
<thead>
<tr>
<th>Local</th>
<th>English Usage</th>
<th>Javanese Usage</th>
<th>Botanical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh produce</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cruciferae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cabbage</td>
<td>kohl</td>
<td>pak</td>
<td>Brassica oleracea</td>
</tr>
<tr>
<td>watercress</td>
<td>jembak</td>
<td></td>
<td>Nasturtium officinale</td>
</tr>
<tr>
<td>chinese mustard</td>
<td>sawi hijau</td>
<td>pak</td>
<td>Brassica Juncea</td>
</tr>
<tr>
<td>chinese cabbage</td>
<td>sawi putih</td>
<td>koi</td>
<td>Brassica chinensis</td>
</tr>
<tr>
<td>*</td>
<td>pak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leguminosae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lead tree, Leucaena</td>
<td>pete cina</td>
<td>koj</td>
<td>Leucaena leucocephala</td>
</tr>
<tr>
<td>goa bean</td>
<td>kecipir</td>
<td>kapri</td>
<td>Phaseolus tetra.</td>
</tr>
<tr>
<td>chinese pea</td>
<td>kapri</td>
<td>koj</td>
<td>Pisum arvense</td>
</tr>
<tr>
<td>long bean, cow pea</td>
<td>kacang panjang</td>
<td>kapri</td>
<td>Vigna sinensis</td>
</tr>
<tr>
<td>Rice bean</td>
<td>kacang tolo</td>
<td>koj</td>
<td>Phaseolus calcaria.</td>
</tr>
<tr>
<td>mung bean</td>
<td>kacang hijau</td>
<td>koj</td>
<td>Phaseolus radiat.</td>
</tr>
<tr>
<td>*</td>
<td>kacang jepang</td>
<td>koj</td>
<td></td>
</tr>
<tr>
<td>string bean</td>
<td>buncis</td>
<td>koj</td>
<td>Phaseolus vulg.</td>
</tr>
<tr>
<td>*</td>
<td>pete</td>
<td>koj</td>
<td>Parkia speciosa</td>
</tr>
<tr>
<td>*</td>
<td>jengkol</td>
<td>koj</td>
<td>Pithecolobium lob.</td>
</tr>
<tr>
<td>Umbelliferae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>parsley</td>
<td>patrosoye</td>
<td>koj</td>
<td>Petrosera sativum.</td>
</tr>
<tr>
<td>celery</td>
<td>seledri</td>
<td>koj</td>
<td>Apium graveol.</td>
</tr>
<tr>
<td>carrot</td>
<td>wortel</td>
<td>koj</td>
<td>Daucus carota</td>
</tr>
<tr>
<td>coriander</td>
<td>adas</td>
<td>koj</td>
<td>Coriander sativum.</td>
</tr>
<tr>
<td>fennel</td>
<td>adas</td>
<td>koj</td>
<td>Foeniculum vulg.</td>
</tr>
<tr>
<td>Allium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>garlic</td>
<td>bawang putih</td>
<td>koj</td>
<td>Allium sativum.</td>
</tr>
<tr>
<td>onion</td>
<td>bawang merah</td>
<td>koj</td>
<td>Allium sativum.</td>
</tr>
</tbody>
</table>

Note: * No common English term is in use.
--- unidentified
come to the end of their resources and must economize until the first
maize harvest, roughly March, or the rice harvest in late April. Peak
sales are in June, the wedding month, and at the breaking of the
Islamic fast which in the year of the survey, fell in late September.

**Cruciferae.** The total volume of goitrogenic vegetables
marketed varies widely over the seasons, but most of this variation
arises from fluctuations in crucifers: the cabbages, mustards and
cresses. Legumes and umbelliferous condiments remain constant
throughout the year. Peak cabbage sales are found in the dry season,
between the months of April and October, when on an average market day
nearly half a kilo of crucifers are available for each household.
This pattern reflects the high value the villagers place on the
cabbage family for side dishes to accompany rice. Peak sales are in
June, the month of wedding feasts, and October, for feasts
commemorating the end of the Islamic fasting season. The patterns of
crucifer availability in the village is a combination of seasonality
of production in the Dieng Plateau and the ability and occasion for
the villagers to buy their favorite vegetables.

**Legumes.** Beans are an important protein source in the largely
vegetarian diet of Prigi. Animal research has shown they play a
well-established role in reducing dietary iodine absorption.3 (See
Appendix 3.3). The average quantity of legumes sold in the periodic
market, a composite of various fresh beans and pulses, is relatively
stable throughout the year at 25 kilograms per market day. This
amount underestimates true availability, since unlike the Cruciferae,
many beans are grown in local gardens. But it does suggest a

Figure 5.2
year-long minimum consumption of beans at 25 kilograms per 150 households per market day. This figure also excludes soybeans. Soybeans are imported to make a popular food, a fermented soybean cake produced as a local cottage industry. Diets containing soybeans reduce the body absorption of the iodine in the diet, resulting in fecal loss of dietary iodine (Appendix 3.3). However, the protein contribution of soybeans in this vegetarian diet should not be underestimated. The soybean cake is a very important contributor of amino acids which are an almost perfect complement to the amino acids of rice. If they are eaten together, they create a mixture of amino acids equal in value to that of fish and meat proteins. However, the heavy consumption of beans, soybeans included, contributes to the endemic goiter rate in the village by causing malabsorption of the precious iodine supplied by the sea foods.3

**Umbelliferae and Allium.** Umbelliferae are sold both fresh and dried in fairly small quantities for use as condiments. The usual no total of carrots or parsley available on a usual market day is no more than one half kilogram. Because of their expense and their role in village recipes, they are thought of exclusively as spices. Amounts are small, but their potential contribution to goitrogenesis should not be overlooked. Seeds of the goitrogenic plants frequently contain the highest concentration of goitrogenic chemicals.2 In many cases the seed is the part of the plant being utilized as a spice. Coriander, celery and parsley, onion and garlic are used in the preparation of almost every spiced dish. As such, umbelliferous and allium spices can be said to contribute a low but continuous dose of goitrogens to the population every day.
Summary. The product exchange with the Dieng Plateau brings to Prigi 24 different vegetables, leaves and seeds which contain suspected goitrogens. Umbelliferae, Cruciferae and Leguminosae figure prominently in this list. Clearly these three genera of vegetables represent a substantial contribution to the diet of the 150 households dependent on that market. The quantities available, and the role of members of these three genera of vegetables in goiter causation elsewhere, suggest they represent an important contribution to endemic goiter in the villages which ring the Dieng Plateau. Particularly in the case of the Cruciferae, this suspicion is strengthened by their origin in an area of recent volcanic activity. The soil there is characterized by a low iodine content and high sulfates common to soils of volcanic origin in high rainfall climates. The iodine contribution of this major import pattern is negligible, while the goitrogenic potential may be unusually high. Cruciferae grown in high sulfate soils have more goitrogenic potential than the same types grown on low sulfate soil. Consequently, Prigi's market place, supplied by the small scale exchange system with the Dieng Plateau, represents a significant source of goitrogenic foods in the village.

Vegetables from Local Gardens

Not all the goitrogenic vegetables in Prigi are imported. Javanese villages are hidden from sight by the small forest of coconut trees and other cultivars. Within the hamlets, in front yards, empty houselots, and gardens (kebon) adjacent to the hamlets, are grown a great variety of fruits and vegetables. Some of these plantings are predominantly commercial, for example, coffee, banana, cloves,
### Table 5.2

<table>
<thead>
<tr>
<th>Vernacular</th>
<th>Javanese</th>
<th>Botanical</th>
<th>Part used as food</th>
<th>Percent Gardens</th>
</tr>
</thead>
<tbody>
<tr>
<td>banana</td>
<td>pisang</td>
<td>Musa. sp.</td>
<td>fruit, pith</td>
<td>100</td>
</tr>
<tr>
<td>coconut</td>
<td>kelapa</td>
<td>Cocos nucifera</td>
<td>sap, cream</td>
<td>100</td>
</tr>
<tr>
<td>cassava*</td>
<td>ketela</td>
<td>Manihot esculenta</td>
<td>leaves, root</td>
<td>100</td>
</tr>
<tr>
<td>taro</td>
<td>lumbu janawari</td>
<td>Colocasia sp.</td>
<td>leaves, root</td>
<td>100</td>
</tr>
<tr>
<td>taro</td>
<td>lumbu kimpul</td>
<td>Colocasia sp.</td>
<td>leaves, root</td>
<td>100</td>
</tr>
<tr>
<td>papaya*</td>
<td>pepaya</td>
<td>Papaya carica</td>
<td>leaves</td>
<td>83</td>
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<tr>
<td>amaranth</td>
<td>bayam</td>
<td>Amaranthus byb.</td>
<td>leaves</td>
<td>75</td>
</tr>
<tr>
<td>(large bean)*</td>
<td>pete</td>
<td>Parkia speciosa</td>
<td>seed</td>
<td>66</td>
</tr>
<tr>
<td>(large bean)*</td>
<td>jenggok</td>
<td>Pithecolobium lobatum</td>
<td>seed</td>
<td>64</td>
</tr>
<tr>
<td>chili</td>
<td>lombok</td>
<td>Capsicum frutescens</td>
<td>seed pod</td>
<td>64</td>
</tr>
<tr>
<td>jackfruit</td>
<td>nangka</td>
<td>Artocarpus</td>
<td>fruit, seed</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>heterophylus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(bean)*</td>
<td>jimbuk</td>
<td>Vigna sinensis</td>
<td>seedpod, leaf</td>
<td>58</td>
</tr>
<tr>
<td>long bean*</td>
<td>kacang panjang</td>
<td>Lansium domst. Cor.</td>
<td>seedpod, leaf</td>
<td>58</td>
</tr>
<tr>
<td>(fruit)</td>
<td>duku</td>
<td>Psophocarpus</td>
<td>fruit</td>
<td>48</td>
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<tr>
<td>winged bean*</td>
<td>kecipir</td>
<td>tetragonobolus</td>
<td>seedpod, leaf</td>
<td>44</td>
</tr>
<tr>
<td>taro</td>
<td>lumbu bandung</td>
<td>Colocasia esculenta</td>
<td>leaf, root</td>
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<td>(large tree)</td>
<td>kelor</td>
<td>Morinda</td>
<td>leaf, flower</td>
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<td>jambu</td>
<td>Ficus sp.</td>
<td>fruit</td>
<td>39</td>
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<tr>
<td>sweet potato</td>
<td>ketela rambat</td>
<td>Psidium guajava L.</td>
<td>leaf, tuber</td>
<td>35</td>
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<tr>
<td>koa haole*</td>
<td>pate cina</td>
<td>Ipomoea batatas</td>
<td>seeds</td>
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<td>sugar cane</td>
<td>tabu</td>
<td>Leucaena glauca</td>
<td>seeds</td>
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<tr>
<td></td>
<td>okra-okra</td>
<td>Saccharum offic.</td>
<td>stalk</td>
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<tr>
<td>lime</td>
<td>jekuk</td>
<td>Ficus elastica</td>
<td>leaf</td>
<td>31</td>
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<td>(tuber)</td>
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<td>Citrus amlycarpa</td>
<td>fruit, leaf</td>
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<tr>
<td></td>
<td>laos</td>
<td>Psidium guajava L.</td>
<td>medicament</td>
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</tr>
<tr>
<td></td>
<td>bengle</td>
<td>Z. galanga Wild.</td>
<td>leaf, medicine</td>
<td>23</td>
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<tr>
<td>mungbean*</td>
<td>ganyong</td>
<td>Canna edulis Ker.</td>
<td>leaf, compress</td>
<td>20</td>
</tr>
<tr>
<td>turmeric</td>
<td>kacangtolo</td>
<td>Curcuma domest.</td>
<td>seed</td>
<td>19</td>
</tr>
<tr>
<td>durian</td>
<td>kunir</td>
<td>Durio zibethinus</td>
<td>spice, medicine</td>
<td>19</td>
</tr>
<tr>
<td>bean/pea*</td>
<td>duren</td>
<td>Lablab purpureus</td>
<td>fruit</td>
<td>18</td>
</tr>
<tr>
<td>sour sopp</td>
<td>kara</td>
<td>Lablab purpureus</td>
<td>seedpod</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>sirat</td>
<td>Annona muricata</td>
<td>fruit, seed</td>
<td>11</td>
</tr>
<tr>
<td>mango</td>
<td>tanu</td>
<td>Curcuma xanth.</td>
<td>medicine</td>
<td>10</td>
</tr>
<tr>
<td>rambutan</td>
<td>mangga</td>
<td>Mangifera indica</td>
<td>fruit</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>rambutan</td>
<td>Neohelium lappaceum</td>
<td>fruit</td>
<td>10</td>
</tr>
</tbody>
</table>

* Goitrogenous and suspected goitrogenous foods

---

* unidentified

113
rambutan, durian, and coconut. The majority are common side-dish vegetables, spices, and traditional medicines which contribute heavily to the local diet. Since they are grown in local soil unsupplemented by commercial fertilizer, they contain little iodine, but there are numerous proved or suspected goitrogens among the 88 different vegetables and fruits.

Although the rich and the poor alike plant the same core of household spices, leafy vegetables, and medicines, the wealthier villagers reported a greater variety of plantings in both the houselots and the more distant gardens. Of an entire hamlet surveyed, only 10 percent of the households reported no garden plantings. Even these households are likely to have occasional access to the vegetable gardens of neighbors, since considerable daily sharing of garden produce was evident.

Of the 35 most commonly planted garden plants (Table 5.2), ten belong to families proved or suspected to be goitrogenic in laboratory animals. There are no crucifers grown in the village, but there is a profusion of legumes, many of which have only recently received attention in the Western world. Two goitrogenic plants common in the gardens in addition to the most frequently implicated genera are cassava, of which the root is a common snack and the leaves a frequent side-dish, and papaya trees providing unripe fruit and leaves. Based on the evidence of the popularity of plantings of various legumes, cassava, and papaya, the goitrogenic potential of locally produced vegetable foods is considerable. They contribute negligible amounts of iodine, reflecting low levels of iodine in the soil, and 13 have been shown to be goitrogenic in other contexts.
Gathered Non-cultivars

In addition to deliberate cultivars, a number of vegetables are gathered free from the village environment such as bamboo shoots, mushrooms, several weeds from the ricefield in weeding season and several varieties of a rambling path weed resembling clover (panegowang). This last weedy member of the Umbelliferae along with some of the others mentioned are eaten infrequently, perhaps 4 or 5 times a year. They are foods which have in the past played a much more important role than they do now. However, knowledge of means of preparation is kept alive by grandmothers and mothers who harvest them occasionally and prepare them in the traditional ways, sometimes in the face of protests by the younger generation. Of this list of gathered vegetables, at least the bamboo shoots, fern shoots and the panegowang are known goitrogens.

Our ability to evaluate the extent of the goitrogenicity of this diet is limited because of our unfamiliarity with these plants. In addition the Javanese eat parts of the plant, such as flowers or leaves, that are not considered food in the West.

Summary

The fate of Prigi residents and that of other villagers living on the rim of the Dieng Plateau is to inhabit an environment that provides a soil low in iodine and abundant potential goitrogens. On the other hand, a long-standing commercial interchange system provides excellent dried seafoods. Taking this environment as a given, the manner in which the traditional cultural practices distribute the wealth of potential goitrogenic vegetables is of great interest. I
examine the flow of these vegetables to households with varying resources within the rice-based, lowland hamlets and within the cassava and maize-based, upland hamlets. Additionally I discuss the efficacy of processing technologies in the elimination of goitrogenous chemicals, as well as food allocation ideals, and finally the role of individual food choice in vegetable distribution.

Processing at the Household Level

Introduction

One of the most distinguishing human characteristics is the transformation of vegetable and animal material into food. Cooking involves combining ingredients and usually the addition of heat to effect chemical and physical changes which make food more palatable. Toxins may be modified making them safer for consumption or, at least, bad tastes disguised. Thus household processing of foods must be considered in evaluating the goitrogenic potential of the diet consumed in Prigi.

In the highlands of central Java the cultural transformation of food in cooking is serving three functions, disguising the taste of environmental toxins, detoxifying goitrogenic foods, and supplying large amounts of salt in response to taste insensitivity. The Javanese of Prigi fall within the recognised culture area of Banyumas, whose culture complex which includes a distinct, country dialect of Javanese, a preference for gamelan war music, and a dietary regimen demanding very hot and salty food. The previous chapter examined the lowered sensitivity for salt that may result from the disease state of
goiter and may cause a nearly population-wide salt craving. The complex spice mixtures used in preparing all dishes with the exception of the staples, insure taste confusion enough to mask an undesirable taste in the vegetable material. Side dishes, relishes and sauces contain much chili pepper, salt, and usually additional dimensions of taste provided by sugar and fermented fish cake, coriander, garlic and onion and even flower blossoms. These complicated taste mixtures have the potential to mask many of the distasteful goitrogens.

Prigi's abundance and variety of goitrogenic food plants have generated numerous food processing techniques which appear to be designed to reduce the exposure of the population to goitrogens. I describe the processes in some detail, and speculate on the possible chemical and physical effects on the goitrogenicity. A quantitative answer to the question of the efficacy of traditional cooking techniques in reducing the goitrogen burden on this community must await more laboratory research. Generally, I describe and evaluate the cooking techniques in the categories of goitrogenic vegetables already defined, Cruciferae, Umbelliferae, Leguminosae and others. Finally I examine the various roles of masking by spicing, detoxification and by adaptation to taste insensitivity brought on by nearly population-wide disease.

Food processing, culinary knowledge and vegetable detoxification processes are entirely the domain of women in Java. Men are discouraged from entering the kitchen area and only rarely visit the vegetable market, where the buying and selling is conducted exclusively by women. These areal and knowledge boundaries are maintained by shaming and humiliation tactics against males beginning
at puberty. Conversely, daughters are progressively incorporated as helpers in the food preparation as choppers, dish washers, and water retrievers. They are not expected to bear full responsibility for meals before marriage, but by daily acquaintance with the procedures acquire a very practical education. The cook may explain that she is removing the taste of bitter (pait), or the smell of grass green (langu), to make the food more palatable. If pressured, she may elaborate that unprocessed foods can cause itching (gatal), or lack of co-ordination (mabok), but generally, explanations are omitted. Detoxification techniques are simply a part of the cooking ritual and not to be modified or questioned. This inflexibility in detoxifying procedures is perhaps an important adaptation to goitrogen hazards, since rigid expectations demand repetition of protective but time-consuming tasks, which might otherwise be omitted.

Cruciferae

The effect of indigenous processing techniques on the goitrogenic potential of cabbage is of interest in the light of the large quantities of cabbage imported into Prigi. Both domesticated and weedy varieties of cabbage contain goitrogenic glycosides in varying amounts. It is precisely these goitrogens that give mustard and horseradish their pungency and lend the unique smell to bruised raw cabbage. Amounts and types of goitrogens vary by subspecies, plant type and even from one head of cabbage to another. Soil minerals account for some of this variation. Goitrogenicity increases progressively with increasing amounts of sulfur in the soil, for example.7
Conclusive evidence in animal experiments links the cabbage family to goiter, but rarely has cabbage been implicated in human goiter. The best documented case is Tasmania where cruciferous weeds in cattle forage raised the level of thioglucosides in milk to goitrogenic levels. Continuous supplementation with iodide pills in the schools did not prevent seasonal endemic goiter corresponding to pasture growth. This episode highlights several important points about the goitrogenic potential of the cabbage family. At least some of the goitrogenic activity cannot be overbalanced by excess iodine and the goitrogens cross the placental and milk barriers to infants and children at stages of life generally believed to be more vulnerable to toxins. Cabbage goitrogens also prevent the concentration of iodine by the thyroid, salivary and mammary glands which produce low iodine milk.

Many scholars since World War II have written that cooking of cabbage constitutes successful detoxification. Heat destroys enzymes necessary to release the goitrogenic glucosides from inactive precursors in the raw plant. More recently goitrogenic compounds have been found to be released during the process of intestinal digestion in spite of previous cooking and denaturing of the enzyme. Thus many of the early assumptions about the effectiveness of cooking procedures may have been unwarranted.

Kozlowska (cited in Holdsworth, 1979) reported that European-style boiling of broccoli destroyed 30-50 percent of the glucoside derivatives. It is upon this somewhat uncertain research base we must extrapolate to evaluate the Javanese methods of cruciferae preparation.
All types of cabbages, including cress, mustard, head cabbage, are prepared in one of only two forms: 1) as part of a crisp blanched salad with peanut dressing \((\text{gado-gado})\), or 2) as a soupy spiced vegetable. Cabbage in soup, spiced with coriander, garlic, and onion is the second most common vegetable dish reported in home menus.

Generally, Javanese preparation techniques for the cabbage family can achieve a 30 percent but not total reduction of goitrogens. They heat all cabbage products. The unknown factor is the degree to which goitrogenic chemicals are changed to active forms by the process of digestion. However, since all the crucifers in the Prigi diet are grown on recent volcanic soils high in sulfates, the residual goitrogenicity after processing is probably considerable.

**Umbelliferae**

An unusual number of spices are derived from the Umbelliferae. The desirable pungency of coriander and fennel, parsley and celery is directly attributable to the goitrogenic compounds they carry. The seeds are particularly high in goitrogens, but because spices are such a minor contribution to the overall diet in the Western world, there are few remarks in the literature. In Asia and particularly in Java, spices are consistently used in larger quantities than in Western cooking. Dried coriander seeds contribute to almost every recipe. Fennel is used as a remedy and its use is much more sporadic. Celery and carrots are imported fresh from the Dieng Plateau and serve as spices and garnishes, but all are cooked in the dishes.

In the absence of information about the detoxification of Umbelliferae \(\text{per se}\), we must extrapolate from the effects of
processing on similar chemicals in the Cruciferae. Drying of coriander should destroy the releasing enzyme. However, some portion of the goitrogens may be activated by the digestive process. Celery, carrot, and parsley are well cooked in their respective uses; we may postulate that cooking could reduce their goitrogenic potential by perhaps 30 percent. The burden of goitrogens supplied by Umbelliferae is small, but consistent from day to day based upon the frequency of their use.

Leguminosae

At least nine members of the legume family provide an important protein supplement to the virtually vegetarian diet of Prigi. Not only the beans, but in several cases the bean leaves are eaten. Many of the bean types are of Southeast Asian or tropical distribution and have only recently come to the attention of agricultural and nutrition research. An exception is the well-studied case of soybean, which is not tropical.

Soybeans cause iodine deficient goiter in laboratory animals by exaggerating fecal loss of dietary iodine, but the goitrogenic effect can be overridden with excess iodine.\textsuperscript{14,15}

In contrast to the soybeans which are imported dried, all eight of the other legumes contributing beans, peas and green leaves to the diet are grown locally. As with other locally grown foods, they reflect the marginal iodine content of volcanic soils. Although lima beans are implicated in goiter,\textsuperscript{16} the literature is silent on the goitrogenicity of other beans. Adding to the difficulty of assessing the role of local beans in goiter is the unfamiliarity of bean leaves
as food in the Western World in contrast to rural Java where they are a common vegetable. Not much is known about the nutrient or anti-nutrient contents of bean leaves. The eight remaining indigenous beans are presumed to bear goitrogens for the purposes of this discussion.

Generally the fresh bean pods are chopped into inch-long segments, then boiled or stir-fried into a mixed vegetable dish. Bean leaves are often cooked in mixtures of three or more kinds, and boiled 10-15 minutes. Later the water is discarded and the leaves wrung out. These relatively dry wrung leaves are eaten with a spicy condiment of coconut shreds and chili.

In contrast to the care and attention paid to the detoxification of beans, is a habit children have of eating only slightly modified or unmodified legumes. Parents refer to their children's behavior as ludes (roughly: lunacy). "We prepare and serve all this good food," they say. "Why do they eat raw beans?" But in fact the regimen of food serving and the amounts allotted do not satisfy children, thus forcing them to become foragers in their own villages. They gather insects, snails, weeds, and domesticated vegetables such as ears of maize, or cassava roots, and Leucaena pods where they play. Flowers and leaves from decorative hedges that are not part of the adult diet, but function only in the world of the play-market (pasaran) become a part of the diet of six-year old girls.

It is likely, despite careful processing, that the volumes of soybeans and other beans and their leaves in the diet constitute hazards to the absorption of dietary iodine. Fermented soybean cakes are eaten on an almost daily basis. The potential of the fermentation
process to change the well known iodine binding character of a soybean diet is unknown.

Other Goitrogenic Vegetables

In addition to the three major genera whose members consistently bear goitrogenic chemicals, there are individual plants contributing anti-nutrients to the iodine/goitrogen balance. Chief among them in importance for the diet are cassava root and leaves and papaya leaves. Some of the minor gathered vegetables such as bamboo shoots and fern shoots are eaten so infrequently that their contribution becomes important only in the context of an already highly goitrogenic diet.

Papaya. Papaya latex and seeds contain the highest glucosinolate content of all goitrogenic vegetables listed in a recent review. The seeds are not eaten in central Java, but unripe fruit and papaya leaves are common vegetables. Usually the bitter leaves are cooked first in water to which a plug of river clay has been added. These clay plugs can be bought in vegetable markets expressly for the purpose of removing the bitter taste from the leaves. The first boiling water and the clay are discarded and the leaves are subsequently washed, wrung, and reboiled with chilis and coconut milk. Occasionally, however, papaya leaves are left bitter, and merely boiled and served. The bitter taste is not entirely without favor in Java. The medicinal taste has led to the belief that it has quinine-like properties and a neighbor may suggest the blanched leaves as a remedy for malarial fevers or to improve the quality of breast-milk. The goitrogens producing the bitter taste are absorbed and not only prevent thyroxin from being made, but prevent iodine
uptake by mammary tissues. The nursing mother who eats bitter papaya leaves will be passing on a dose of goitrogens and less iodine in her breast milk.

**Cassava.** Cassava root is an important provider of calories and the leaves are the most commonly eaten side dish in the village. The people of Prigi classify cassava into two kinds: the green stemmed variety of low toxicity and the red stemmed variety which must be processed more extensively to remove the poison. The validity of this indigenous classification probably has some basis in fact. The potential to release toxic hydrogen cyanide does vary with the species (see Table 5.3) and also with the part of the plant. Even the less toxic varieties of cassava carry a considerable burden of hydrogen cyanide precursors, although they tend to concentrate the glucoside in the bark or peeling of the root more than do the highly toxic varieties. All cassava roots and leaves contain some toxin.
Table 5.3
Concentration of Goitrogens in Plant Parts of
Four Types of Cassava
(in micrograms of hydrogen cyanide per gram fresh weight)

<table>
<thead>
<tr>
<th>Cassava Part of plant</th>
<th>Tabouca</th>
<th>A13</th>
<th>Ta25</th>
<th>461</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf blades</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very young</td>
<td>330</td>
<td>330</td>
<td>490</td>
<td>790</td>
<td>490</td>
</tr>
<tr>
<td>Just full-grown</td>
<td>420</td>
<td>340</td>
<td>570</td>
<td>1040</td>
<td>590</td>
</tr>
<tr>
<td>Older</td>
<td>250</td>
<td>210</td>
<td>320</td>
<td>730</td>
<td>380</td>
</tr>
<tr>
<td>Leaf stalks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very young</td>
<td>400</td>
<td>750</td>
<td>770</td>
<td>940</td>
<td>720</td>
</tr>
<tr>
<td>Just full-grown</td>
<td>210</td>
<td>350</td>
<td>350</td>
<td>460</td>
<td>340</td>
</tr>
<tr>
<td>Older</td>
<td>120</td>
<td>110</td>
<td>170</td>
<td>180</td>
<td>150</td>
</tr>
<tr>
<td>Bark roots</td>
<td>400</td>
<td>540</td>
<td>890</td>
<td>730</td>
<td>640</td>
</tr>
<tr>
<td>Inner roots</td>
<td>36</td>
<td>55</td>
<td>210</td>
<td>240</td>
<td>140</td>
</tr>
</tbody>
</table>

Source: Adapted from de Bruijn, 1973, p. 45.

The rarity of episodes of cassava toxicity in the light of the importance of cassava for human food world-wide suggests the efficacy of traditional techniques. There is considerable disagreement in the literature regarding the effectiveness of traditional detoxifying techniques. Figure 5.3 depicts the various processing routes cassava products may take in Prigi. The various techniques should be evaluated by laboratory investigation for their results. But even for factory processed cassava products there has been little laboratory evaluation of the cyanide content of the end products.
Cassava Processing in Rural Central Java

Figure 5.3
Generally hydrogen cyanide (HCN) produced in cassava roots and leaves is soluble and volatile at normal cooking temperatures. However, HCN does not exist as such in the living plant. It is released only upon the disintegration of the plant tissue, for example in wilting, fermentation, and maceration, where the enzymes also present in plant tissue change the thioglucosides to HCN. When fresh cassava is cooked, only the enzyme is denatured, leaving the thioglucoside. Some of the latter is converted to HCN during digestion. For household processing to be effective, it must release the HCN prior to soaking or heating. The Javanese techniques that promote its release before heating are wilting, peeling, chopping, and grating.

The Javanese pass over young leaves containing the highest concentrations of toxins in favor of middle aged or older leaves, thus avoiding some toxin. The half-day or overnight wilting allowed before cooking, which appears to be poor planning or simple negligence, permits the hydrolysis of the glucoside to HCN, the first step in detoxification. Leaves are then cooked twice. The first boiling water containing the now soluble HCN is wrung out of them and discarded. The second cooking is frequently by steam, but may involve cooking in coconut cream. The resulting vegetable is high in protein and vitamin A, and probably very low in toxins.

Roots are classified by stem color during harvest and their subsequent processing depends upon that original assessment. Toxic varieties are peeled, thus removing the site of the most concentrated toxins, then cut and soaked overnight before being sun dried for several days.
Of all the processes for detoxifying cassava root, this one is least likely to be complete. Most of the cassava dried in this form is exported from the village. These procedures are not so complicated they cannot be done at the household level. However, they are time consuming. Considerable specialization has developed in the village. Snack making from toxic cassava is channeled through a few households. The desire for a very light color in the snacks insures that the more thorough process involving soaking and grating is followed, rather than sun drying.

For the cassava roots judged to be less toxic, each household processes its own occasional harvest. The post-harvest storage varies from one to three days. During this phase, hydrolysis of the toxin begins. Peeling, as with the more toxic types, removes the concentration of toxin. Household cooking procedures include baking, boiling, deep frying or steaming. Each of these in combination with a variable storage time, has varying efficacy in removing the toxin. Efficacy of the procedures rests predominantly on the length of storage after harvest. Thus the HCN potential of the home-processed cassava must also vary from low to moderate.

It appears that diligent traditional preparation using the natural processes of wilting and fermentation preceding cooking of cassava roots and leaves is highly effective in reducing the HCN. Indonesian researchers found no elevated blood or urine levels of HCN in a cassava-dependent area of central Java known as Gunung Kidul. 20
Summary: Processing of Goitrogens

Overall, women expend much effort toward the detoxifying of foods. Judicious selection of plant parts, the peeling away the parts of highest toxicity plus drying, wilting, grating, and boiling more than once, are all employed. There are probably residual toxins in all of these foods after processing. The unresolved debate over the amount of goitrogens which can be released during digestion in spite of the previous destruction of their enzyme releasers makes evaluation of the success of these household efforts difficult. Certainly some of the most effective of the procedures are those involving the bitter cassava roots and leaves, wherein the natural enzymes are allowed to release the goitrogens by wilting, grating and soaking before the application of heat and water which finishes the volatilization of the HCN. With other goitrogenic vegetables either much less rigorous efforts are made or their efficacy is in doubt. Certainly there must be a continuous moderate exposure to goitrogenous substances enhanced occasionally by the lapses in the cultural armor against them, as in a child's ingestion of raw Leucaena seeds or a nursing mother's deliberate consumption of a bitter dish of papaya leaves.

Any HCN surviving the detoxifying techniques of the village would have to be detoxified by the body in one of two available pathways. The two processes eventually change HCN to thiocyanate, a goitrogen which is, however, a 200-fold reduction in toxicity. Vegetarians are reported to use the pathway which produces most goitrogen,21 because of a shortage of vitamin B-12. However, the Javanese have a rich
source of that vitamin in their fermented fish paste, *trasi*. Fish paste is consumed regularly by most households but most faithfully by those in the upland hamlet which depends on cassava for a staple.

**Goitrogen Consumption By Economic Levels**

Unequal access to foods which must be purchased and foods which are gathered locally suggest the possibility of different patterns of consumption of goitrogenic vegetables among the widely divergent classes of wealth in the village. Goitrogenic vegetables fall into four categories (Figure 5.4). Crucifers are exclusively of marketed origin and the various individual species in the "other" category such as cassava and papaya leaves fall exclusively into the local,
non-marketed category. Umbelliferae and Leguminosae are both marketed and are grown locally. These four kinds of goitrogens appear in unique patterns of household consumption at the various levels of the economic ladder. There are distinct seasonal variations in the consumption of cabbages. February, which is early in the wet season before crops can be harvested is the low point and, June, the wedding month, is the peak (Table 5.4). The wealthiest group in the village, the elite of the lowland hamlet, which represents 10 percent of all households, eats cabbage at higher levels throughout the year. The other households eat cabbage with any regularity only in June, when the harvest has just been completed and many have cash and an adequate supply of a basic staple. The lower economic category of households of the cassava-based upland hamlet reported an anomalously high frequency of cabbage consumption in the dry season when the supply of local leaves dry up and they are forced to buy small amounts of cabbage.

Umbelliferae consumption, which function exclusively as spices, is a constant in that spices are needed for every dish. In plentiful seasons, as after spring harvest, more dishes are cooked and the amount of Umbelliferae increases accordingly. The elite of the lowland hamlet, in contrast to other groups, prepare numerous side dishes throughout the year. Accordingly, goitrogen use increases with household resources.
Table 5.4

Cruciferae Frequency in the Diet

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite</td>
<td>0.4</td>
<td>0.4</td>
<td>1.2</td>
</tr>
<tr>
<td>middle</td>
<td>0.25</td>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>poor</td>
<td>0.14</td>
<td>0.0</td>
<td>0.53</td>
</tr>
<tr>
<td>Upland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>upper</td>
<td>0.29</td>
<td>0.14</td>
<td>0.29</td>
</tr>
<tr>
<td>lower</td>
<td>0.57</td>
<td>0.0</td>
<td>0.43</td>
</tr>
</tbody>
</table>

* Number of reported dishes containing crucifers in the two days of survey each season.
** Refer to definitions of economic levels in Chapter II, pages 58-60.

Total legume preparation, of both market and garden origin, is high in all economic levels and shows little seasonal variation (Table 5.5). The elite of the lowland rice hamlet are the highest and most consistent consumers. This even seasonal pattern is achieved by the importation of string beans in the dry season and by a widespread and high consumption of soybean cake. Separating out the soybean consumption we can see the popularity of this household industry and the ability of the elite to consume it more than twice as frequently as people in the next economic level, the middle class of the lowland hamlet (Table 5.6).
Table 5.5

Legume Frequency in the Diet

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland hamlet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite</td>
<td>2.6</td>
<td>2.6</td>
<td>2.2</td>
</tr>
<tr>
<td>middle</td>
<td>1.13</td>
<td>1.0</td>
<td>1.25</td>
</tr>
<tr>
<td>poor</td>
<td>1.2</td>
<td>1.0</td>
<td>1.13</td>
</tr>
<tr>
<td>Upland hamlet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td>0.85</td>
<td>0.57</td>
<td>1.14</td>
</tr>
<tr>
<td>Lower</td>
<td>1.3</td>
<td>0.57</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*Number of reported dishes containing legumes in the two days of survey each season.

Table 5.6

Soybean Cake Frequency in the Diet

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland hamlet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>elite</td>
<td>2.4</td>
<td>2.2</td>
<td>1.8</td>
</tr>
<tr>
<td>middle</td>
<td>1.0</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>poor</td>
<td>0.75</td>
<td>0.6</td>
<td>0.73</td>
</tr>
<tr>
<td>Upland hamlet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>upper</td>
<td>0.42</td>
<td>0.43</td>
<td>0.71</td>
</tr>
<tr>
<td>lower</td>
<td>1.28</td>
<td>0.57</td>
<td>1.0</td>
</tr>
</tbody>
</table>

* Number of reported dishes containing soybean cake in the two days of survey each season.
In another perspective on the same data, of 126 household diet interviews, 102 included dishes with soybean cake. By comparison, 43 reported cooking cabbage dishes, the second most popular dish reported. Considering the variety available to the village through the market, gardens, or opportunistic gathering, the popularity of soybean cake and cabbage is striking.

In the consumption of the composite category of local vegetables including cassava and papaya leaves, the behavior of the lowland elite contrasts with that of the rest of the village (Table 5.7). Elite households do prepare locally-grown goitrogenic vegetables as do other economic categories, but the frequency is low and stable over the year. The middle level of households from the lowland hamlet follow this pattern but at a higher level of consumption. By contrast, the poor of the lowland hamlet and both levels of the upland hamlet show strong seasonal swings in their consumption of the local vegetables, with the peaks coinciding with seasons of ample rainfall. In the dry season, the poorer households in the village are forced to buy small quantities of cabbages, but for most of the year, when rainfall permits abundant local vegetable harvesting, the poorer groups consume local vegetables, predominantly, cassava leaves, and papaya leaves in that order of popularity.
Table 5.7

Local Vegetable Frequency in the Diet

<table>
<thead>
<tr>
<th>Economic level</th>
<th>Average number of side dishes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland hamlet</td>
<td></td>
</tr>
<tr>
<td>elite</td>
<td>0.6</td>
</tr>
<tr>
<td>middle</td>
<td>0.87</td>
</tr>
<tr>
<td>poor</td>
<td>0.42</td>
</tr>
<tr>
<td>Upland hamlet</td>
<td></td>
</tr>
<tr>
<td>upper</td>
<td>0.71</td>
</tr>
<tr>
<td>lower</td>
<td>0.57</td>
</tr>
</tbody>
</table>

The consumption patterns of wealthier households, in particular those of the elite of the lowland hamlet, do not reflect the seasonal availability of imported or local produce. Economic advantage, then, is a definite force in determining which of the goitrogenic vegetables available will be consumed in a household. Wealth does not afford an escape from the threat of goiter as will be seen below.

Total Goitrogen Consumption by Economic Level

The pattern of goitrogen burden across the community is obscured by the many vegetables involved, that are differentiated by price, distance to source of supply and by the relative popularity in the local diet. Effective goitrogenicity only partially depends on the gross amounts of vegetables consumed, but also upon the traditional detoxification procedures.

In an effort to summarize goitrogen burdens on the different economic levels and the two hamlet types, I developed a formula to
incorporate estimates of the degree of detoxification and the amounts of each vegetable consumed. As in the interpretation of the average goitrogen scores by economic levels, these scores can be taken only as relative indications of goitrogen burden. The formula is as follows:

Goitrogen score = (Cruciferae x 1) + (Legumes x 1) + (Umbelliferae x 1) + (cassava x .25) + (other local leaves x .25) + (soybeans x 1)

The data used in the formula derive from a household diet survey conducted in three seasons with a 20 percent stratified sample of two hamlets, one of them a lowland rice-based hamlet and the other an upland cassava hamlet. (See the discussion explaining the diet survey in chapter II, pages 26-29.)

Average goitrogen scores for the five economic levels are displayed in Figure 5.5. The much higher goitrogen consumption levels of the elite 10 percent of households are clear. The middle and lower classes of the rice hamlet and the two classes of the upland hamlet are strikingly similar in their lower pattern of goitrogen consumption. However, since cassava root consumption was underreported most strongly by the poorest classes who depend on it for a major supplier of calories, the goitrogen scores of the lowest classes are probably underestimates.
Average Household Goitrogen Scores

Figure 5.5
Based upon this observed disparity we can predict that the village elite families suffer more serious risk of goiter than the poor. According to my informal observations the wealthy were certainly not exempt. Most of the elite women and children had obvious goiter, but the goiter survey conducted by the Indonesian Department of Health collected no socioeconomic data about individuals. They simply counted goiters. Thus the information to explore the suggested effect of the increasing wealth to increase goitrogens in the diet is not available.

Intra-household Allocation of Goitrogens

In addition to the traditional processing of potential goitrogenic foods, there are elaborate social rules that regulate each individual's consumption of these foods. The socially approved proportion of side-dishes to rice is more a decoration than a serving. At formal parties, funerals and other public eating situations where food is served formally, the ideals are clearly executed. For example, only one piece of soybean cake of the standard size and shape made in this area (approximately two inches by three inches by one-half inch) accompanies an entire plate of rice. Appropriate amounts of side dishes for this same rice plate are the size of a level tablespoon. Excessive spicing of side dishes reinforces the ideal of small helpings and reduces the amount each family member can consume. More than once cooks expressed the idea that if side dishes were less spicy, their family would eat more than they could afford.
Likewise, in everyday eating situations, the proportions on a plate are usually dictated by someone other than the consumer. People do not serve themselves. For example, in food for work situations the employer allocates only an amount of side dish considered socially appropriate, that is, minimal. And in most households on a daily basis, the mother or an older sister allocates food by the actual dishing of the plate (diambilkan). Occasionally an elite household will use “Dutch-style” service. In this case food is presented in serving bowls to the father and guests. People served Dutch style are expected to obey the proportions understood to be polite. In commercial situations, too, it is in the interests of the restaurant owner to dish up the plates economically, that is, to be saving of the side-dishes. As strong as the social dictates are, they are not completely effective. A few individuals may suffer the effects of their own indulgence. The poor of the village substitute staples which must be purchased with free leafy vegetables according to seasonal availability.

The effect of these social rules reduces the amount of goitrogens consumed by the individual. The staples, consumed in quantity, play a neutral role in the cases of maize and rice, processed cassava, and "cassava rice". Exceptions to the allocation system are children who eat raw seeds, leaves and flowers out of sight of the adults.

In addition to the general social rules for food allocation described above, that of foods to infants both before and after birth is of interest in the context of endemic goiter and its concomitant, cretinism. The neurological damage to cretins is thought to occur
early in development. Thus, the diet of pregnant women assumes great importance. Interviews with roughly 200 young mothers asking them to report pregnancy food taboos and prescriptions revealed that no specific foods are prescribed during pregnancy. Pregnancy cravings are highly idiosyncratic and always met because of a belief that it is the fetus that craves.

Both during pregnancy and after birth, many foods are forbidden to the mother (Table 5.8). The logic of the tabooed foods in pregnancy is in many cases based in sympathetic magic. For example, eating snails which are reluctant to come out of their shell, or bee's larvae still in the honey comb, could produce a difficult birth. Or a woman who eats strange looking meat may give birth to a baby that looks just like cartilage. The three goitrogen-containing foods mentioned are in the list for nursing mothers to avoid: papaya, blanched mixed vegetable salad, and watercress. The lists concentrate on avoidance of certain iodine bearing foods (fish flakes and shrimp), and do not develop any consistent pattern of avoidance of goitrogenic vegetables. As such they appear to be maladaptive to the problem of special iodine requirements during pregnancy and lactation.
Table 5.8
Foods Tabooed During Pregnancy and Nursing

<table>
<thead>
<tr>
<th>Taboo During Pregnancy</th>
<th>Taboo During Nursing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gnetum gnemon leaves</td>
<td>Strong smelling meat</td>
</tr>
<tr>
<td>snails</td>
<td>Chili</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>Goat meat</td>
</tr>
<tr>
<td>Cartilage</td>
<td>Gnetum gnemon leaves</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>Watercress</td>
</tr>
<tr>
<td>Breadfruit</td>
<td>Fish Flakes</td>
</tr>
<tr>
<td>Eggs</td>
<td>Mushrooms</td>
</tr>
<tr>
<td>Bee larvae</td>
<td>Breadfruit</td>
</tr>
<tr>
<td>Shrimp</td>
<td>Ripe banana</td>
</tr>
<tr>
<td>Fried rice</td>
<td>Jackfruit</td>
</tr>
<tr>
<td>Coconut sap sugar</td>
<td>Coconut milk</td>
</tr>
<tr>
<td></td>
<td>Papaya</td>
</tr>
<tr>
<td></td>
<td>Blanched salad</td>
</tr>
<tr>
<td></td>
<td>Garlic</td>
</tr>
<tr>
<td></td>
<td>Sweet fruits</td>
</tr>
</tbody>
</table>

Individual taste

From the preceding discussion it is clear that food choice in this highland Javanese village is bounded by social conventions, economic standing, and the lack of variety on any particular day. Nonetheless, some small measure of choice remains to the individuals. Thus, the ability of this goitrous population to taste the goitrogenic bitter chemicals in their food is of interest.

The sense of taste is often interpreted as a protective and survival mechanism in animals mediating the selection of a most important part of the environment, specifically, the food resource.
For man, the bitter taste is usually evaluated as undesirable, a piece of folk wisdom corroborated by pharmacological research, which has shown that bitter compounds are often drugs or poisons. However, in the Banyumas dialect of Javanese, bitter can be expressed two ways, *aur* or *pait*. *Aur* is always delicious; *pait* may be.

Since its discovery, the phenomenon of individual variance in sensitivity to the bitter and goitrogenic thiourea chemicals, occurring widely in domesticated vegetables, has been widely used as a genetic marker for human populations. It is probably the only taste modality which has been systematically tested in many cultural and racial groups. The percentage of any population insensitive to the taste of the thioureas is usually far less than 50 percent, ranging from 1-8 percent in American Indians, Chinese and Africans, to 45-61 percent of Greenland Eskimos. In Caucasian groups, the distribution of which approximates the distribution of the Indo-European language family, insensitivity ranges between 25 and 35 percent of the population. Other than the slight decline in sensitivity with age and smoking and the differences between the sexes, no environmental effects on taste sensitivity have been found.

Despite the unanimity of genetic research findings regarding the non-modifiability of thiourea taste sensitivity, animal research suggests sensitivity itself may be modifiable by the environment. Dukes' *Physiology of Domestic Animals* states that the chicken's sensitivity to salt and bitter is reduced by a thyroxine shortage. A study of non-human primates suggested that cabbage in the diet and
possibly other unknown factors could decrease thiourea taste sensitivity. By contrast, the impact of particular environmental factors on the expression of human ability to taste goitrogens, and therefore, to reject them, is virtually unexplored.

Compared to other populations, this population was quite insensitive at the time of the first test. If the division between sensitive and insensitive in PROP trials of other researchers is observed, the antinode is almost always at the ninth or tenth solution (Table 5.9).

In the standardized test, solution strengths double from numbers 1 to 15, but in my series the strength is quadrupled between each step. Table 5.9 shows the frequency distribution of taste thresholds for PROP trials and illustrates how my solution concentrations compare to those in other studies. Based on the consistency with which the data falls into a bimodal curve with the antinode at solution number nine, I am drawing the line between sensitive and insensitive tasters there, between concentration numbers eight and ten. By this criterion, 46 percent of Prigi's population was insensitive to PROP at the original testing. This finding is highly unusual in contrast to other findings in Southeast Asia.²⁸,²⁹
Table 5.9

Frequency Distribution of Taste Thresholds for Various PROP<sup>a</sup> Trials

<table>
<thead>
<tr>
<th>Source</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisher and Griffin, 1961</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>-</td>
<td>48</td>
</tr>
<tr>
<td>Fisher et al., 1965</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>15</td>
<td>12</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>66</td>
</tr>
<tr>
<td>Glanville &amp; Kaplan, 1965</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>11</td>
<td>20</td>
<td>29</td>
<td>25</td>
<td>16</td>
<td>18</td>
<td>8</td>
<td>7</td>
<td>9</td>
<td>187</td>
<td></td>
</tr>
<tr>
<td>Fisher and Griffin, 1974</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>20</td>
<td>34</td>
<td>26</td>
<td>17</td>
<td>28</td>
<td>31</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>228</td>
<td></td>
</tr>
<tr>
<td>Kaplan et al., 1976</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>11</td>
<td>37</td>
<td>62</td>
<td>94</td>
<td>36</td>
<td>55</td>
<td>58</td>
<td>67</td>
<td>40</td>
<td>23</td>
<td>10</td>
<td>505</td>
</tr>
<tr>
<td>Chapman&lt;sup&gt;c&lt;/sup&gt; (1977)</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>48</td>
<td>-</td>
<td>177</td>
<td>-</td>
<td>97</td>
<td>-</td>
<td>43</td>
<td>45</td>
<td>-</td>
<td>-</td>
<td>411</td>
</tr>
<tr>
<td>Chapman&lt;sup&gt;c&lt;/sup&gt; (1978)</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>7</td>
<td>-</td>
<td>124</td>
<td>-</td>
<td>166</td>
<td>-</td>
<td>66</td>
<td>-</td>
<td>26</td>
<td>22</td>
<td>-</td>
<td>-</td>
<td>411</td>
</tr>
</tbody>
</table>

<sup>a</sup>6-n-propyl-2-thiouracil

<sup>b</sup>Solution numbers are adjusted to Glanville & Kaplan, 1965, equivalents

<sup>c</sup>Author's field tests.
This degree of insensitivity to the goitrogens in cabbage and carrots results from relative iodine deficiency and must necessarily impair individuals' ability to reject goitrogenic foods. Thus the factors which cause goiter in Prigi, the marginal iodine supply and abundance and variety of goitrogens, act in a vicious circle to reduce taste sensitivity to goitrogens, and to ensure their continued high consumption.

In early 1977, 547 men, women and children in six hamlets of the endemic goiter village were tested for their sensitivity to PROP, a goitrogenic thiourea chemical related to the chemicals in cabbage. Near the end of the field study, the entire county received injections of Lipiodol iodized oil. Iodized oil injections have been used increasingly over the last 25 years for prophylaxis of goiter where infrastructure and administrative capacities make iodized salt and other schemes unfeasible. The shot in the upper arm establishes a reservoir of iodine which is released first rapidly, then continuously at a lower rate for up to five years. Because men do not usually suffer from large goiters and it is the iodine deficient women who may bear cretinous children, both sexes up to the age of 22 and women of childbearing years received injections.

Individuals who had been to all appearances iodine deficient in 1977 were now amply supplied with iodine. Four-hundred and eleven of the original 547 men women and children were retested between May and July, 1978, 15 to 18 months after their initial test.

After iodized oil injections, there was an increase of individuals in the lower concentrations at the expense of the higher, a trend toward improved sensitivity in the population (Table 5.10).
At the second testing, only 27 percent were insensitive by the original definition given above. A t-test for paired samples reveals a t-value of 9.11 (P < .01). In other words, although the same 411 individuals were retested the results are different enough to declare they were samples drawn from two different sampling populations.

Table 5.10
Percent of Prigi Sample in PROP* Taste Thresholds Before (Test #1) and After (Test #2) Iodized Oil Shots

<table>
<thead>
<tr>
<th>PROP Concentration Level</th>
<th>Test #1</th>
<th>Test #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>.2</td>
<td>1.7</td>
</tr>
<tr>
<td>4</td>
<td>11.7</td>
<td>30.2</td>
</tr>
<tr>
<td>6</td>
<td>43.0</td>
<td>40.4</td>
</tr>
<tr>
<td>8</td>
<td>23.6</td>
<td>16.0</td>
</tr>
<tr>
<td>10</td>
<td>10.5</td>
<td>6.6</td>
</tr>
<tr>
<td>12</td>
<td>10.9</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Note: * 6-n-propyl-2-thiouracil solution numbers follow Glanville and Kaplan, 1965. Solution strengths quadruple between level 2 and 4, for example, with solution number 12 being the strongest.

A breakdown by whether or not tested individuals had received the iodine injection at the time of the second taste test revealed that the pattern of improvement held true in both groups. Improvement
was less dramatic in the group that said it did not get an iodine injection. Probably the general benefit of the injections to the entire community is due to the heavy excretion of iodine in the urine of those who received iodine. In a New Guinea community, improvement in goiter size of both the iodinized and the controls was attributed to the "primitive water system". The same mechanism may be at work here.

The dietary pattern probably did not change between the taste tests. Thus, the results of the second test cannot be interpreted as an accurate reflection of the intrinsic sensitivity of the population to thiourea since the residual 27 percent insensitive taster rate is still higher than would be expected in a Southeast Asian population. The new sensitivity probably reflects a new balance in the iodine to goitrogen ratio for the population. The old insensitive percentage of 47 percent reflects the traditional balance of a highly goitrogenic diet and a marginal iodine supply.

The final word on this subject of taste sensitivity and food choices in an environment with dietary hazards is written by custom. In a vegetable desirability ranking exercise with 50 elementary school children who had been tested for thiourea sensitivity both before and after the iodine shots, there seems to be little relationship between old or new sensitivity scores and the degree of preference for goitrogenic vegetables. The lack of correlation may be due to the number of children who told us they disliked a vegetable they had never eaten. They had avoided it on the basis that someone told them it was bitter or untasty. During the exercises I saw this in action several times when teachers or parents coached a child to evaluate a
vegetable as untasty by shouting, pait, pait (bitter, bitter). The implications of this custom are that any eating group needs only one person who can taste the goitrogen. He or she will probably discourage the children of the group from trying the vegetable. Thus cultural co-operation and communication of sensory information supersedes a biological handicap brought on by the disease state.

**Conclusion**

Substantial amounts of goitrogenic vegetables are consumed in the goitrous village of Prigi both from local production and imported sources. Because of the recent volcanic origin of both areas, vegetables from either source will contain very little iodine. Cruciferae from the geologically active Dieng Plateau are more goitrogenic than samples grown on low sulfur soils. Not only are goitrogen-bearing vegetables abundant, they are highly goitrogenic. Local processing with traditional techniques is partially effective, but the degree difficult to assess. Generally the wilting, chopping, drying, blanching and severe paring combined with double boiling have the effect of reducing the level of goitrogens available to the community.

Goitrogens are so abundant both in purchased and local vegetables that wealth does not protect against goiter hazard. While some goitrogenic vegetables are available locally at no cost, all the imported vegetables must be purchased. Thus, there is a disparity in the kind of goitrogen consumed by different economic levels. The elite 10 percent can afford to eat less cassava, and more cabbage, soybean cake, beans, cresses, and carrots in their diet. Its wealth, and notion of desirable foods in the context of the abundance of
available goitrogens from the Dieng Plateau, increase its total goitrogen consumption beyond the moderate level of the other 90 percent of the village inhabitants. However, this lower level of goitrogen intake is sufficient to contribute to the 62 percent goiter rate in the village.

Relative iodine deficiency brought on by a minimal supply of iodine overburdened by goitrogens in the diet has produced a taste handicap toward the goitrogens, and reduces ability of individuals to reject toxic vegetables. Possibly as a response to individual taste deficiency, cooking procedures partially detoxify most goitrogenic vegetables and household rules limit the size of portions consumed.
References


Abstract

This case study of one village on the edge of the Dieng Plateau stands as an example of a goitrogenic environment where prophylaxis based entirely on the hypothesis of absolute iodine deficiency can be only partially successful. After an expensive iodine injection program, the action of goitrogens in the diet is still apparent. In many similar Third World contexts, goiter may be complicated by an active goitrogenic vegetable diet. In addition to the requisite goiter survey, the diet should be surveyed for active goitrogens, particularly those which custom does not detoxify or carefully allocate. A goiter prevention policy should then be developed for each community which would include an appropriate emphasis on iodine supplements and diet modification.

Summary and Integration of Findings

Iodine/Goitrogen Ratios

My research in one of the highly goitrous villages, chosen by the Indonesian Department of Health for iodization programs, documents goiter which is not the result of absolute iodine shortage. A seafood importation scheme supplies iodine to the interior of Java. It has presumably operated for centuries.
Despite a 62 percent goiter rate, 90 percent of the village households consume iodine-bearing seafoods on a regular basis. Amounts are not large and there has recently been some erosion of iodine supply for certain categories of people. Women, children and the poor received less dietary iodine as monosodium glutamate grew in popularity over the last decade, replacing fish flakes as a condiment. However, the elaborate system of importing seafoods from the coast probably supplies just short of the 150 milligrams recommended per capita each day to prevent goiter. The 62 percent goiter rate must be a result of the large number and volume of goitrogenic vegetables in the diet.

Although gross patterns of goitrogens and iodine consumption in the case village vary by levels of household resources, as was shown in chapters IV and V, it would be a mistake to treat those average household scores as real numbers. Some general comparisons between iodine intake and goitrogen load are possible, however.

The elite of the upland hamlet, constituting only 3 percent of the upland hamlet, fare the best. They have high iodine scores constant throughout the year and only a moderate goitrogen score. This is the result of a very traditional diet pattern combining a variety of local vegetables with fish stew made in quantity and eaten continuously until it is all consumed. Their staple is more frequently rice and corn than cassava, thus lowering their total goitrogen score.

The lowland elite, approximately 6 percent of the population, have the worst diet from the perspective of goiter hazard. They choose to consume expensive local meats in place of preserved seafood.
much of the year, thus severely reducing their iodine supply. Their supply of goitrogenic side dishes is varied and abundant. Thus they combine the highest goitrogen scores with the lowest iodine scores. Of course, they are eating a better diet from most other nutrition perspectives and thus appear more robust and healthy than the rest of the village. Their complacency and confidence that public health efforts are for the poorer members of the population will make them a difficult group to treat.

The majority of the population falls into neither of the above groups. In middle and poor households iodine consumption is consistent throughout the year but depressed by inability to buy more of the dried fish. It is this group who depend most heavily on cassava root for their calories, rather than corn or rice. They refused to admit cassava root consumption and thus their recorded goitrogen scores are certainly far too low. For this large group, economic deprivation is a major cause of diet pattern and consequently of disease prevalence. Small improvements in disposable income might improve the iodine/goitrogen ratio of the diet, allowing increased fish consumption and the substitution of rice for cassava. But with higher incomes there is the likelihood that they might emulate the diet pattern of the elite. This would erode the iodine supply as local meats were substituted for fish and more cabbage could be purchased.

Based upon the above observations goiter should be most prevalent among the poor and the elite lowland households and lowest among the elite uplanders. Comparison of these predictions to real rates is not possible because the goiter survey done by the Indonesian
Department of Health did not collect data on the economy of the
dividuals surveyed. The public health nurse who did the survey gave
his impression that there was less goiter in the upland hamlets. This
observation confirms the direction of the prediction based on the
iodine/goitrogen ratios from the diet survey.

The Etiology of Goiter

Understanding of the etiology of endemic goiter can be
illuminated by examining the successive refinements of my model for
goitrogenesis as the research progressed. At the outset, I proposed
that the model of simple iodine deprivation was an insufficient
explanation for endemic goiter foci remaining in developing countries
and that goitrogenic plants might play a part. I anticipated that
there might be evidence of cultural responses to the goiter hazard in
prescriptions for the distribution of iodine and goitrogen-bearing
foods. Inherited low population taste sensitivity to the thiourea
goitrogens in vegetables would play a permissive role, allowing the
consumption of a highly goitrogenic diet.

In Prigi a continuous low level of iodine supplied to the
village by importing preserved seafood products provided the
justification for searching for non-iodine causes of goiter in the
area. They were not hard to find. Goitrogenic vegetables constitute
a substantial part of the diet. In addition to the cabbage and spices
imported from the Dieng Plateau, an abundance of local goitrogenic
vegetables, bring the total to 35 suspected goitrogens. Several of
these are consumed on almost a daily basis. Traditional preparation
techniques are probably only partially successful in detoxifying the
vegetables. Increasing access to resources does not afford safety from the goiter hazard since the elite households consume less dried fish products and increase their burden of vegetable goitrogens.

Thus far the research results confirm, rather than reject, the propositions I began with. However, one set of data was so unusual that it demanded further explanation. Initially the population's ability to taste salt and thiourea bitters was one of the lowest ever recorded for a human group. Even more unusual, the original subjects' ability improved dramatically after iodine prophylaxis. There is little precedent in 50 years of taste research by geneticists and physical anthropologists or medical researchers to explain these results.

Before and after taste tests on the same sample with an intervening highly successful iodine prophylaxis provided invaluable information. Not only is thiourea taste sensitivity modifiable by the nutritional environment, but taste sensitivity acts as a barometer, in this case, to two different balances between goitrogen and iodine supply. At the outset of the study, before any public health intervention, one iodine/goitrogen ratio prevailed. A minimal iodine supply was being overpowered by goitrogens acting in different capacities, that is reducing iodine absorption, reducing uptake into the thyroid, reducing production of thyroxine, and in other areas of the body, reducing the usefulness of circulating thyroxine. This iodine/goitrogen ratio was reflected in the population's unusually low taste sensitivity for thiourea.

At the repetition of the taste test on the same subjects, the most conspicuous intervening change was the prior intervention of the
iodine prophylaxis. Diets had not changed. The level and types of goitrogens remained unchanged. Taste sensitivity for both salt and thiourea bitters was dramatically improved. Clearly the ratio of goitrogens to iodine had changed, due to the massive increase in available iodine. But the number of residual insensitive tasters in the village, 27 percent, is still high by contrast with other Southeast Asian populations. By this barometer we can surmise that certain of the goitrogens which cannot be overridden by iodine are diminishing taste sensitivity to the thioureas even after the iodine injection campaign. Other signs such as goiter, cretinism, and reduced neuromotor coordination may also continue to occur in a small percentage of the population due to the residual effects of the goitrogens. Iodine prophylaxis is not sufficient for endemic goiter communities of the type Prigi represents.

I am not suggesting that all or even most of the endemic goiter found in Indonesia is due to the particular goitrogenic vegetables delineated here. However, the example of Prigi and villages that fringe the Dieng Plateau suggests that elsewhere in Indonesia unique complexes of iodine supply, goitrogenic diet, and cultural and behavioral practices are operating. Food plants other than those in the diet of Prigi may be involved. Certainly the possibility of complication of endemic goiter by goitrogenic diets must be considered in Indonesia and other developing countries where isolation and poverty contribute to the overall picture.
What We Know, What We Need to Know

This medical geographic case study of disease etiology is an example of the benefits of a broad behavioral ecological approach to disease. The following findings derive directly from the study:

1. There is a traditional iodine supply system to villages rimming the Dieng Plateau via a long extant seafood import scheme.

2. The high rate of endemic goiter in the case village and others like it in highlands central Java is a result of a minimal iodine supply over-burdened by a combination of 35 goitrogenic vegetables. The goitrogenic vegetables most frequently consumed are cassava root and leaves, cabbages, soybeans and papaya leaves.

3. Taste sensitivity for salt and thiourea, a goitrogen, was remarkably depressed by the original low iodine/heavy goitrogen ratio. This previously unsuspected symptom of endemic goiter affects, in turn, the eating habits of entire communities.

4. Iodine supplementation alone cannot correct the goitrogenic system here. Evidence that goitrogenic vegetables are still affecting the system lies in the residual taste insensitivity, despite much improvement, after the iodized oil injection campaign.

5. A detailed understanding of the pattern of processing and consumption of the relevant foods is presented upon which further research and prophylactic action can be based.
These advances in understanding the etiology of endemic goiter point to new areas where more technical and laboratory research should be done:

1. How effective are the local processing techniques in reducing goitrogenicity of soybeans, papaya and cassava leaves or cassava root? Improved processes that can be done at the household level with simple technology should be developed.

2. How precisely is taste insensitivity to thiourea a reflection of the iodine/goitrogen ratio? The test needs further development before it can be used as a non-invasive technique for discovering goitrogens in the diet which cannot be overridden by iodine supplementation.

The Problem of Goiter Prophylaxis

The Problem of Goiter

Fifty years after the implementation of iodization prophylaxis in Europe and North America, endemic goiter and cretinism have almost disappeared, but they remain prevalent today throughout the Third World. Our appreciation of the real damage of the disease of goiter has grown over the last decade with increased attention from medical researchers. Not only can an endemic goiter community expect a rate of cretinism between one and eight percent, but the non-cretinous population can be expected to have a prevalence of irreversible neuromotor damage up to 20 percent. Until recently, the goitrous populations in question lived as peasant farmers under simple technological regimens, but increasingly developing countries are
introducing machinery in factories, in raw material processing plants
and transportation which demands accuracy and dexterity from the
worker. The neglect of endemic goiter, always unconscionable, should
now be rectified by programs of effective prophylaxis. Errors or
omissions in the model of goiter etiology, upon which prophylaxis will
be based, must be made clear and incorporated into these programs.

If prevention of cretinism is taken as the most salient goal of
iodine supplementation programs, more assurance is necessary that
iodine supplements alone can counteract the effect of goitrogen in
crucial stages of human development, fetal stages and early post-natal
life. There has been no research published, for example, on the
efficacy of iodine in preventing cretinism in the children of mothers
whose diets include regular servings of unprocessed papaya leaves.
The same statement could be made for most of the 35 goitrogenic
vegetables in the Prigi diet. The two areas which report reduced
cretinism after iodized oil campaigns, Papua New Guinea and Zaire,
claim to have only one dietary goitrogen, that is cassava root. In an
iodated population whose source of goitrogen was crucifers (Tasmania)
high rates of goiter remained.

Endemic goiter and cretinism

To further this cause I have reviewed the growing trend in
goiter research literature, beginning slowly in the late 1960's and
finally blossoming in the late 1970's, toward the consideration of
non-iodine or goitrogenous causes of endemic goiter. The early
literature consisted of independent research efforts attributing
goiter to a wide variety of agents, for example, to cassava in Zairel
or to bacterial agents in water in the Andes. They seemed to have
little in common and, perhaps inevitably, were not considered part of
the mainstream of goiter research. However, since 1975, when I
proposed to investigate non-iodine causes of goiter in Indonesia, two
excellent review articles have appeared, establishing a large number
of naturally occurring goitrogens in dietary items.3,4

Despite the growth in number and visibility of these reports
wherein vegetable goitrogens are established as etiologic agents in
endemic goiter, the research findings have not been incorporated into
goiter prophylaxis programs. One chapter on goitrogens is included in
the recent impressive compendium intended to update the 1960 Kelly and
Snedden volume,5, a work which has stood for 20 years as the world's
most comprehensive survey of goiter. The same volume contains a major
section on goiter prophylaxis, a comprehensive and sophisticated
approach in eight chapters considering especially political, social
and technical barriers to goiter prevention.6 However, over 100 pages
are devoted to iodine delivery and only one brief sentence mentions
the possibility of confronting the complications of goitrogens.

The leading article in the section which focuses on goiter
prophylaxis begins: "There is still a lag between the availability of
knowledge and its application to the prevention of endemic goiter and
endemic cretinism."7 I can only comment that the editors themselves
are guilty of the error. Knowledge of vegetable goitrogen involvement
evidenced in their own volume is not being incorporated into goiter
prophylaxis. Instead, the model of goiter prophylaxis presented in
this volume reflects the idea that single, simple technological
interventions can solve the problem, as is epitomized by the
development and increasing popularity of programs of iodized oil injections.

Only one article in this most recent consideration of the state of the art of goiter prophylaxis considers the problem of the simplistic notion of the iodine "program" against endemic goiter versus the more sophisticated notion of a "goiter policy". This latter is a broader concept based on the idea that disease is the outcome of multiple interactions between people and their environment and as such is susceptible to multiple intervention. A goiter policy can be re-examined and changed in the light of new information from the scientific community, or from the goiterous areas themselves.

In the history of goiter prophylaxis in Indonesia, one probably not atypical in the Third World, we can see the suggestions of various specialist advisory groups such as the group mentioned above. Endemic goiter was rediscovered in the early 1970's after being forgotten for three decades in the upset of war, revolution and the early years of nationhood. The early stages of rediscovery were marked by several medical studies employing collaboration between Indonesian doctors and European doctors. The next stage involved training public health nurses to diagnose and survey for goiter throughout the archipelago. Even before that phase was complete, the national Department of Health with funding from several international sources (UNICEF, OXFAM) planned and executed a prophylaxis based on the idea that the cause of goiter is simply a deficiency of iodine. It first planned a program to iodize and distribute salt, but when the distribution failed in parts of Java, an iodized oil injection program followed in less than a year.
Practically speaking, any public health "solution" should be one which is sustainable by the system affected. What is the likelihood of repeating iodized oil injections for the many endemic goiter foci in Indonesia every four years until the turn of the century? It is not unreasonable to insist that from the longest perspective health comes from a people's whole interaction with their environment. This investigation discovered an extant iodine supply system which has reinstated itself after two threats in this century. Culturally maintained restrictions and behavior patterns at several levels limit the populations' intake of goitrogens through processing, allocation and etiquette.

It is reasonable to expect that a public health education campaign which considered extant cultural patterns to be health preserving and enhances them will have more success than one which disregards the human ecosystem.

Application of This Research to Prophylaxis

This case study of one village on the edge of the Dieng Plateau stands as an example of a goitrogenic environment where prophylaxis based entirely on the hypothesis of absolute iodine deficiency can be only partially successful. It is not my intention to challenge the use of iodine in goiter prophylaxis, but to refine the model of goiter etiology beyond that of "iodine deprivation only". Iodine supplementation has been highly successful in the past and should be one of the first actions taken. However, in Prigi and the dozens of
villages in similar circumstances fringing the Dieng Plateau, the
environment, history and economic plight of the people have produced
an intractable goitrogen burden. After an iodized salt distribution
followed by a most expensive iodine injection program, the action of
goitrogens in the diet is still apparent in a taste insensitivity
rate ten percent higher than it should be for Southeast Asia.

Recommendations

The Dieng Goiter Complex

For the particular villages of the Dieng Plateau and surrounding
territory, of which Prigi is only an example, exclusively iodine-based
prophylaxis is unlikely to be totally successful because of the action
of the goitrogens in the diet which cannot be overcome by excess
iodine. An education campaign in combination with the iodine
prophylaxis could alleviate the most serious of the goitrogens. Yet
people cannot be admonished to abandon three-quarters of their diet.
Nor is an economic, transportation and food technology revolution
foreseeable in the near future. Overworked public health nurses and an
occasional doctor suggested not eating soybean cakes, the major
vegetable source of amino acids which in combination with rice make up
most of the protein in the diet. This is impractical and unwise.
Family planning workers were exhorting women attending their meetings
to eat more green leaves, in order to increase vitamin A intake. But
this flies in the face of the etiquette of proper proportions of
side-dishes to staple and, if followed indiscriminantly, would substantially increase the intake of goitrogens. The restrictions on portion sizes are now limiting the amounts of goitrogens individuals can ingest.

In such a highly goitrogenic situation, I believe very focused and limited education campaign should be waged, taking the entire village nutrition picture into account. It is at this stage when detailed knowledge of the distribution of iodine and goitrogen-bearing foods at household and individual levels becomes useful in a multi-leveled prophylaxis. The campaign would involve these steps:

1. Educate to change the aspects of extant taboos during pregnancy and nursing which are highly dangerous, such as avoidance of fish.

2. Educate to institute a few more taboos regarding toxic offenders. Highest on the list must be bitter papaya leaves which are taken deliberately now to improve breast milk.

3. The detoxification procedures already in the cooking techniques should be reinforced and extended to papaya leaves and cassava roots currently classed as non-toxic. Improvements based on laboratory research but possible with household level technology should be taught in simple education programs.

4. Benign green leaves should continue to be encouraged in the diet, while the most goitrogenic ones should be discouraged. Family planning workers should encourage the consumption of only specific green leaves, not all as is currently being done.

5. Encourage a return to fish flakes as a condiment instead of their recent replacement, monosodium glutamate (MSG). The fortuitous
allocation of soup from the vegetables to infants, toddlers and virtually every family member makes it a fit vehicle for iodine distribution. Perhaps the popular MSG itself, could be used as the vehicle for nutrient supplementation, as is being tried in the Philippines. The merits of MSG are far from clear, but its cheap packaging and universal usage do make it a likely carrier of dietary supplements.

Third World Endemic Goiter

The possibility of goitrogen involvement must be raised very early in the discovery of a new goiter focus. Before prophylaxis is planned, preferably during the initial goiter survey, a thorough search of the diet for goitrogens must be made. Information about the distribution and processing of the relevant foods can be incorporated into a multifaceted goiter prophylaxis that includes not only iodine supplementation, but educational and other efforts directed at the intractable goitrogens.
References


Appendix 1
A Glossary of Indonesian Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>aur</td>
<td>A bitter but desirable taste.</td>
</tr>
<tr>
<td>Bahasa</td>
<td>The Indonesian national language.</td>
</tr>
<tr>
<td>Indonesia</td>
<td></td>
</tr>
<tr>
<td>Bahasa</td>
<td>The Javanese language.</td>
</tr>
<tr>
<td>Jawa</td>
<td></td>
</tr>
<tr>
<td>buruh</td>
<td>Unskilled labor.</td>
</tr>
<tr>
<td>diambilkan</td>
<td>A system of dishing up plates for guests or family.</td>
</tr>
<tr>
<td>gado-gado</td>
<td>A blanched vegetable salad consisting of a variety of vegetables such as</td>
</tr>
<tr>
<td></td>
<td>green beans, cabbage, bean leaves, mung bean sprouts, and topped with a</td>
</tr>
<tr>
<td></td>
<td>peanut dressing.</td>
</tr>
<tr>
<td>gamelan</td>
<td>The traditional Indonesian percussion orchestra.</td>
</tr>
<tr>
<td>garam</td>
<td>Salt.</td>
</tr>
<tr>
<td>gatal</td>
<td>To itch. Itchy.</td>
</tr>
<tr>
<td>gondok</td>
<td>A large swelling of the thyroid gland recognised in the study area as</td>
</tr>
<tr>
<td></td>
<td>diseased.</td>
</tr>
<tr>
<td>gudang garam</td>
<td>Warehouse for salt.</td>
</tr>
<tr>
<td>kebon</td>
<td>A mixed garden.</td>
</tr>
<tr>
<td>kuah</td>
<td>The water vegetables have been cooked in.</td>
</tr>
<tr>
<td>kampongan</td>
<td>Showing characteristics of rural backwardness.</td>
</tr>
<tr>
<td>langu</td>
<td>A taste or smell roughly like the smell of green grass. Usually evaluated</td>
</tr>
<tr>
<td></td>
<td>as undesirable.</td>
</tr>
<tr>
<td>ludes</td>
<td>Parents' negative judgement of children's consumption of non-food items</td>
</tr>
<tr>
<td></td>
<td>such as raw seeds, flowers, snails and grasshoppers.</td>
</tr>
<tr>
<td>mabok</td>
<td>Uncoordinated. Drunk.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>mangsa</td>
<td>A Javanese calendar unit varying in length from 21 to 43 days. There are twelve in one year.</td>
</tr>
<tr>
<td>nyelok</td>
<td>A mortar and pestle made of volcanic rock or baked clay used to grind spices for cooking.</td>
</tr>
<tr>
<td>pait</td>
<td>A bitter, undesirable taste.</td>
</tr>
<tr>
<td>panegowang</td>
<td>Literally, a potsherd. One of three closely related plants with small potsherd shaped leaves that ramble around stones in pathways and are occasionally eaten as a vegetable.</td>
</tr>
<tr>
<td>pasaran</td>
<td>A game popular with young girls. They pretend they are market vendors and housewives buying at the market using non-food seeds, leaves and flowers of plants available in the yards. Often the &quot;produce&quot; is eaten raw.</td>
</tr>
<tr>
<td>rese</td>
<td>Dried fishflakes. No salt is added in the process.</td>
</tr>
<tr>
<td>sawah</td>
<td>Rainfed rice terraces that receive enough water to be farmed all year.</td>
</tr>
<tr>
<td>pengairan</td>
<td>Dry, upland areas planted to crops requiring little water, such as cassava and corn.</td>
</tr>
<tr>
<td>tegal</td>
<td>A fermented fish paste resembling cheese in consistency. Used as a base for the local chili relish.</td>
</tr>
</tbody>
</table>
Appendix 2

Plates of the Study Area

Rural villages in Central Java are composed of several densely nucleated hamlets set in the terraced rice fields and gardens.

A goitrous mother may bear cretinous children. This child is probably much older than his height and co-ordination suggest.
A public health nurse demonstrates the correct position for palpating the smaller grades of goiter during a grade school survey.

Cabbage is collected by middlemen in small towns along the Dieng Plateau producing area.
The oldest daughter in this Prigi household learns to grind the characteristic blend of spices in the nylok: onion, garlic, salt, chili and coriander.

By 8 p.m. most of the produce of this Prigi marketwoman is sold. Several varieties of cabbage, salt briquettes, potatoes, greenbeans, turmeric roots and monosodium glutamate packets are visible.
Village cooking is done over a waste-wood fire in a low brick and concrete fireplace. Utensils are of copper, baked clay, aluminum, basketware and plastic.

Two women alternate pounding the hulls off of corn. This implement is nowadays rarely used to hull rice since the gas-powered rice mill is four miles away.
Appendix 3

Summary of the Actions of Goitrogens

Appendix 3.1

Appendix 3.1 constitutes a summary of the referenced tables, and specific references are omitted in the paragraphs below.

Mineral goitrogens

Simple absolute iodine deficiency is the most commonly acknowledged cause of goiter. Excesses of most of the minerals in periodic group VII (chlorine, manganese, fluorine and bromine) have been implicated in goitrogenesis. The mode of action frequently suggested is the competition with iodine for absorption into the thyroid by elements similar in form. Even excess iodine can cause the "iodine goiter" in areas of excessive seaweed consumption in Japan, but the mode of action is uncertain. In normal subjects large doses of iodide inhibit the release of thyroid hormones. This, in turn, sets off the feedback mechanism whereby the pituitary senses the lack of thyroid hormones and chemically orders the thyroid to build up tissue for hormone production. Excess iodine does not result in goiter for all subjects, perhaps because of variability in familial susceptibility.
Lithium compounds used as anti-depressants in psychiatric medicine frequently cause goiter as a side effect. Again the mechanism is unclear.

Calcium supplements to rats on low iodine diets produce hyperplasia of the glands and an increased iodine uptake by the thyroid. The mechanism by which calcium acts as a goitrogen is not known, but it appears to exert its goitrogenic effect by inhibiting the synthesis of thyroxine. The effect is only noticeable on an extremely low iodine diet.

Cruciferae

Virtually all members of the Cruciferae genera contain one or more of the fifty thiourea goitrogens identified to date. Several of the purified thiourea chemicals are used medicinally in cases of hyperthyroidism, thus considerable knowledge has accumulated regarding their actions. Thiourea chemicals inhibit the uptake of iodine by the thyroid, preventing the production of thyroid hormones. Similarly, they inhibit the normal uptake of iodine by the salivary and mammary glands and are passed through the mother's milk to the nursing infants.

In addition to reducing iodine uptake, some of the goitrogens in cabbages appear to impair thyroxine production and even reduce the activity of thyroxine at sites outside the thyroid gland.

Leguminosae

The human body has iodine conserving mechanisms which can be disrupted by diets containing excessive amounts of soybeans. Under normal conditions between 25 and 30 per cent of the thyroxine of the

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body is excreted with the bile and reabsorbed from the intestine. However, a soybean diet interferes with the reabsorption and recycling of iodine.

Other members of the legumes, including snap beans and lima beans, contain hydrogen cyanide which results in thiourea burdens as it is detoxified in the human body.

Umbelliferae and others

Parsley, carrots and other members of the Umbelliferae genera contain thiourea chemicals which contribute to the pungent tastes of these vegetables. The seeds contain the highest concentrations and many, such as coriander, have become universally popular spices.

Other vegetables, although they do not contain thiourea, *per se*, contain its antecedents. Plants such as cassava and papaya contain hydrogen cyanide precursors. Hydrogen cyanide is detoxified to thiourea within the human body by one of two pathways. Vegetarians, typically deficient in vitamin B₁₂, process the toxin via a pathway that produces relatively more thiourea. Meat-eating individuals, on the other hand, are typically sufficient in vitamin B₁₂ and produce less thiourea via another process. Both processes result in the production of the goitrogenic thiourea and thus have the same result as Cruciferae consumption.
## Appendix 3.2

**Non Vegetable Factors Implicated in Goiter**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Test Animal</th>
<th>Goitrogenic activity</th>
<th>Overridden by Iodine</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>man</td>
<td>lithium treatment produces goiter</td>
<td></td>
<td>Schorr, et al., 1968</td>
</tr>
<tr>
<td>Lithium</td>
<td>rat</td>
<td>goiter with increased iodine stores in the gland, increased uptake, decrease of thyroxine in plasma and decreased excretion rate</td>
<td></td>
<td>Berens, et al., 1970</td>
</tr>
<tr>
<td>sulphate</td>
<td>man</td>
<td>sulfate in rainwater implicated in goitrogenesis</td>
<td></td>
<td>Zak, et al., 1967</td>
</tr>
<tr>
<td>propylthiouracil</td>
<td>rat</td>
<td>on low levels of iodine, 6 micrograms of PTU/rat/day increased thyroid weight, due to periferal block of di-iodization of T4</td>
<td>yes, high doses</td>
<td>Herrera, et al., 1968</td>
</tr>
<tr>
<td>Calcium, iron, water hardness, Eucheria coli</td>
<td>man (Himalayas)</td>
<td>implicated in endemic goiter</td>
<td></td>
<td>Day, et al., 1972</td>
</tr>
<tr>
<td>protein deficiency</td>
<td>rat</td>
<td>found protein had a protective function in the presence of thioureas</td>
<td></td>
<td>Gaitan and Merino, 1976</td>
</tr>
<tr>
<td>DDT/Dieldrin</td>
<td>birds</td>
<td>long term high dose results in competitive displacement of thyroxine from serum</td>
<td></td>
<td>Jeffries and French, 1972</td>
</tr>
<tr>
<td>thiocyanate</td>
<td>cattle</td>
<td>iodine content of milk depressed, thiocyanate content of milk increased</td>
<td></td>
<td>Piironen and Virtanen, 1963</td>
</tr>
<tr>
<td>Calcium</td>
<td>---</td>
<td></td>
<td></td>
<td>Taylor, 1954</td>
</tr>
<tr>
<td>Bromine</td>
<td>---</td>
<td></td>
<td></td>
<td>Claude, et al., 1961</td>
</tr>
</tbody>
</table>
Appendix 3.3
Vegetables implicated in Goiter: Leguminosae

<table>
<thead>
<tr>
<th>Latin</th>
<th>Vegetable</th>
<th>Goitrogenic chemical</th>
<th>Test animal</th>
<th>Goitrogenic activity</th>
<th>Overridden by Iodine</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;</td>
<td>soybean</td>
<td>unknown</td>
<td>rat</td>
<td>goitrogenic</td>
<td>yes, twice normal</td>
<td>Sharpless, et al., 1939</td>
</tr>
<tr>
<td>&quot;</td>
<td>soybean</td>
<td>unknown</td>
<td>rat</td>
<td>curd more goitrogenic than bean</td>
<td>---</td>
<td>Suwa, et al., 1979</td>
</tr>
<tr>
<td>&quot;</td>
<td>soybean</td>
<td>unknown</td>
<td>man (athyreotic cretin)</td>
<td>high soybean diet reduces re-absorption of thyroxine</td>
<td>---</td>
<td>Pincherra, et al., 1965</td>
</tr>
<tr>
<td>&quot;</td>
<td>soybean</td>
<td>unknown</td>
<td>---</td>
<td>reduces fecal absorption of organic iodine</td>
<td>yes, if not organically bound</td>
<td>Stanbury and Hetzel, 1980</td>
</tr>
<tr>
<td>Phaseolus lunatus</td>
<td>lima bean</td>
<td>cyanogenic glucosides</td>
<td>---</td>
<td>implicated</td>
<td>---</td>
<td>Stein, 1976</td>
</tr>
<tr>
<td>Phaseolus lunatus</td>
<td>lima bean</td>
<td>hydrogen cyanide</td>
<td>domestic animals</td>
<td>implicated</td>
<td>---</td>
<td>Hill, 1973</td>
</tr>
</tbody>
</table>
## Appendix 3.4
### Vegetables Implicated in Goiter: Cruciferae

<table>
<thead>
<tr>
<th>Latin</th>
<th>English</th>
<th>Goitrogenic chemical</th>
<th>Test animal</th>
<th>Goitrogenic activity</th>
<th>Overridden by Iodine</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Brassica oleracea</em></td>
<td>cabbage</td>
<td>thiocyanate</td>
<td>rats</td>
<td>sulphates in soil increases goitrogenicity</td>
<td></td>
<td>Sedlak, 1961</td>
</tr>
<tr>
<td>various</td>
<td>various</td>
<td>various</td>
<td>man,</td>
<td>goitrogens travel from pasture weeds through milk to children</td>
<td>no</td>
<td>Clements, 1960</td>
</tr>
<tr>
<td><em>Brassica oleracea</em></td>
<td>kale</td>
<td>thiocyanate</td>
<td>sheep,</td>
<td>goitrogenic activity increased by fertilizer containing Chilean nitrate, rather than</td>
<td>yes</td>
<td>Allcroft and Salt, 1960</td>
</tr>
<tr>
<td></td>
<td>mustard cabbage</td>
<td></td>
<td>rabbits</td>
<td>ammonium sulfate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>various</td>
<td>various</td>
<td>various</td>
<td>man,</td>
<td>goitrogenic weeds transmitted through cows' milk to man</td>
<td></td>
<td>Arstila, et al., 1969</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Finland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crucifer</td>
<td>various</td>
<td>various</td>
<td>cattle, man</td>
<td>long-term iodine supplementation of cattle diet did not inhibit effect of goitrogenic forage</td>
<td>no</td>
<td>Petola, 1965</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>phenylthiourea</td>
<td>thyroidectomized rats on a low-iodine diet</td>
<td>labeled $^{131}$I given as thyroxine showed decrease by 50% of extra-thyroidal metabolism</td>
<td>---</td>
<td>Escobar del Ray, 1960</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Horcaite de Escobar, 1960</td>
</tr>
<tr>
<td><em>Brassica oleracea</em></td>
<td>broccoli</td>
<td>isothiocyanates</td>
<td>---</td>
<td>30-50% loss of goitrogenicity when boiled</td>
<td>---</td>
<td>Holdsworth, 1979</td>
</tr>
<tr>
<td><em>Brassica oleracea</em></td>
<td><em>italia</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Brassica oleracea</em></td>
<td><em>sprouts</em></td>
<td>thioglucosides</td>
<td>---</td>
<td>blanching increases allyl cyanide and decreases allyl isothiocyanate</td>
<td>---</td>
<td>Holdsworth, 1979</td>
</tr>
<tr>
<td><em>Brassica oleracea</em></td>
<td><em>pennsylvanica</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Brassica oleracea</em></td>
<td>head</td>
<td>isothiocyanates,</td>
<td>---</td>
<td>amount increases to a maximum and then decreases as cooking is continued</td>
<td>---</td>
<td>Holdsworth, 1979</td>
</tr>
<tr>
<td></td>
<td>cabbage</td>
<td>cyanide</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

References:
- Sedlak, 1961
- Clements, 1960
- Allcroft and Salt, 1960
- Arstila, et al., 1969
- Petola, 1965
- Escobar del Ray, 1960
- Holdsworth, 1979
- Holdsworth, 1979
- Holdsworth, 1979
### Appendix 3.4 (continued)  Vegetables Implicated in Goiter: Cruciferae

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Latin</th>
<th>English</th>
<th>Goitrogenic chemical</th>
<th>Test animal</th>
<th>Goitrogenic activity</th>
<th>Overridden by Iodine</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cauliflower</td>
<td>Brassica oleracea</td>
<td>cyanide</td>
<td>isothiocyanate</td>
<td>---</td>
<td>with dehydration, allyl cyanide increases, allyl isothiocyanate lost</td>
<td>---</td>
<td>MacLeod and MacLeod, 1970</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>Brassica napus</td>
<td>thiocyanate</td>
<td>goitrin</td>
<td>---</td>
<td>yes (thiocyanate) no (goitrin)</td>
<td>Hill, 1973</td>
<td></td>
</tr>
<tr>
<td>Cabbage</td>
<td>Cruciferae</td>
<td>thiocyanate, goitrin allyl- isothiocyanate</td>
<td>rats</td>
<td>combination of these chemicals as they occur in cabbage were more goitrogenic than in isolation</td>
<td>---</td>
<td>Langer, 1966</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 3.5
### Vegetables Implicated in Goiter: Umbelliferae and Others

<table>
<thead>
<tr>
<th>Latin</th>
<th>Vegetable</th>
<th>Goitrogenic chemical</th>
<th>Test animal</th>
<th>Goitrogenic activity</th>
<th>Overridden by Iodine</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Umbelliferae</td>
<td>carrot, fennel, dill</td>
<td>goitrogenic glucosides</td>
<td>laboratory</td>
<td>effects may be accumulative, acute poisoning unusual</td>
<td>---</td>
<td>Martin and Ruberte, 1979</td>
</tr>
<tr>
<td>Carica papaya</td>
<td>papaya</td>
<td>benzyl-isothiocyanate glucosinolate</td>
<td>laboratory</td>
<td>seeds and latex have highest glucosinolate counts found: 67,000-106,000 micrograms/gram</td>
<td>---</td>
<td>Tang, 1973; van Etten and Tookey, 1979</td>
</tr>
<tr>
<td>Manihot esculenta</td>
<td>cassava</td>
<td>cyanide</td>
<td>man (Indonesia)</td>
<td>blood tests in consumers showed no elevation over smokers</td>
<td>---</td>
<td>Ismoldt, et al., 1977</td>
</tr>
<tr>
<td>&quot;</td>
<td>cassava root</td>
<td>cyanate</td>
<td>man (Nigeria)</td>
<td>implicated in endemic goiter</td>
<td>---</td>
<td>Ekpechi, et al., 1966</td>
</tr>
<tr>
<td>&quot;</td>
<td>cassava root</td>
<td>thiocyanate</td>
<td>man (Congo)</td>
<td>elevated blood levels in endemic goiter</td>
<td>---</td>
<td>Ermans, et al., 1969</td>
</tr>
<tr>
<td>&quot;</td>
<td>cassava root</td>
<td>thiocyanate</td>
<td>rats</td>
<td>acted to increase urinary excretion of iodine</td>
<td>---</td>
<td>Ermans, et al., 1972</td>
</tr>
<tr>
<td>&quot;</td>
<td>cassava</td>
<td>thiocyanate</td>
<td>man</td>
<td>vitamin B-12 may be protective</td>
<td>yes, if iodine intake high</td>
<td>Ermans, et al., 1972</td>
</tr>
<tr>
<td>&quot;</td>
<td>cassava</td>
<td>thiocyanate</td>
<td>cattle</td>
<td>iodine content of milk depressed</td>
<td>---</td>
<td>Piironen and Virtanen, 1963</td>
</tr>
<tr>
<td>&quot;</td>
<td>cassava</td>
<td>blood thiocyanate</td>
<td>man (Ubangi)</td>
<td>adaptation achieved by drop in T4 levels and high TSH levels</td>
<td>---</td>
<td>Bourdoux, et al., 1978</td>
</tr>
<tr>
<td>&quot;</td>
<td>cassava leaf</td>
<td>cyanide</td>
<td>---</td>
<td>boiling 5-10 minutes effectively drove off cyanide</td>
<td>---</td>
<td>Eggum, 1970</td>
</tr>
<tr>
<td>&quot;</td>
<td>cassava root and leaf</td>
<td>thioglucoside</td>
<td>lab</td>
<td>levels of toxin vary by sub-species</td>
<td>---</td>
<td>deBruijn, 1973</td>
</tr>
<tr>
<td>Latin</td>
<td>Vegetable</td>
<td>Goitrogenic chemical</td>
<td>Test animal</td>
<td>Goitrogenic activity</td>
<td>Overridden by Iodine</td>
<td>Reference</td>
</tr>
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<td>--------------------</td>
<td>----------------------</td>
<td>-------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Manihot esculenta</td>
<td>cassava root</td>
<td>thioglucoside</td>
<td>lab, female rats</td>
<td>high cassava diet caused excessive excretion of iodine and thiocyanates</td>
<td>no</td>
<td>Ekpechi, 1973</td>
</tr>
<tr>
<td></td>
<td>cassava root</td>
<td>thioglucosides</td>
<td>lab</td>
<td>fried fresh root released HCN in process of digestion, although the releasing enzyme was destroyed by heat</td>
<td>---</td>
<td>Nestel and MacIntyre, 1973</td>
</tr>
<tr>
<td></td>
<td>cassava root</td>
<td>thioglucosides</td>
<td>rats</td>
<td>enzyme deactivated in rape-seed meal, but produced both nitriles and goitrin in urine</td>
<td>---</td>
<td>Hill, 1973</td>
</tr>
<tr>
<td>Pinus sp.</td>
<td>piñon</td>
<td>?</td>
<td>rats</td>
<td>produced goiter</td>
<td>---</td>
<td>Telez, et al., 1969</td>
</tr>
<tr>
<td>Bambusa sp.</td>
<td>bamboo shoot</td>
<td>cyanide</td>
<td>?</td>
<td>implicated in goiter</td>
<td>---</td>
<td>Montgomery, 1969</td>
</tr>
</tbody>
</table>
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