Ecology of Food and Nutrition, 1982, Vol. 12, pp. 89–95
0367-0244/82/1202-0089 $06.50/0

NUTRITIONAL SIGNIFICANCE OF TWO IMPORTANT ROOT FOODS (SPRINGBANK CLOVER AND PACIFIC SILVERWEED) USED BY NATIVE PEOPLE ON THE COAST OF BRITISH COLUMBIA

H. V. KUHNLEIN, N. J. TURNER and P. D. KLUCKNER

Division of Human Nutrition, University of British Columbia, Vancouver, B.C., Canada
and
British Columbia Provincial Museum, Victoria, B.C., Canada
and
Environmental Laboratory, British Columbia Ministry of Environment, Vancouver, B.C., Canada

(Received December 1, 1981; in final form February 12, 1982)

The roots of Pacific silverweed (*Potentilla anserina* spp. *pacifica*) and the rhizomes of springbank clover (*Trifolium wormskioldii*) are two foods known to have been used extensively by native groups of British Columbia. Reported here are nutrient content and scores on acceptability of these foods gathered and prepared with two methods used by the Nitinaht and Nuxalk (Bella Coola) Indians. It was found that silverweed and clover "roots" have excellent contents of Ca, Mg, Fe, Cu, Mn and Zn in comparison to the potato, which is the modern replacement food in the Indian diet. Steaming or pit-cooking did not appreciably change the contents of six minerals studied. Overall mean acceptability scores on a 5-point hedonic scale were 3.0 and 3.5 for pit-cooked and steamed silverweed roots and 4.1 and 3.7 for pit-cooked and steamed clover rhizomes.

KEY WORDS: *Potentilla anserina* spp. *pacifica*, *Trifolium workskioldii*, indigenous foods, root foods, nutrient composition, minerals.

INTRODUCTION

The use of locally available cultural foods by native people in North America has declined dramatically in recent years because of a complex set of social, cultural, environmental and economic factors, the results of which have led to the dietary replacement of the indigenous foods with marketed products. In most of Canada, Indian reserves are located in rural areas or small communities where transportation is arduous, and the most successfully imported foods are necessarily durable or processed to enhance transportation and storage. It is common knowledge that there is little diversity in food supplies marketed in small native communities, and that income levels are generally low and dietary quality poor. It is therefore reasonable to consider the possibilities of education to increase the use of locally available indigenous foods known to have been used by native people in the past. Before this is feasible in the context of modern scientific knowledge, there should be documentation on the nutrient content of these foods, both fresh and prepared. In addition, the presence of any potentially toxic substance should be identified, and data gathered on the environmental availability of the resource and its general acceptance as food.

This report concerns the "roots" of two plants indigenous to coastal British Columbia: Pacific silverweed (*Potentilla anserina* L.spp. *pacifica* [Howell] Rousi) roots and springbank clover (*Trifolium wormskioldii* Lehm.) rhizomes. These "roots"† have been ethnographically documented as having been used as food in the recent past by many Indian groups in British Columbia occupying territory near shorelines, tidal flats or alluvial flood-plains (Turner and Kuhnlein, 1982; Turner, 1975). The ecological conditions for these species are common along the coast of British Columbia, and the plants are abundant, relatively easily located and identified (Turner and Kuhnlein,

†For convenience, hereafter referred to as "roots," since no distinction between roots and rhizomes has been made by native people.

1982). To date there is no documentation on nutritional or toxicological properties of these foods, even though their availability and use as food are well known.

In British Columbia silverweed and clover roots were often eaten cooked, in season. They were also stored for winter use by burying in boxes of soil in root cellars or by roasting, drying and placing them in the rafters of houses where they would be kept dry and preserved by smoke from the cooking fire. In this paper, the cooking methods of the Nitinaht and Nuxalk (also called Bella Coola) Indians are emphasized. In both groups, the contemporary elders related that cooking of the roots was done most recently by steaming in a large kettle. In the past, for preparing the roots in large quantities for feasts or for regular family use, cooking was done on or in the ground. The Nitinaht used a pit technique where hot rocks lined the bottom and specific vegetation was used in layers separating bundles of silverweed roots, clover roots and camas (*Camassia quamash, C. leichtlinii*) bulbs (Turner *et al.*, in press). The Nuxalk Indians preferred clover roots cooked on top of hot rocks either in pits or on top of the ground (Turner, 1973). Both clover and silverweed roots were also used in stews with fermented salmon eggs, ooligan grease (a fat rendered from fermented *Thaleichthys pacificus*), flour and sugar (Edwards, 1979). In both the Nitinaht and Nuxalk communities, the fresh cooked roots were commonly eaten with a prepared oil of animal origin—this was usually seal or whale oil in the case of the Nitinaht and ooligan grease for the Nuxalk.

When Indian people are asked today why they no longer use silverweed or clover roots, they say it is because they can buy potatoes instead. One wonders what are the nutritional consequences of this adaptation. This report concerns the nutrient content and general food acceptability of the roots of Pacific silverweed and the rhizomes of springbank clover.

METHODS

Obtaining Samples

Samples of silverweed and clover roots were harvested in 1980–81 from two areas in British Columbia, which were close to the reserve lands of the Nitinaht Indians of Port Renfrew or of the Nuxalk Indians of Bella Coola (Figure 1).

The silverweed was harvested in September and October from several sites between the Sooke River estuary and the estuarine flats of the Cheewhat River on the coast of Vancouver Island and from the tidal flats at the mouth of the Bella Coola River. Clover was harvested in September and October from the San Juan River estuary, the banks of Nitinat Lake (a coastal tidal lake also fed by the freshwater Nitinat River), and, from the Bella Coola tidal flats. All sites of harvest were near the sea, and plants were typically watered by both sea water and fresh river water as well as rain.

The roots were carefully dug to prevent breakage so that they could be bundled in the traditional manner for cooking. They were rinsed of loose dirt in the water on site and then rinsed in distilled water several times before bundling. The silverweed roots averaged 22 cm in length (range 7–60 cm) and 5 mm in width (range 3–8 mm) and the clover roots averaged 14 cm in length (range 6–40 cm) and 2 mm in width (range 1–3 mm). Roots from one site were mixed to provide a homogeneous sample and then bundled by aligning the roots together and tying with cotton string. The bundles of fresh roots weighed from 75–150 g, each bundle containing the roots of 30–50 plants. Bundles were secured in clean plastic bags and frozen on dry ice immediately after bundling (for raw samples) or after cooking.

Cooked Samples

Sufficient roots were harvested from Port Renfrew, Cheewhat River, Nitinat Lake and Bella Coola to make several bundles for cooking experiments to examine changes in mineral content. Steamed samples were prepared with clover and silverweed roots in the Nitinaht tradition by lining a large stainless steel kettle with dried grass and layering the bundles with salal (*Gaultheria shallon*) and red alder (*Alnus rubra*) branches and the fronds of sword fern (*Polystichum munitum*) and wood fern (*Dryopteris expansa*). Enough water was added to cover the grass layer (about 5cm) in the bottom of the kettle. This was brought to boiling, then the kettle was covered and the contents allowed to steam for 30 minutes. At Bella Coola, roots were steamed for 30 minutes in a covered enamel kettle with a perforated liner, again using a small amount of water.

The pit-cooking of clover and silverweed roots was accomplished with the Nitinaht traditional method, as described previously (Turner and

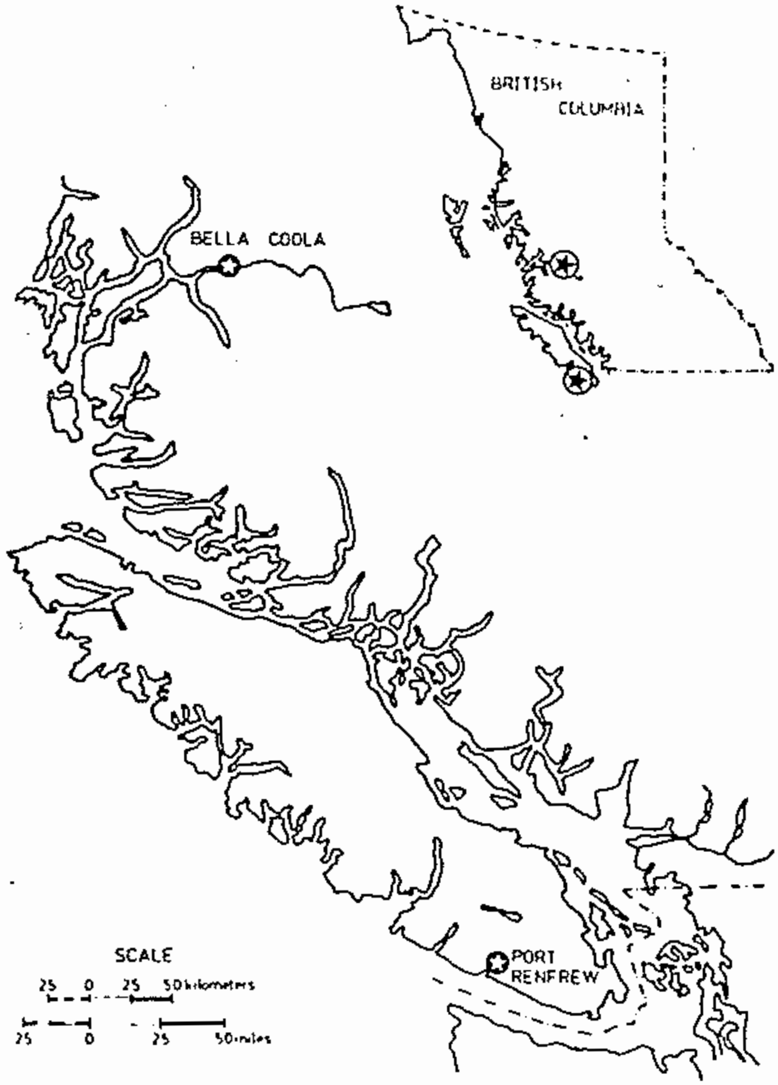

FIGURE 1 Location of Bella Coola and Port Renfrew in British Columbia. These are only two of the many potential harvesting areas on tidal flatlands found on the coast of British Columbia.

Kuhnlein, 1981). Essentially, a pit $1m^3$ was lined with red hot round beach rocks 8–10 cm in diameter. The rocks were covered with vegetation as described above for kettle steaming with the addition of bracken fern (*Pteridium aquilinum*) fronds. The root bundles were layered with fern fronds and the pit, covered with vegetation. A post in the center of the pit was removed, and about two liters of water poured into the depression to generate steam. A large square of burlap weighted with rocks was used to cover the pit and the whole was buried with sand overnight to allow the contents of the pit to cook in a smoky, steamy environment. The next morning the pit was carefully opened and the food taken out and prepared for taste evaluation or frozen for later analysis.

Taste Evaluation

To assess the general acceptability of these roots as food, a simple hedonic scale adapted from Dawson and Harris (1951) was used. After the ranking scale was explained, individuals (all adults) were asked to taste the roots at the site of the pit cooking

(Port Renfrew) or in the family kitchen (Bella Coola) and to record the appropriate ranking on a score sheet.

Nutrient Analyses

Frozen roots were thawed and homogenized with an equal weight of distilled deionized water in a Waring blender with stainless steel bucket. Several aliquots for the various analyses were transferred to acid-washed teflon bottles. Percent moisture was determined after drying to constant weight in a vacuum oven; ash determinations were made after ashing at 550°C for 24 hours. Fat was determined with the Goldfisch continuous extraction apparatus (AOAC, 1970). Total kjeldahl nitrogen was determined with standard procedures (McQuaker, 1976) and sulfur with the Leco method when the sample is combusted to SO_2/SO_3 using an induction furnace and an oxygen atmosphere. Subsequently, SO_2 is titrated with KIO_3 in the presence of KI, with a starch indicator (Tiedemann and Anderson, 1971). Mineral element contents of samples were determined by analysis of a nitric-perchloric acid digest on an inductively coupled plasma-atomic emission spectrometer (McQuaker *et al.*, 1979a; 1979b). The presence of titanium in quantities greater than 15 ppm was used to indicate soil contamination in root bundles. A sample of raw unpeeled commercial Idaho potato (*Solanum tuberosum*) was prepared as above and used as a standard sample for all analyses.

RESULTS AND DISCUSSION

The composition of fresh silverweed and clover "roots" is given in Table I.

Values for the standard sample of fresh unpeeled potato are used for comparison because it is this food which native people say has replaced the use of traditional root foods such as clover and silverweed. Mean and range values of moisture, ash and fat in silverweed and clover are within those typical of plant root foods. These parameters in the analyzed standard sample of potato are very close to those reported by Watt and Merrill (1963). Nitrogen was quite variable in the two native root foods, which probably means that some roots older than one growth season were included in the bundles. As the quantity of true protein in the samples could not be determined, the factor N = 6.25 was used. The fresh samples thus contained an average of 1.6 and 1.8 g protein/100 g. We recognize that this may result in overestimation of the protein content of these foods. Raw potato is reported to contain 2.1 g protein/100 g (Watt and Merrill, 1963; Paul and Southgate, 1978).

Calcium and magnesium were consistently higher in the silverweed and clover samples than in potato. Phosphorus was more variable in silverweed than in clover roots, but it is apparent that the calcium to phosphorus balance is better in these foods than in the potato.

Iron was exceptionally variable in both silverweed (5–12 mg/100 g fresh weight) and clover (3–6 mg/100 g fresh weight). Such variability is to be expected in foods with large surface area exposed to soils, since soils in British Columbia are known to vary considerably in mineral content (Valentine, *et al.*, 1978). The content of iron, copper and manganese in these foods is consistently superior to that of the analyzed potato sample. Values for zinc were higher and more variable in silverweed than in clover roots, and except for one sample of clover roots, all were higher in this mineral than potato.

Low but detectable levels of chromium (23–103 μg/g) were present in the silverweed roots, but only one of three clover root samples had detectable levels of this element. Other minerals essential in human nutrition that were determined but undetectable in all samples were nickel, cobalt and molybdenum.

Nonessential and potentially toxic elements that were undetectable were arsenic, tin, lead and cadmium. Vanadium was undetected in two clover root samples, and present in low levels in the other foods, as was barium. Strontium and aluminum were contained in larger amounts. The presence of aluminum, like iron, is expected in roots with large surface area. The significance of these levels of vanadium, barium, strontium and aluminum in foods is not known.

In Table II, the contents of six minerals are reported in single homogeneous samples of silverweed roots from two sites and clover roots from two sites that were analyzed raw or after steaming or pit-cooking. The pit-cooked silverweed samples from Port Renfrew had small increases in calcium, phosphorus, and magnesium, whereas pit-cooking of the Cheewhat River sample resulted in similar increases only for calcium. Pit-cooking of the clover roots from Nitinat Lake resulted in similarly small increases of calcium, phosphorus, magnesium and manganese. Steaming of silverweed or clover did not result in appreciable changes of

TABLE I
Composition of raw silverweed (*Potentilla pacifica*) and clover (*Trifolium wormskioldii*) "roots" compared with Idaho potato (*Solanum tuberosum*)

Component	*Silverweed* (n = 6)	*Clover* (n = 3)	*Potato*[e] Analyzed (n = 1)	*Potato*[e] Reported
		g/100 g fresh weight		
Moisture	77.2 (74.2–81.8)[a]	83.8 (81.4–88.2)	78.8	79.8[f]
Ash	1.4 (1.1–2.0)	0.9 (1.1–0.8)	0.8	0.9[f]
Fat	0.3 (0.2–0.4)	0.3 (0.2–0.5)	0.1	0.1[f]
		mg/100 g fresh weight		
N	262.2 (126.9–505.4)	285.3 (66.8–398.6)	404.9	
S	26.8 (22.9–31.3	18.6 (16.4–20.8)	20.1	35[g]
Ca	41.0 (24.4–53.6)	38.4 (20.0–60.8)	9.3	7[f]
P	52.9 (25.2–96.6)	25.8 (21.7–28.6)	39.4	53[f]
Mg	49.1 (42.0–58.5)	38.6 (34.0–44.1)	22.0	34[g]
		μg/100 g fresh weight		
Fe	9110 (5659–12345)	4606 (3056–6156)	551	600[f]
Cu	179 (118–258)	225 (186–271)	84	115[g]
Mn	876 (283–1292)	444 (212–728)	148	
Zn	530 (377–696)	227 (130–328)	190	300[g]
Cr	51 (23–103)	72[d]	21	
Ni	undetectable[b]	undetectable	undetectable	
Co	undetectable[c]	undetectable	undetectable	
Mo	undetectable	undetectable	undetectable	
V	49 (46–54)	18[d]	21	
Sr	769 (232–1264)	595 (427–874)	21	
Al	8289 (4128–13444)	3138 (1440–4836)	360	
Ba	156 (65–232)	63 (24–93)	21	
As	undetectable	undetectable	undetectable	
Sb	undetectable	undetectable	undetectable	
Pb	undetectable	undetectable	undetectable	
Cd	undetectable	undetectable	undetectable	

[a]Values are given as mean and range
[b]Undetectable at less than 5–10 μg/g dry weight
[c]One sample contained 436 μg/g Co
[d]Two samples had undetectable Cr and V
[e]Raw, with skin
[f]From Watt and Merrill (1963)
[g]From Paul and Southgate (1978)

these minerals—there were slight decreases in calcium and manganese of the Port Renfrew silverweed and in phosphorus and copper of the Bella Coola clover roots. Other minerals either stayed the same or increased slightly with steaming, presumably as a result of additions from the water or cooking vessel. It can be concluded that with respect to these six minerals, there would be no appreciable dietary additions by cooking silverweed or clover roots with the traditional Nitinaht pit method or by steaming in small amounts of water.

In all cases, the content of the various fiber components and the ultimate availability of each of these minerals is not yet known.

An indication of the acceptability of these roots as food is shown in Table III. Since there were only 6–7 persons evaluating the foods, the mean and range of scores are given, and further statistical interpretation was not possible. The mean scores show that acceptability was from fair to good, with clover roots ranking higher than silverweed. In retrospect, it would have been interesting to compare acceptability of these foods when eaten with a traditional oil condiment or in comparison to steamed or pit-cooked potato. Some individuals

TABLE II

Minerals in silverweed (*Potentilla pacifica*) and clover (*Trifolium wormskioldii*) "roots" with two methods of cooking

Sample	Ca	P	Mg	Cu	Mn	Zn
SILVERWEED ROOTS	mg/g dry weight			µg/g dry weight		
1. Port Renfrew						
Raw	1.13	4.47	2.71	6	34	28
Pit-cooked	1.35	5.14	2.87	8	30	30
Steamed (a)	1.01	4.23	2.74	6	29	28
Steamed (b)	0.94	4.57	2.99	8	30	31
2. Cheewhat River						
Raw	1.79	1.07	2.19	5	12	16
Pit-cooked	2.02	0.86	2.01	5	13	18
CLOVER ROOTS						
1. Nitinat Lake						
Raw	1.85	1.17	2.03	10	21	7
Pit-cooked	2.40	1.34	2.12	8	25	7
Steamed	2.11	1.14	1.87	9	21	7
2. Bella Coola						
Raw	1.70	2.29	3.74	23	18	19
Steamed	1.87	2.12	3.81	17	18	19

TABLE III

Scores for food acceptability of silverweed (*Potentilla pacifica*) and clover (*Trifolium wormskioldii*) "roots" from two areas in British Columbia, Canada

Food and site (number of persons)	Method of cooking	Mean score	Range of scores
SILVERWEED ROOTS			
Port Renfrew (6)	Steamed	3.5	2–5
Port Renfrew (6)	Pit-cooked	3.0	2–4
CLOVER ROOTS			
Bella Coola (7)	Steamed	3.7	3–4
Port Renfrew (6)	Pit-cooked	4.1	4–4.5

Individuals were asked to record a number corresponding to their impression of the overall acceptability of the food on the following scale:

5. Very good (in all respects, you know of no improvement)
4. Good (enjoyed it, minor improvement desirable)
3. Fair (could eat it without enthusiasm, improvement needed)
2. Poor (edible, but that's all)
1. Very poor (inedible).

noted on their score sheet that they like the nutlike flavour of the silverweed roots or the sweet leguminous flavour of the clover roots better than potato. Some silverweed roots had a distinct bitter taste, which may relate to the age of the root and a higher nitrogen content. Although more sensory evaluation scores in several taste elements from more than ten judges in a controlled environment would better define taste parameters of these foods, the simple hedonic scale used here is good for use with native people in a field setting. It can be concluded from this small experiment that silverweed and clover roots are acceptable foods.

COMMENT

If root foods such as silverweed and clover were formerly used in the diets of native people two or three times per week, in quantities similar to that of a contemporary serving of potatoes, from 400–600 g of fresh weight food would have been consumed. This would have substantially contributed to the weekly need for several of the nutrients reported here—calcium, iron, phosphorus, magnesium, copper, manganese, iron, zinc, and probably fibre and energy as well. It is documented that coastal native people formerly consumed traditional diets rich in shellfish, fish and animal foods (Boas, 1921; Drucker, 1965). Since these foods are generally good sources of many nutrients, including some of the minerals discussed here, the ultimate nutritional impact (the contribution to minimum nutrient needs) of the root foods is not known. There is little doubt, however, that the contemporary diets of people on most Indian reserves of coastal British Columbia are not as optimal as they once probably were. Poor diets and nutrient inadequacies have been recently reported (Lee *et al.*, 1971; Stepien, 1978; Schaefer, 1977) and are thought to be widespread. It appears, then, that Indian people would benefit nutritionally by using foods with a nutrient density such as is contained in silverweed and clover roots. It is also possible that an effort to increase use of these and other traditional foods would have social, cultural, and economic benefits as well.

It has been shown here that the roots of *Potentilla anserina* spp. *pacifica* (Pacific silverweed) and the rhizomes of *Trifolium wormskioldii* (springbank clover) are food resources that are acceptable and basically nutritious. Although analytical work on other nutrients and non-nutrient components, specifically potential toxins, has yet to be done, these foods are good candidates for reintroduction into the diets of native people living in coastal British Columbia. With attention to cultivation and harvesting efficiency, these foods could also be used by the general public who wish more variety in the diet.

ACKNOWLEDGEMENTS

The authors wish to thank the people who assisted with the harvesting, preparation and taste evaluation of the foods at Bella Coola and Port Renfrew: Sandy Moody, Felicity Walkus, Willie Hans, Karen Anderson, Darlene Tallio, Edward Moody, Margaret Siwallace, John Thomas, Ida Jones, Barry Carlson, Sue Carlson, Harold Amoss and Pam Amoss. We also thank Jeff van Haastregt for assistance with mineral analyses.

This research was partially funded by support to Harriet Kuhnlein from the Natural Science and Engineering Research Council of Canada (A-7148) and from the National Museum of Man (1630-1-052). Assistance to Nancy Turner was provided by the Friends of the British Columbia Provincial Museum.

REFERENCES

Association of Official Analytical Chemists (1970). *Official Methods of Analysis.* 11th Ed., Washington, D.C.

Boas, F. (1921). *Ethnology of the Kwakiutl.* Bureau of American Ethnology, 35th Annual Report. Smithsonian Institution, Washington, D.C.

Dawson, E. H. and B. L. Harris (1951). *Sensory Methods of Measuring Differences in Food Quality.* U.S. Dept. Agriculture, Agr. Infor. Bull. No. 34.

Drucker, P. (1965). *Cultures of the North Pacific Coast.* Chandler Publ. Co., San Francisco.

Edwards, G. (1979). Indian spaghetti. *The Beaver,* Autumn, 4–11.

Lee, M., B. C. Alfred, J. A. Birkbeck, I. D. Desai, G. S. Myers, R. G. Reyburn, and A. Carrow (1971). *Nutritional Status of British Columbia Indian Populations.* UBC mimeograph.

McQuaker, N. R. (1976). *Chemical Analysis of Waters, Wastewaters, Sediments, and Biological Materials* 2nd ed., Province of British Columbia, Ministry of Environment, Environmental Laboratory, Vancouver.

McQuaker, N. R., D. F. Brown and P. D. Kluckner (1979a). Digestion of Environmental Materials for Analysis by Inductively Coupled Plasma-Atomic Emission Spectrometry. *Anal. Chem.* **51**(7), 1082–1084.

McQuaker, N. R., P. D. Kluckner and G. N. Chang (1979b). Calibration of an Inductively Coupled Plasma-Atomic Emission Spectrometer for the Analysis of Environmental Materials. *Anal. Chem.* 51(7), 888–895.

Paul, A. A. and D. A. T. Southgate (1978). *The Composition of Foods* 4th ed., Elsevier/North-Holland Inc., New York.

Schaefer, O. (1977). Changing Dietary Patterns in the Canadian North. Health, Social and Economic Consequences. *Can. Dietet. Assoc. J.* **38**, 17–25.

Stepien, Y. Z. (1978). *Food Patterns, Shopping Habits and Food Beliefs of Indian Families on Selected Isolated and Non-Isolated Reserves in B.C.* M.Sc. Thesis in Human Nutrition, University of British Columbia, Vancouver.

Tiedemann, A. R. and T. D. Anderson (1971). Rapid Analysis of Total Sulfur in Soils and Plant Material. *Plant Soil* **35**, 197–200.

Turner, N. J. (1973). The Ethnobotany of the Bella Coola Indians of British Columbia. *Syesis* **6**, 193–220.

Turner, N. J. (1975). *Food Plants of British Columbia Indians. Part 1. Coastal Peoples.* British Columbia Provincial Museum Handbook, No. 34, Victoria, B.C.

Turner, N. J. and H. V. Kuhnlein (1982). Two Important "Root" Foods of the Northwest Coast Indians: Springbank Clover (*Trifolium wormskioldii* Lehm.) and Pacific silverweed (*Potentilla anserina* L. spp. *pacifica* [Howell] Rousi). *Economic Botany* (in press).

Turner, N. J., J. Thomas, B. F. Carlson and R. T. Ogilvie (1982). *Ethnobotany of the Nitinaht Indians of Vancouver Island.* British Columbia Provincial Museum, Occasional Paper Series, Queen's Printer, Victoria, and Parks Canada, Western Region, Pacific Rim National Park, Tofino, B.C. (in press).

Valentine, K. W. G., P. N. Sprout, T. E. Baker and L. M. Lavkulich (1978). *The Soil Landscapes of British Columbia.* Resource Analysis Branch, Ministry of Environment, Victoria, B.C.

Watt, B. K. and A. L. Merrill (1963). *Composition of Foods.* Agricultural Handbook, No. 8, U.S. Department of Agriculture, Washington, D.C.