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LOMATIUM DISSECTUM (APIACEAE): MULTI-PURPOSE PLANT OF THE PACIFIC NORTHWEST

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ABSTRACT.—The genus *Lomatium* played a key role in the *subsistence economies* of the Sahaptian and Salishan-speaking Indian peoples of the Columbia Plateau of the Pacific Northwest. *L. dissectum* (Nutt.) Math. & Const. is unusual among the *Lomatium* species of cultural significance in this area for its medicinal value, which was recognized by Native Americans throughout the species' geographic range. Its value as a fish poison was less widely recognized. Highlighting its role as a piscicide, we summarize here reports of the ethnobotanical value of this species and describe preliminary experimental results confirming its physiological activity.

RESUMEN.—El genus *Lomatium* jugó un papel clave en las *economías de subsistencia* de los indígenas hablantes de lenguas sahaptianas y salishanas de la Meseta del Columbia en la régión del Pacífico Noroccidental de Norteamérica. *L. dissectum* (Nutt.) Math. & Const. es inusitada entre las especies culturalmente significativas de *Lomatium* en esta zona por su valor medicinal, reconocido por los indigenas americanos a lo largo de toda la distribución géografica de esta especie. Su valor como veneno para la pesca se reconocía menos ampliamente. Resumimos aquí informes del valor etnobotánico de esta especie, resaltando su papel como veneno para pescado, y sintetizamos los resultados de un experimento preliminar en laboratorio que confirma su actividad fisiológica.

RESUME.—Le genre *Lomatium* a joué un rôle clé dans les économies de subsistance des Indiens du Plateau Columbia de la région Nordouest de l'Amérique du Nord, surtout chez les peuples de groupes linguistiques Sahaptian et Salishan. *L. dissectum* (Nutt.) Math. & Const. est atypique parmis les espèces du genre en raison de ses propriétés médicinales, largement reconnues par les différentes tribus qui ont partagé son aire de distribution naturelle. Son usage en tant que poison pour se procurer des poissons consommables était beaucoup moins souvent reconnu. En soulignant ce dernier rôle, nous allons résumer ici les rapports ethnographiques qui décrivent sa valeur ethnobotanique, et nous presenterons les résultats préliminaires de nos expériences en laboratoire qui ont confirmé son efficacité pour intoxiquer des poissons.

INTRODUCTION

Hunn and French (1981) document the importance of the genus *Lomatium* Raf. (APIACEAE, or UMBELLIFERAE) in the subsistence economy of Sahaptin-speaking Indians, traditional inhabitants of the southern half of the Columbia River Plateau. Sahaptin-speakers recognize and name over a dozen species of this genus, using at least eight species as food. Turner, Bouchard, and Kennedy (1980) confirm a similar key role for this genus among the Salishan-speaking Okanagan Colville of north-central Washington and south-central British Columbia, Canada. The several species of *Lomatium* (formerly *Peucedanum)* with edible starchy, tuberous roots are known popularly as ''biscuit roots;'' they may also be known as ''desert parsleys,'' indicative of their abundance in open, arid lands of western North America. We prefer the anglicized term ''lomatium'' as a common name. It is less well known that at least one species of the genus, *Lomatium dissectum* (Nutt.) Math. & Const., was widely used and highly regarded as a broad-spectrum medicine in Native American cultures of western North America. We summarize here published and unpublished ethnographic data on the uses of *L. dissectum* by Native American groups, then focus on its employment as a fish poison in parts of the Great Basin and southern Columbia Plateau. We present information collected by the senior authors from Sahaptin-speaking elders who participated in or observed the traditional modes of use (see also Hunn & French 1981; Hunn 1990). We also summarize the results of a laboratory study of the effects of extracts of *Lomatium dissectum* root on fish performed by the junior author (Cox 1983).

LOMATIUM DISTRIBUTION AND PATTERN OF USE IN WESTERN NORTH AMERICA

Lomatiums are well represented in the Pacific Northwest, constituting the majority of all species of the Apiaceae native to that region (Hitchcock and Cronquist 1961). The presumed genetic epicenter of this genus of some 80 species is the arid steppe of eastern Washington, Oregon, and Idaho (Mathias 1938). Lomatiums are tap-rooted perennials that flower in early spring before the arrival of intense summer heat and drought. Many species store energy in tuberous-thickened roots as an adaptation to thin soils, such as the lithosols and serpentines widespread in the Columbia Plateau and surrounding foothills (Schlessman 1980). Such species (e.g., *L. canbyi* Coult. & Rose, *L. cous* [Wats.] Coult. & Rose, *L. piperi* Coult. & Rose) are among the most important in the local Native American economies. Others were eaten as ''greens'' in early spring (e.g., *L. grayi* Coult. & Rose, *L. nudicaule* [Pursh] Coult. & Rose). *L. nudicaule* in particular has been shown to be a rich source of dietary ascorbic acid (Benson *et al.* 1973, Norton *et al.* 1984). Hunn (1981) has argued that the role of anadromous fish (especially salmonids) in meeting Indian food energy requirements before Euro-American contact has been exaggerated. Rather, plants harvested for their edible underground parts may have contributed on average twice as many calories as fish to Plateau Indian diets.

Although scattered ethnohistorical references to lomatiums as subsistence food and medicine exist, the scope of these plants' cultural importance appears to have been masked in part by their overt morphological similarity and the notorious taxonomic difficulty of the genus, a new species of which was discovered in Kittitas County, Washington during the 1970s (Schlessman & Constance 1979). Problems related to plant recognition are obvious in some of the accounts of early western ethnographers. Led by Kroeber and his colleagues who compiled the Culture Element Distributions, these workers were usually untrained in field botany, and their descriptions of vegetable product use by Great Basin and Plateau Native Americans—including those noting lomatium use—often lack precision and correct botanical identifications (cf. Ray 1933; 1942).

Given the morphological similarity of the lomatium species, the high degree of cognitive investment allotted to this genus by Sahaptian and Salishan-speaking peoples should be viewed as an indication of its cultural importance. Of the approximately 30 species of *Lomatium* which are found within traditional Sahaptin-speaking territory, ten folk taxa correspond precisely with scientific species while at least four others are "over-differentiated" when compared to the taxonomic treatment found in Hitchcock and Cronquist (1961). Many of these 14 named folk taxa remain well known to elderly Sahaptin speakers. They were regularly used, a number collected in truly large quantities, and several are gathered to a lesser extent today.

The new evidence we report herein lends support to the growing appreciation of the economic significance of *Lomatium* to many of the Plateau Indian groups, not only as a primary producer of food and medicine, but also as an occasional indirect procurer of animal protein. We focus here on one species of exceptional cultural significance, *L. dissectum*. The uses reported for this species are summarized in Table 1. Its application by Sahaptin speakers to stupefy freshwater fish for human consumption (usually trout—*Salmo* spp., but probably also redside shiner—*Richardsonius balteatus*—and other Cyprinidae), is described. Preliminary experimental work undertaken to identify its piscicidal properties is presented.

RANGE AND CULTURAL ROLE OF *LOMATIUM DISSECTUM*

L. dissectum ranges from Vancouver Island, British Columbia, east to Alberta and western Montana, and south to Colorado, New Mexico, Nevada and interior southern California (Jepson 1936). It can be found from sea level to elevations over 2500 m mostly in dry rocky slopes, meadows and talus. Despite the recognition of three geographical populations by Hitchcock and Cronquist (1961:551), subspecific distinctions are not recognized by Sahaptin speakers, nor, as far as we can tell, are they made in other Native American languages. The plant, shown in Figure 1, is variously known in English as "toza root," "cough root," "chocolate tips," and "Indian balsam."

L. dissectum has been widely used by American Indians in human and veterinary medicine, administered both internally and externally. It has been less widely employed as food, the young shoots consumed raw as a green vegetable (Murphey 1959; Turner 1978; Turner *et al.* 1980) or the roots eaten (Steedman 1930; Turner 1978; Turner *et al.* n.d.).

Table 1.—Aboriginal names and uses[1] of *L. dissectum* throughout its geographic range. Syns. *Leptotaenia dissecta* Nutt. in T. & G., *Ferula dissecta* Gray, *Lept. multifida* Nutt. in T. & G., *Ferula multifida* Gray, *Lept. dissecta* var. *multifida* Jeps., *Lomatium dissectum* var. *multifidum* Math. & Const., *Lept. dissecta* var. *foliosa* Hook., *Lept. foliosa* Coult. & Rose, *Lept. eatoni* Coult. & Rose, *Lept. multifida* var. *eatoni* M.E. Jones (Hitchcock & Cronquist 1961(3):551).

Native area/group	Term	Use	Source
I. Columbia Plateau			
A. Salishan languages			
1. Shuswap	gayú=the plant; sewayá=the young "tops"	young root as food, roasted and eaten; old root as medicine for sores	Palmer 1975
		older shoots and roots of young plants eaten	Turner 1978
2. Thompson	tǝx=qin (="chocolate tips," *L. dissectum)*	root eaten; as medicine in infusion for colds and asthma, to soak broken limbs, dried and crushed roots on wounds, sores, boils; dog and horse medicine for sores	Turner 1978 Turner *et al.* n.d.
Thompson	taxqâi•n (=*Lept. dissecta)*	root dried, cooked when needed, used as horse and dog medicine, root dried, crushed, sprinkled on wounds	Steedman 1930
Thompson	taxqáin (=*Ferula dissoluta)*	roots for food	Teit 1930
3. Okanagan-Colville			
a) Okanagan-Colville	gayuˀ (=*L. dissectum)* shoots called sewiyaˀ; called "chocolate tips" in English	roots to poison fish; young shoots gathered as they break ground (early March) and eaten, inedible later; mature tops rubbed on cattle to kill lice; fish poison solution poured on	Turner *et al.* 1980

		horses/cattle to kill vermin; roots used as poultice for sores, cuts, boils, bruises; to cure dandruff	
Okanagan-Colville	ai•yú		Steedman 1930
b) Okanagan	ai•yú (=*Ferula dissoluta)*	roots for food	Teit 1930
c) S. Okanagan (Sinkaietk)	cwaya=term used by Spier to apply to the entire plant; but acc. to Turner 1978=the young shoots only	famine food	Turner 1978 Turner *et al.* 1980 (citing Spier 1938)
d) Sanpoil-Nespelem	ayu^{s}, ai'u, a´yu' (=''Balsam root *[Osmorhiza* sp.] .. id not certain ..)	as food; for sores, wounds, bruises, boils, general illness; for easing horses	Ray 1933
Sanpoil	*L. dissectum*	''First roots'' ceremony	Turner *et al.* 1980
e) Lakes	*L. dissectum*	roots used to make a steam bath for rheumatism, sprains, pneumonia	Turner *et al.* 1980
4. Columbia-Wenatchi	(unspecified plant, probably *L. dissectum)*	fish poison	Ray 1942
B. Sahaptian languages			
1. Sahaptin			
a) Northwest dialects			
1) Klikitat	čalúkš	suffocate fish; topical application for sores, crippled arm, dandruff, psoriasis; infusion drunk against colds	
Klikitat	(unspecified plant, probably *L. dissectum)*	fish poison	Ray 1942

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Native area/group	Term	Use	Source
2) Yakima	čalúkš	horse medicine; fish poison; drank infusion of root for colds, tuberculosis	
3) Kittitas	(unspecified plant, probably *L. dissectum)*	fish poison	Ray 1942
b) N.E. dialects			
1) Snake River	čalúkš	kill fish; topical application for sores; whiten hides	
c) Columbia R. dialects			
1) Umatilla	čalúkš (=*L. dissectum* var. *multifidum)*	fish poison; medicinal; not eaten	
2) John Day River	čalúkš (=*L. dissectum* var. *multifidum)*	fish poison; topical application for wounds, boils, saddle sores; infusion drunk for colds, flu; inhalant to strengthen horses; root as ball in stick game; not eaten	Hunn & French 1981
3) Rock Creek	čalúkš (=*L. dissectum* var. *multifidum)*	medicine for dandruff	
4) Tenino	"sunflower root" (probably *L. dissectum)*	fish poison	Ray 1942
5) Warm Springs dialects (Celilo,	čalúkš (=*L. dissectum* var. *multifidum)*	for tanning rawhide (deer); human and horse medicine; tick wash in	French (pers. comm.), Cox 1983

Tenino-Tygh)		spring; infusion for sick horses who are also made to inhale smoke; cure for distemper; hair wash for humans, to remove ticks, lice, to cure dandruff; in infusion for fever; chewed while sweating; sprouts eaten	
6) unspecified Warm Springs	cha-luksch (=*Lept. multifida* syn. *L. dissectum* var. *multifidum* or "Indian Balsam")	tea made for coughs or flu from root chips; external wash for dandruff, to rid horses of ticks; root for tanning hides	Murphey 1959
2. Nez Perce	titalam (=*L. dissectum*); upper root called i•cus	famine food; upper root considered too oily to be eaten; gathered when necessary in Jan./Feb.	Marshall 1977
Nez Perce	*L. dissectum*	roots eaten, baked underground for 1 or 2 days; root is medicine: oil rubbed on sores, sore eyes; root mixed with tobacco and smoked for sinus trouble; drunk as tea to cure tuberculosis or increase appetite	Hart 1976
C. Chinookan languages			
1. Upper chinookan			
a) Wasco-Wishram/ Cascades	a-gə́x+gəx a-gáx+gax (=*L. dissectum* var. *multifidum*)	for horse grooming and medicine (especially race horses); for sores and wire cuts on horses. . . for similar things on humans; for head lice; for preparing deer hides; to stupefy fish	French (pers. comm.)
II. Great Plains			
A. Algonquian languages			

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Native area/group	Term	Use	Source
1. Blackfoot	o-muck-kas (=*L. dissectum* var. *multifidum)*	horse medicine and magic; gathered in fall; tonic for humans	Johnston 1970 (citing McClintock 1910 & Ewers 1955)
Blackfoot	"big turnip" (=*L. dissectum)*	medicine for horse fertility; as inhalant for distemper in horses	Hellson & Gadd 1974 (citing Ewers 1955)
Blackfoot	"big turnip" (=*Lept. multifida*)	for colic and distemper in horses; as fertility/growth amulet for horses	Ewers 1955
2. Arapaho	nee-a-tat (=*Lept. multifida*)	see Wind River Shoshone below	Nickerson 1966
B. Siouan languages			
1. Crow	isé (=*Lept. multifida* or "bear root")	incense in sweat lodge; medicine for children to make them grow straight; cure-all: chewed for colds, tooth ache, used as liniment on sores	Lowie 1935
III. Great Basin/ California	*L. dissectum* ("fern-leaved lomatium")	semi-sacred cure-all; still in common use in 1980s	Fowler 1986
A. Numic languages			
1. N. Paiute	tóza (=*Lept. dissecta* var. *multifida*)	roots pounded and soaked in water or smoke from smudge fire fanned over water to stupefy fish; root smoked or chewed to cure colds	Stewart 1941

a) unspecified "Paiute"	toza (=*Lept. multifida*)	see Murphey entry for Shoshone	Murphey 1959
unspecified "Paiute"	*toh*-aw-sav-ve, *toh*-sah, *toh*-sah-*ah*, *toh*-sup	see Train *et al.* entry for Shoshone	Train *et al.* 1957
2. Shoshone			
a) unspecified	toza (=*Lept. multifida*)	stalks eaten in spring; tea made for coughs or flu and as a tonic (from root chips); "Ruby Valley Shoshone cut fresh root. . . drop of oil in each eye of a trachoma sufferer. . . "; for distemper in horses, force them to inhale smoke of root; ground root powder for saddle sores; wash of root to get rid of ticks, and for dandruff	Murphey 1959
unspecified	*toh*-aw-sa-ve, *toh*-sah, *toh*-sup (=*Lept. multifida*)	panacea: coughs/colds, hayfever, bronchitis, pneumonia, tuberculosis, prepared as tea but smoked, or chewed for sore throat; external washes against smallpox, skin rashes, sores, or as poultice; drops of oily juice on skin problems, as eye drops for trachoma or gonorrheal infections; fresh root ground and applied to newly cut umbilical cord; root in poultice for swelling, sprains, rheumatism; root to cure horse distemper (horse exercised then made to inhale fumes from burning root)	Train *et al.* 1957
unspecified	tootsa (=*L. dissectum* var. *multifidum*)	important medicine for humans and animals; root collected in summer, cut	Smith 1972

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Native area/group	Term	Use	Source
		and dried for colds/flu as a tea; ground root mixed with tobacco and smoked for head and lung congestion; root placed in nostrils for headache; root steeped in hot water for rheumatic pain; external washes prepared for dandruff and skin abrasions	
b) Nevada Shoshone	tatsip, tooza, to:dza	fish poison, leaf smoked	Steward 1941
c) Wind River or E. Shoshone	*Lept. multifida*	root eaten, raw or cooked; young shoots cooked and eaten; dried root chips added to "Bull Durham" for friendly smoke; water boiled with root to sponge off a sick person; dry root pounded with grease for massage of affected parts; root boiled into decoction for colds/flu; steam likewise inhaled	Nickerson 1966
d) Gosiute	tó-dzûp (=*Ferula multifida*)	young shoots and seeds eaten; smoke from root inhaled for horse distemper; smashed root applied to wounds, cuts, bruises, broken bones. . . "most valued (of) medicines"	Chamberlin 1911

3. unspecified Nevada Indians	toza (=*Lept. multifida*)	"big medicine": powdered for use on sores; a tea drunk for coughs and as a tonic; chips burned, smoke inhaled for asthma or bronchial problems	Nickerson 1966
4. S. Paiute			
a) "Ute"	tố-dzûp (=*Ferula multifida*)	remedy for horse distemper: smoke from burning root inhaled	Chamberlin 1911
b) Uinta Ute	tố-tûv (=*Ferula multifida*)	"highly valued medicine", applied externally on wounds; smoke of pulverized root inhaled by horse against distemper	Chamberlin 1909
B. Hokan languages			
1. Atsugewi (Pit River)	*Lept. multifida*	to poison fish	Stewart 1941
Atsugewi (Pit River)	"wild parsley" (*Ligusticum grayi* Coult. & Rose, id felt to be uncertain by author) = bố́hom (poss. *L. dissectum*)	to poison fish; eaten in spring when tender; remedy for colds/flu/cough, children's stomach ache; root either chewed or prepared in infusion	Garth 1953
2. Washoe	*d*osa, *d*oza	same as Train *et al.* 1957 for Shoshone	Train *et al.* 1957
Washoe	doza	tea for cough/flu from root chips	Murphey 1959
Washoe (incl. Atsa)	toza (=*Lept. multifida* = "Ind. balsam")	fish poison; smoked and chewed to cure cold	Stewart 1941
3. Karok	coma'ish (=*L. dissectum*)		Constance n.d.

The clearest reference to the plant's use as "fish poison" has been, until recently, from Northern Paiute bands in the western Great Basin (Stewart 1941: 425). Only within the last ten years has its use in the Plateau as a fish stupefacient been documented in detail. Investigations among Salishan-speaking Okanagan-Colville (Turner *et al.* 1980) and Sahaptin-speaking Yakima and John Day River Indians (Hunn 1990) show clearly that its use in capturing fish is not

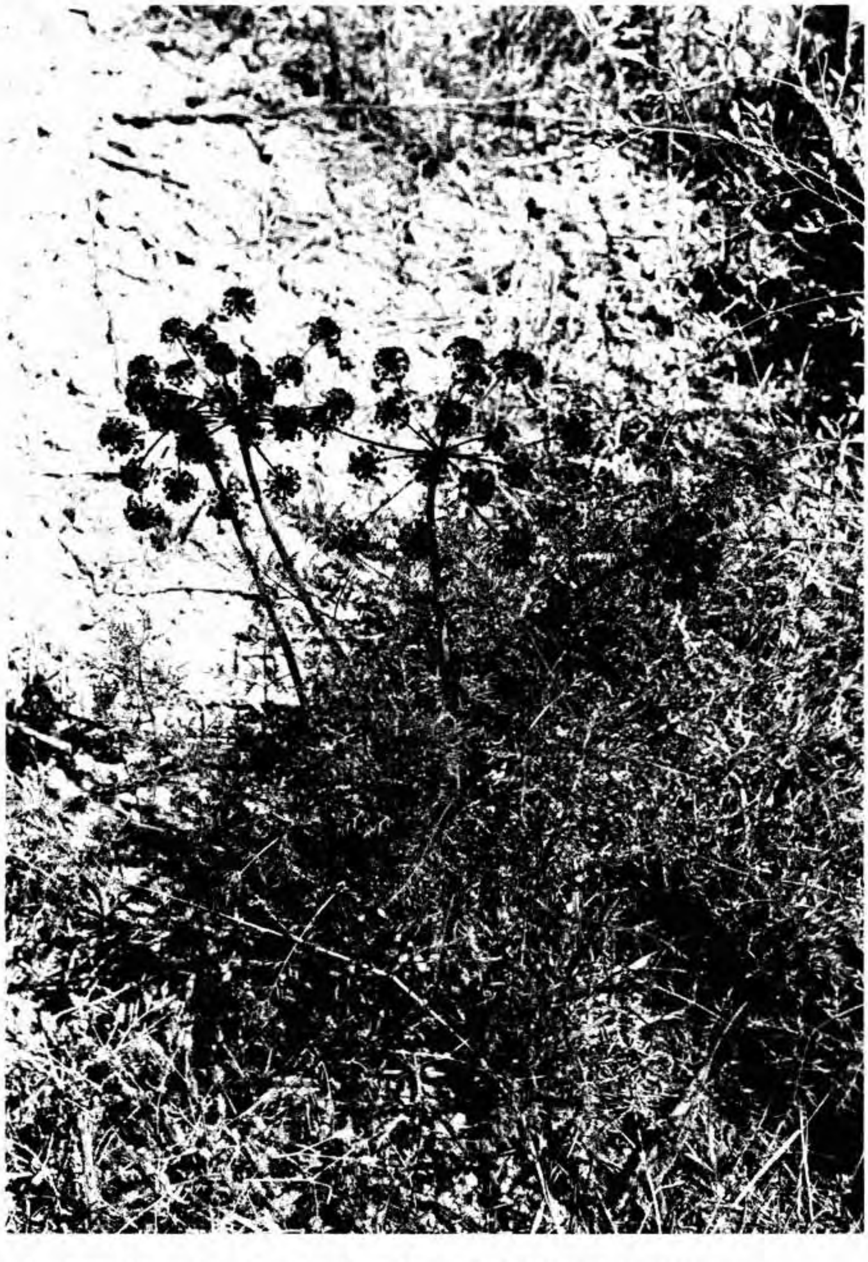

FIG. 1.—*Lomatium dissectum* in its natural habitat. Photo by N.J. Turner.

restricted to the Great Basin. On the strength of these ethnographic reports we may conclude that *L. dissectum* was the unidentified fish poison Ray (1942:114) ascribed to Wenatchi, Kittitas, Tenino, and Klikitat Indians.

Citing Rostlund's (1952) monograph on aboriginal fishing—which relies on Ray's testimony—Cressman (1977:118) asserted that "limited use [of unspecified fish poisons] is reported for the Columbia Plateau in the area of tributary streams running to the Columbia River from the eastern flanks of the Cascade Mountains. It [fish poison use] is absent in the rest of the Far West." He indirectly attributes the absence of fish poison use to the presence of the leister spear, a two or three pronged thrusting instrument suitable to freshwater spear fishing. According to Cressman " . . . The two methods are mutually exclusive" (1977:115). The fact that *L. dissectum* was widely used to stupefy fish by Columbia Plateau Indians—who also employed the leister spear—belies Cressman's conclusion. The two methods, in fact, complement one another, each appropriate to different settings: poisoning to small, quiet streams in the mountains, the leister spear to the deep waters of bigger rivers. The absence of large rivers in the Great Basin seems a more likely explanation for the leister spear's limited distribution south of the Columbia River than the presumed "blocking" action attributed by Cressman to fish poisons.

ETHNOGRAPHIC ACCOUNTS OF THE USE OF *LOMATIUM DISSECTUM* AS A FISH POISON IN THE PLATEAU

The following information on *L. dissectum* use is based on interviews with nine native Sahaptin-speaking elders (born between 1911 and 1923) representing all three major dialect groups of the Sahaptin language. All referred to the plant as *čalúkš* (etymology uncertain, perhaps *ča-* [= "pull, as with the teeth or mouth"] + *lúkš* [= Columbia River dialect term for *Lomatium canbyi*]). Four of these consultants positively identified voucher specimens of *L. dissectum* as *čalúkš* (Hunn 270840, 270886, 270899, WTU). Two other consultants regularly identified the species *in situ* as such. Individuals of both locally occurring varieties, *L. d. dissectum* and *L. d. multifidum* (Nutt.) Math. & Const., as well as individuals of yellow and dark purple petaled populations, were named *čalúkš* without distinction. No special terms were recorded for either the shoots or root crown, as has been noted elsewhere (Table 1). According to our consultants, *L. dissectum* was commonly employed to harvest fish at the following sites: Moses Coulee, Douglas Co., WA.; Little Klickitat River, Klickitat Co., WA.; Logy Creek, Yakima Co., WA.; and around the headwaters of the John Day and Umatilla Rivers in Oregon. Our information accords well with that for the Okanagan-Colville reported by Turner *et al.* (1980:66). French's Warm Springs Sahaptin consultants have denied the use of *L. dissectum* as a fish poison, though Ray (1942:114) attributes to the Tenino the use of "macerated sunflower" root to poison trout *(Salmo* spp.) and whitefish *(Prosopium* spp.).

In April and May when root-digging began in earnest for Native Americans living in the southern Columbia Plateau, small groups of people moved away from the river into the upper Sonoran and transition vegetation zones to well-known root-digging areas, while others stayed at the river to harvest the spring Chinook salmon run (Hunn 1990). Those moving into the foothills followed a round which ensured continual correspondence between labor availability and plant maturation in response to elevation and other factors. Large quantities of *Lomatium* and *Lewisia* (bitterroot) roots were harvested and dried for winter consumption.

While away from the Columbia River and their usual salmon protein source in late spring and summer, root-digging groups used *L. dissectum* opportunistically to stupefy smaller non-anadromous fish for immediate consumption. According to James Selam, a John Day River elder (born 1919), securing the root was not difficult. The plant is widespread and commonly found on rocky slopes and in talus adjacent to streams. According to Mr. Selam this apparent fortuitous coincidence was not coincidence at all. He remarked that "the Maker must have put it *[L. dissectum]* there for the fisherman." The roots were extracted with the digging stick, the tool of choice for harvesting bitterroot and edible tuberous lomatiums. The roots were then placed in a burlap sack and mashed with the hands or a rock. The sack was then placed in a slow moving section of stream, the greater the water volume the more roots used. Two or three roots would normally suffice, but up to ten might be needed for a particularly large pool. When fish started to float to the surface, the sack was pulled out and the larger fish gathered up. The remaining fish, according to our consultants, would revive once the sack was removed and clear water allowed to flow through. The effect of the poison on the fish was likened to them "getting drunk" or being "knocked out." Streams were apparently not dammed for this purpose, perhaps because, as Mr. Selam claims, one should use *L. dissectum* only in flowing water or "you will kill all the fish." A second method was reported by Gilbert Smartlowit, a Yakima Indian of Upper Cowlitz extraction (born 1911), describing a Klikitat Indian practice. The roots were boiled and the water then poured into the stream or pool with the same result. The harvested fish were strung on a willow twig for transport back to camp where they were cooked and eaten.

Despite these detailed accounts, Hunn was unable to replicate the ethnographic fish poisoning technique of Selam on 21 March, 1979. According to Mr. Selam, the target species of fish poisoning, trout *(Salmo gairdneri, S. clarki)*, were absent from mountain streams before late May or June because of low water temperatures. Furthermore, it is possible that *L. dissectum* roots lose potency in the winter. Mr. Selam suggested these as the reasons for the failure of Hunn's experimental effort.

Protein derived from such freshwater fish was clearly secondary to that contributed to the native diet by salmon fishing and deer hunting. However, it should not be overlooked in a comprehensive description of native subsistence. It served as an efficient way of securing needed protein in areas where other sources might not have been readily available.

BIOCHEMICAL STUDIES OF *LOMATIUM DISSECTUM* AS A FISH POISON

The exact nature of the fish-stupefying mechanism in *L. dissectum* is unknown. However, we have been able to verify anthropological reports regarding the piscicidal property of this species through an experiment in which samples of dried and ground *L. dissectum* root were placed in small water-filled tanks occupied by coho salmon *(Oncorhynchus kisutch)*[2]. In addition, chemical extractions of *L. dissectum* root coupled with bioassays using coho salmon allowed us to investigate the molecular composition of the plant's ichthyotoxic ingredient(s). We also present data from sodium uptake experiments as a first attempt to characterize the physiological effect of the plant on fish.

In our preliminary set of experiments, samples of dried root were administered to fingerling salmon which ranged in weight from 3–20 g. The L.D.-50 was established at 0.20 g/l (dried root/water). At first the fish were hyperactive, exhibiting sudden bursts of energy, jumping from the water, displaying overactive gill motion, and frequently hitting themselves against the sides of the holding tank. Subsequently, they would slow, begin to lose equilibrium, float belly up, and sometimes begin to sink. The same fish might repeat this contrasting pattern three or four times within one minute.

Once anthropological reports on the ichthyotoxic effect of *L. dissectum* were successfully verified, organic separations were carried out on the root of the plant with the intention of identifying a toxic fraction. Extracts—both organic and water soluble—were assayed for activity using fingerling salmon. Those fractions showing the most toxicity were subjected to chemical identification by two dimensional paper chromatography and ultra-violet spectroscopy.

At the time of our experiments, previous extraction procedures undertaken on *L. dissectum* and related species were known to have isolated ichthyotoxic furanocoumarin molescules (Gupta & Soine 1964; Lloyd & Jenkins 1942). The furanocoumarin peucedanin, isolated as the active ingredient from *Peucedanum officinale* L. (Apiaceae), had been shown to kill fish (Murray *et al.* 1982:2). The roots of the umbelliferous species *Pteryxia terebinthina* Coult. & Rose (= *Cymopterus terebinthinus* [Hook] T. & G.), produced a crystaline substance known as pteryxin which showed toxicity to fish. Chemical analysis indicated that this activity was probably due to a benzopyrone (Call & Fischer 1958; Thompson *et al.* 1979).

In light of these studies, we chose to follow an extraction scheme designed to isolate coumarin-like moities. Among the several separation procedures attempted, those designed after the scheme employed by Steck (1973) produced the most toxic fraction. This extract showed general coumarin-like properties such as sweet "fresh mown hay" scent, blue flourescence under UV light, and Rf values of 0.82, 0.78–0.77. A UV absorption analysis revealed the following (in EtOH): a λ maximum at 325 nm, A = 0.93; a λ maximum at 255 nm and 247 nm, A = 0.37, and a λ minimum at 261 nm, A = 0.20. These values correspond to the known UV absorption spectrum of coumarins isolated from Apiaceae for which specific molecular configurations have been determined (Nielson & Jensen 1976; Smith *et al.* 1957; Steck 1973; Willette & Soine 1962; 1964). Figure 2 illustrates, for comparison, the UV absorption bands of the toxic fraction isolated here from *L. dissectum* with those for two previously isolated furanocoumarins, columbianetin (a) from *L. dissectum* and suksdorfin (b) from *L. suksdorfii* (Wats.) Coult. & Rose (Willette & Soine 1962; 1964). These bands closely correspond to the absorption data obtained here for the toxic fraction derived from *L. dissectum* roots. This suggested that the major components of our *L. dissectum* toxic fraction were furanocoumarin-like molecules.

Subsequent to our experiments, others have shown that coumarin glycosides are indeed major components of the organic fraction of *L. dissectum* root (Van Wagenen *et al.* 1988). However, despite their presence in *L. dissectum,* such compounds were not found to be toxic to fish by these workers (1988:139). Rather, VanWagenen *et al.* claim that the piscicidal action is caused by unrelated tetronic acid molecules. These were found in *L. dissectum* to be unstable and in low abundance. Based on the description in VanWagenen *et al.* (1988), we feel it is possible that tetronic acids co-migrated with our coumarin components and were

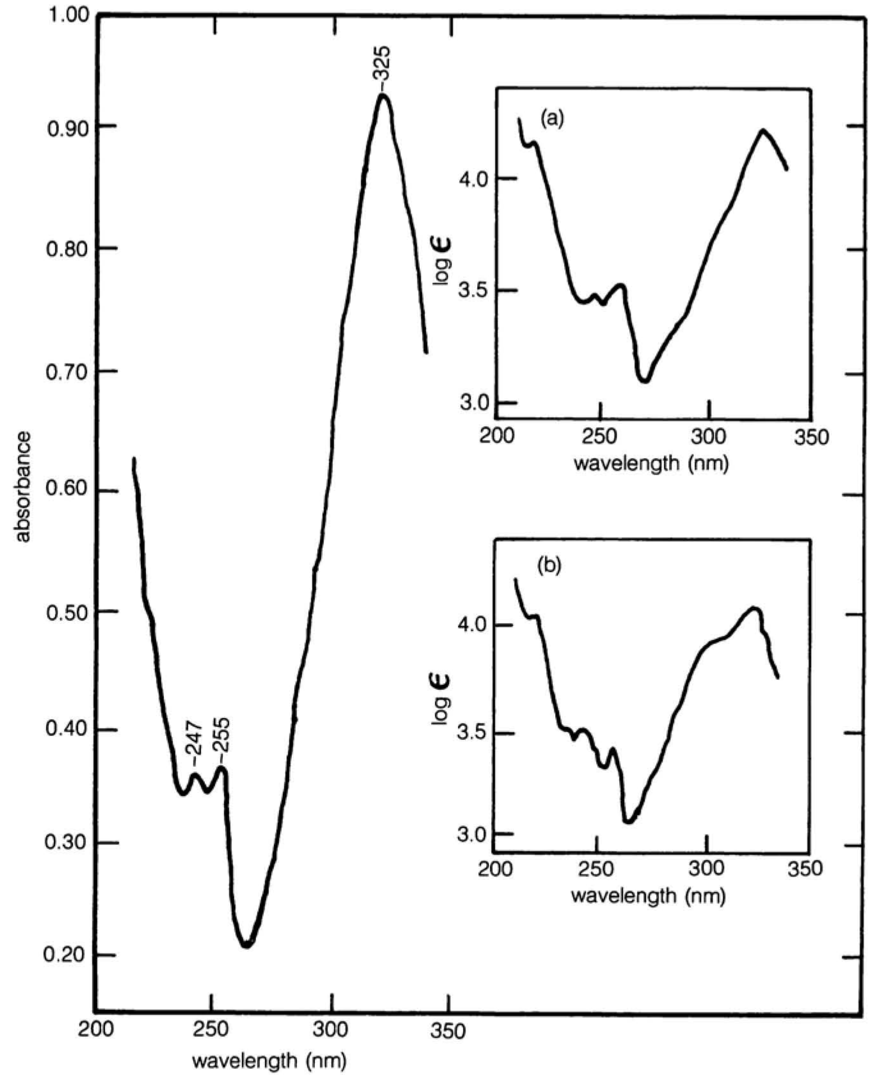

FIG. 2.—UV absorption spectrum for toxic fraction of *L. dissectum.* Insets show (a) UV spectrum for columbianetin (taken from Willette & Soine 1964), (b) UV spectrum for suksdorfin (taken from Willette & Soine 1962).

present in such low quantities that they went unrecognized in the toxic fraction generated by our extraction procedures.

In spite of the recent findings of VanWagenen *et al.*, the exact piscicidal mode of action of *L. dissectum* root remains to be characterized. We undertook preliminary experiments in an attempt to do this. One hundred sixty salmon fingerlings were equally distributed between two baths, each bath containing equal doses of radioactively labelled sodium. One bath contained a homogenate of the dried root. Every half hour for seven hours, four fish were removed from each bath and whole body sodium content was counted. As shown in Figure 3, fish in the *L. dissectum* bath proved to be consistently lower in sodium levels, sug-

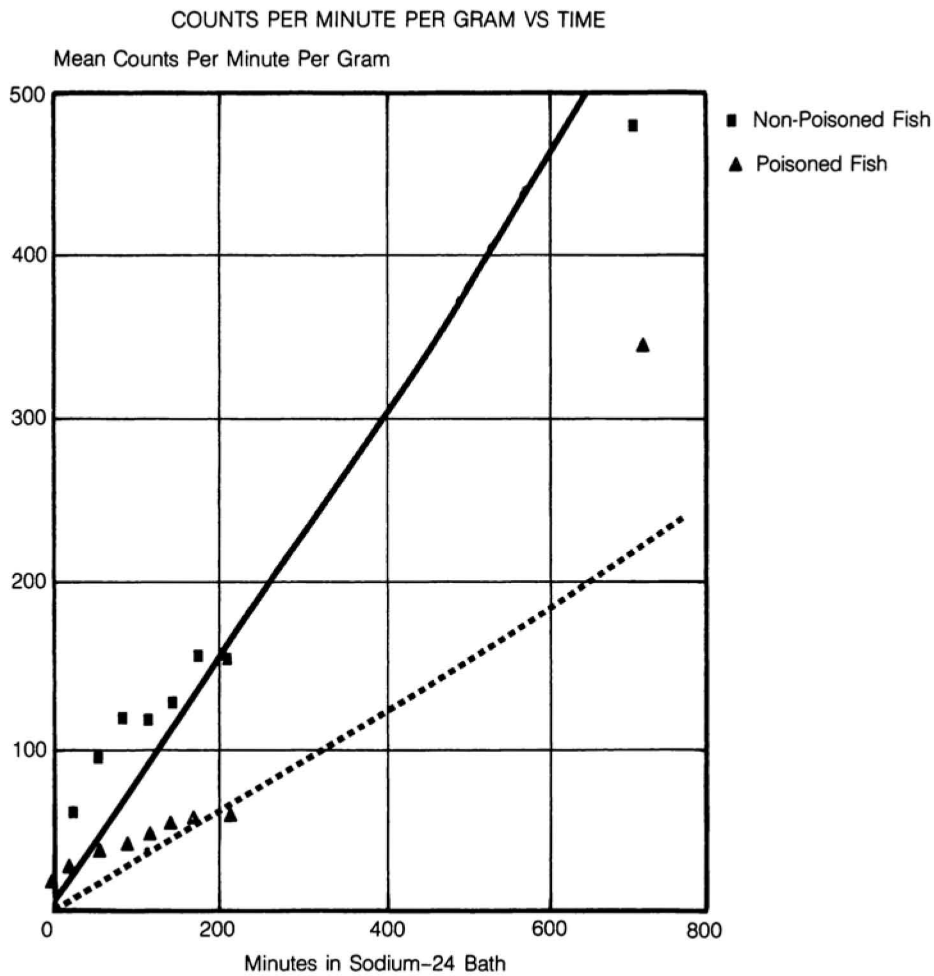

FIG. 3.—Sodium uptake in poisoned and non-poisoned salmon fingerlings.

gesting that affected fish were experiencing inhibition of sodium uptake at the gills. This indicated a possible broad spectrum inhibition of molecular uptake at the gills including, among other things, reduced oxygen transfer.

While the results of our UV absorption and paper chromatography tests performed on the toxic fractions of *L. dissectum* root suggested that furanocoumarin- or coumarin-like molecules made up a majority of the chemical mixture, and were possibly the piscicidal agents somehow affecting sodium uptake, others have claimed that ichthyotoxicity is due to small, unstable quantities of tetronic acids (VanWagenen *et al.* 1988). In light of our findings and of the several earlier studies demonstrating toxicity of coumarins to fish, we hope that further experiments, generating detailed bioassay data, will be forthcoming for this interesting plant.

CONCLUSIONS

While it has been shown recently that lomatiums have made significant if not primary contributions to the diet of Sahaptin-speaking Plateau Indians, it seems increasingly that their cultural contribution was and remains highly elaborate and multidimensional, as the *L. dissectum* example above demonstrates. Fully more than one-third of the species occurring in the traditional Sahaptin range were named and used. The remarkable correspondence between cultural focus and folk systematic differentiation within this taxonomically difficult genus is demonstrated not only by the widespread medicinal use of lomatiums, but by their nutritional contributions in terms of carbohydrates, vitamins, minerals and, indirectly, protein through fish incapacitation.

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NOTES

[1]The orthography follows that found in the published sources. Where no source is provided, the data is from Hunn's field notes.

[2]Plant material used for both bioassays and chemical extractions was collected on the north side of the Columbia River, about 3 miles east of Bingen, WA. A voucher specimen of this plant material (No. 4579), identified as *L. dissectum* var. *dissectum*, has been placed in the herbarium at the Reed College Biology Department.

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