sp. (Staphylinidae)—predator-scavenger, 1%; *Nabis ferrus* (Linnaeus) (Hemiptera: Nabidae)—predator, 0.5%. Quesnel, Feb. 11, 1976; 4-ha (10-acre) spruce chip stockpile: *S. bidentatus*—100%. Williams Lake, Sept. 4, 1975; 4,000 BDU chip stockpile, 1 month old, 20°C at 13-m (40-ft) sample level: *Monotoma longicollis* Gyllandel (Coleoptera: Rhizophagidae)—vegetarian, 90%; *Typhaestericoria* Linnaeus (Coleoptera: Mycetophagidae) — fungus feeder, 6%; *Corticaria* sp. (Coleoptera: Lathridiidae)—vegetarian scavenger, 2%; *Atheta* sp., 2%.

In view of the variety of insects recovered from a relatively few unscheduled collections, it seems probable that at least a few other species are common. It is likely that the predominant species (cucujids, carabids, rhizophagids) serve as food, directly or indirectly, for most of the minor species.—David Evans, Pacific Forest Research Centre, Victoria, B.C.

Variation in Shoot and Needle Growth Patterns on 46-cm Branch Tips of Healthy White Spruce.—The 46-cm (18-in.) branch tips of balsam fir (*Abies balsamea* [L.] Mill.) and white spruce (*Picea glauca* [Moench] Voss) have been widely used as a collection unit for spruce budworm (*Choristoneura fumiferana* [Clem.]) surveys in Canada (Harris, For. Chron. 39:199-204, 1963, and 40:195-201, 1964; Miller et al., Bi-mon. Res. Notes 28:31, 1972; DeBoo et al., Phytoprotection 54:9-22, 1973; Martineau and Benoit, Phytoprotection 54:23-31, 1973). This size of branch tip is often convenient to remove from tree crowns, is easy to store and examine, and has characteristics that relate to the oviposition, feeding, and resting sites of the budworm. Current-year shoot growth on the 46-cm tip may also be used to derive estimates of annual defoliation and bud damage.

There is interest in using the 46-cm branch tip to monitor spruce budworm larvae and damage in white spruce forests of northern Alberta and the Northwest Territories. However, no data exist from these areas on the within-crown variation of several foliage characteristics of the 46-cm unit for trees of different size that can aid in the sampling procedure and interpretation of results. This study reports on the variation in length of current-year shoots, total length of shoots, number of buds, needle density of current shoots, and dry needle weight of the 46-cm branch unit. Three naturally stocked stands of white spruce that showed no previous identifiable budworm damage were selected near High Level, Alta. Stand I (average age 83 yr) was predominantly white spruce with scattered trembling aspen (*Populus tremuloides* Michx.), while stand II average age of spruce 44 yr) and stand III (average age of spruce 30 yr) both had an overstory of trembling aspen (Table 1).

Ten codominant spruce were selected from each stand for the foliage analysis. The cardinal directions were marked on the main stem of each tree to designate four equal quadrants; then each tree was felled. On trees from stand I the live crown (average length 10.8 m) was divided into four equal levels, designated A (uppermost quarter), B, C, and D. A 46-cm branch tip was clipped from near the center of each level quadrant, the yield being 16 branch tips per tree. Procedures for sampling stands II and III were identical, except that because of their smaller size, three equal crown levels (A, B, C) were measured on stand II trees (12 branch tips per tree) and two equal levels (A,B) on stand III trees (8 branch tips per tree). The average lengths of live crown of trees from stands II and III were 8.5 and 5.5 m respectively. All foliage samples were collected in May and June, 1968, but to standardize sample units all 1968 shoot growths were excluded.

For each branch tip the foliated surface was estimated as the product of its length and the total midpoint width (Morris, Can. J. Zool. 33:225-294, 1955). The length of 1967-formed shoots was measured separately from the total foliated shoot length of the 46-cm tip because budworm larvae prefer current year's shoots as food over older needles. All live terminal, lateral, and internodal buds that produced new shoot growth in 1968 were counted, because all were considered potential feeding sites of second- and third-instar larvae. Needle counts were made on 15-cm lengths of 1967-formed shoots from each branch tip. The needle weight on the 1967-formed shoots was determined from a sample of 100 needles per branch tip after drying at 105°C. Needles formed prior to 1967 were measured as a group. Branches were air-dried to the point of needle drop. Needles were mixed and a sample of 100 needles representing several years' growth was dried at 105°C and weighed.

Analysis of the branch tips suggested no differences between quadrants within levels of each tree age class with respect to all branch characters. Branch-tip surface area varied between crown levels of trees within the same stand, and also between crown levels of the different stands (Table 1). Mean foliated surface area per tree was 1,261, 970, and 787 cm^2 respectively for stands I, II, and III. Within crowns of trees in each stand, foliated surface area was least in the A crown levels, while in stands I and II maximum foliated area appeared to be at midcrown level or below.

The pattern of total shoot length within and between crowns of the three stands appeared to be similar to that for surface area (Table 1). In stands I and II highest total shoot length occurred at or below midcrown level. An explanation for this may be that maximum shoot length coincided with maximum number of years of foliated shoot growth, although this was not verified. Growth of 1967-formed shoots in crown level D of stand I and level C of stand II was greatly reduced and occasionally absent. The longest growth of 1967-formed shoots occurred in the upper crown, as expected, but was progressively less in trees of the younger stands sampled.

TABLE 1

Summary of mean and S.E. of foliage area, shoot lengths, numbers of live buds, needle density, and dry needle weights on 46-cm branch tips from spruce crowns in northern Alberta

Stands	Age	No. of trees sampled	Crown levels	Foliated area, cm^2	Length 1967 shoots, cm	Total shoot length, cm	No. of live buds	No. of 1967- formed needles/cm shoot	Avg dry weight per needle, mg: 1967-formed	Avg dry weight per needle, mg: Pre-1967-formed
I	83	10	A*	1 032 ± 51.3	137 ± 7.7	467 ± 27.0	88 ± 4.3	22.4 ± 0.34	4.5 ± 0.10	4.3 ± 0.08
			B	1 355 ± 54.6	111 ± 9.7	616 ± 35.5	65 ± 5.3	21.1 ± 0.34	4.6 ± 0.10	4.5 ± 0.07
			C	1 432 ± 57.0	36 ± 5.9	644 ± 36.4	25 ± 3.7	19.3 ± 0.40	4.4 ± 0.15	4.7 ± 0.12
			D	1 226 ± 46.3	13 ± 2.8	430 ± 23.7	10 ± 2.2	17.6 ± 0.46	4.2 ± 0.23	4.4 ± 0.10
II	44	10	A*	929 ± 28.1	88 ± 4.3	308 ± 13.3	47 ± 2.0	21.6 ± 0.50	4.6 ± 0.09	4.3 ± 0.07
			B	1 006 ± 25.0	47 ± 3.0	392 ± 19.2	31 ± 1.7	21.4 ± 0.51	4.4 ± 0.13	4.4 ± 0.09
			C	974 ± 30.1	16 ± 2.2	329 ± 17.0	12 ± 1.5	19.0 ± 0.62	4.3 ± 0.19	4.5 ± 0.08
III	30	10	A*	755 ± 21.1	68 ± 3.3	240 ± 7.3	40 ± 1.8	26.5 ± 0.47	4.3 ± 0.12	4.1 ± 0.07
			B	819 ± 23.4	20 ± 3.0	283 ± 6.8	13 ± 1.8	25.7 ± 0.75	4.1 ± 0.15	4.2 ± 0.09

*Crown level A was uppermost.

Within each age class of trees the numbers of live buds per branch tip decreased from the upper level to the lower level and, on the average, were considerably less on trees in stands II and III than on trees in stand I. Data obtained in 1971 revealed that 46-cm branch tips in two spruce stands similar in site and stand characteristics to stand I had nearly identical numbers of buds in the four crown levels as stand I, even though they were from different areas and were collected at different times (Cerezke, unpublished data).

Density of needles per unit length of shoot affects both the quantity of food available to larvae and the choice of oviposition site by female moths (Greenbank, Entomol. Soc. Can. Mem. 31: 202-218, 1963; Miller, Entomol. Soc. Can. Mem. 31:75-87, 1963). In the present study highest needle densities per centimeter of shoot length occurred in the upper crown levels and decreased toward the base (Table 1). This finding lends support to the observed distribution of eggs and larvae in tree crowns (Morris, 1955; Harris, 1963 and 1964) and to the fact that female moths prefer to oviposit on relatively new needles and on shoots with closely spaced needles (Greenbank, 1963). However, needle density per centimeter of shoot may vary with rate of shoot growth (Smith, Can. J. Forest Res. 2:173-178, 1972).

Average dry weights per needle of 1967-formed and older needles for each age class of tree were similar, but within crowns of the three age classes different trends were apparent. On trees from the younger stands, II and III, dry weights of the 1967-formed needles decreased down the crown, whereas dry weight of older needles showed a trend of increase down the crown. These data agree with those of Smith (1972), who reported a decrease in dry needle weight down the crown of Douglas-fir and western hemlock and a general increase with age of needles. On trees from stand I maximum weight of both 1967-formed and older needles appeared to be near midcrown level. Similar data collected on open-grown Douglas-fir revealed significant differences in dry needle weight between upper and lower crown, between old and new needles, and between tall and short trees (Mitchell, USDA Forest Res. Pap. PNW-181:1-14, 1974). In the present study on spruce only the pattern of dry weight of 1967-formed needles in trees from stands II and III was consistent with findings in Mitchell's study. Some of the variability in needle dry weight may be attributed to variation in needle size.

The results of this study provide a general description of the 46-cm branch tip as a collection unit on nondefoliated northern white spruce and may serve to identify some problems inherent in its use for surveys of spruce budworm abundance and damage, such as are encountered when changes in growth pattern occur after budworm feeding. Variability in the collection unit may change with duration and intensity of defoliation. On trees subjected to several years of heavy budworm feeding, the effects of defoliation may alter the normal growth pattern of branch tips differentially down the crown through loss of needles, twig and bud mortality, and stimulation of epicormic shoots (Batzer, Environ. Entomol. 2:727-728, 1973). As an example, in a budworm outbreak near Fort McMurray, Alta., bud numbers on 46-cm tips increased two- to threefold (average 101 ±S.E. 5.7), and subsequently the branch tips grew somewhat three-dimensionally in form. Such a change in branch form may result in increased current-year shoot growths on the 46-cm tip and possibly provide a less meaningful measurement of relative budworm abundance.

Bud numbers per branch tip may be a useful criterion for expressing abundance of second- and third-instar larvae since they initially feed within the buds. Early spring mining of needles has not been observed thus far in northern Alberta. Larval and egg abundance may also be expressed in terms of weight of the 46-cm tip as discussed by Morris (1955).

For most general surveys of the budworm in northern spruce forests, the 46-cm tip as a sample unit is probably adequate and should be taken from the midcrown level of the tree (Miller et al., 1972). However, data in Table 1 indicate that 46-cm midcrown tips from trees of different age are not equal as sampling units with respect to several foliage characters, and caution is therefore necessary in comparing budworm abundance and damage in different stands. When the midcrown level is sampled with conventional pruning tools, this height is convenient to reach in most immature spruce forests, but difficult in mature forests.—H.F. Cerezke, Northern Forest Research Centre, Edmonton, Alta.

Introduction of the Birch Casebearer Parasites ***Campoplex*** **and** ***Apanteles*** **into Newfoundland.**—The birch casebearer (*Coleophora fuscedinella* Zeller) is native to Europe and was accidentally introduced into eastern North America about 1920 (Gillespie, Maine Forest Serv. Bull. 7,1932). This insect was discovered in Newfoundland in 1953. By 1971 it had spread throughout the Island and has become the most important pest of white birch (*Betula papyrifera* Marsh.) (Raske and Bryant, Can. Entomol. 108:407-414, 1976). The most common damage is the browning of foliage; but, when populations are high, the larvae destroy the flushing buds and may cause twig, branch and sometimes tree mortality.

In 1968 the Canadian Forestry Service, in cooperation with the Commonwealth Institute of Biological Control, initiated a biological control program against the birch casebearer by studying the biologies of European hymenopterous parasite species with the aim of introducing some of these into Newfoundland. Introductions began in 1971 and were terminated in 1975. Details of the releases in 1971 and 1972 have been published (Raske, Nfld. Forest Res. Centre Inf. Rep. N-X-108, 1974), and this report presents data on all the releases and on the recovery of parasite progeny.

The parasite species released in all years were two species complexes: *Campoplex* spp. (Ichneumonidae) and *Apanteles* spp. (Braconidae). The *Campoplex* complex consisted of *C. borealis* and an undescribed species. The *Apanteles* complex included three species: predominantly *A. coleophorae,* and a few each of *A. mesoxanthus* and *A. corvinus* (H. Pschorn-Walcher, unpublished). Living individuals of both species complexes could not be identified; therefore exact numbers of each species released are not known.

Campoplex spp. were released in western Newfoundland (Cormack) in 1971 and in central Newfoundland (Badger) in 1972 to 1975. *Apanteles* spp. were released in eastern Newfoundland (Gambo) in 1974 and 1975 (Table 1). All parasites were released in August, when a high percentage of the host is in the first-instar larval stage, susceptible to the parasite.

In 1974 at Gambo, the parasites *Apanteles* spp. were released onto two trees caged in the same manner as for the 1971 and 1972 releases (Raske 1974). Parasites were released beneath uncaged trees at all other times, but always within 40 m of the trees caged in the previous years.

Birch casebearer pupae were collected at the release site in mid to late July before parasite emergence began, and placed in closed opaque containers for rearing. At Gambo host pupae were collected from four

TABLE 1

Number of parasites released from 1971 to 1975 against the birch casebearer in Newfoundland, and recovery of parasite progeny at the release sites in 1973 to 1975[1]

Locality and year	No. parasites released		No. hosts reared (and parasites recovered)		
			1973	1974	1975
CAMPOPLEX spp.					
Cormack					
1971	215	179	5278(2)	2344(1)	5329(10)
Badger					
1972	31	26	—[2]		
1973	104	98	—		
1974	291	230		961(0)	
1975	154	144			2053(2)
APANTELES spp.					
Gambo					
1974	147	114		—	
1975	90	59			202(8)[3]

[1]All parasite progeny identified by W.R.M. Mason, Biosystematics Research Institute, Ottawa.
[2]Dash indicates no host pupae reared.
[3]All from trees caged in 1974.

ISSN 0317-6908

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Vol. 33, No. 3, MAY-JUNE 1977

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