Meristic and morphometric variation in pink salmon (*Oncorhynchus gorbuscha*) in southern British Columbia and Puget Sound

TERRY D. BEACHAM

Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station, Nanaimo, B.C., Canada V9R 5K6

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Variation in the number of gill rakers and four morphometric characters was examined for 4 stocks from the even-year brood line and 20 stocks from the odd-year brood line of pink salmon (*Oncorhynchus gorbuscha*) in southern British Columbia and Puget Sound. Significant differences in gill-raker frequencies were observed among stocks within each brood line, but differences were greater between the brood lines than within each brood line. Sizes of the morphometric characters standardized to a body length of 419 mm were also variable among stocks within a brood line, but stocks spawning in rivers in the same region in alternate years were more similar morphometrically than to those spawning in different regions. It is suggested that patterns of meristic and morphometric variability are reflective of genetic differences, with meristic variability illustrating the genetic differences between the brood lines, and morphometric variability reflecting adaptation to local water velocity conditions in the streams the stocks return to during spawning.

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La variation du nombre de peignes branchiaux et la variabilité de quatre caractéristiques morphométriques ont fait l'objet d'une étude chez quatre souches de la lignée des années paires et chez 20 souches de la lignée des années impaires du saumon rose (*Oncorhynchus gorbuscha*) dans le Sud de la Colombie-Britannique et dans le Puget Sound. Il existe des différences significatives dans la fréquence des peignes branchiaux d'un stock à l'autre de la même lignée, mais ces différences sont plus grandes d'une lignée à l'autre. Les dimensions des caractéristiques morphométriques, standardisées pour une longueur totale de 419 mm, sont elles-aussi variables d'un stock à l'autre de la même lignée, mais les stocks qui frayent dans les cours d'eau de la même région sont plus semblables morphométriquement que les stocks qui frayent dans des régions différentes. Les tendances de la variabilité méristique et de la variabilité morphométrique reflètent probablement des différences génétiques; la variabilité méristique reflète probablement les différences génétiques entre les lignées, alors que la variabilité morphométrique semble plutôt être le reflet d'une adaptation aux conditions locales de vitesse de courant dans les ruisseaux où retournent les stocks pour se reproduire.

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Introduction

Pink salmon (*Oncorhynchus gorbuscha*) are found in hundreds of rivers along the Pacific coast of North America. They return to spawn and die in their natal rivers at 2 years of age (Bilton and Ricker 1965). This rigid 2-year life cycle has divided pink salmon into even-year and odd-year brood lines that can differ markedly in abundance within the same river. In southern British Columbia, the odd-year brood line is dominant in rivers tributary to Johnstone Strait, Georgia Strait, and the Fraser River (Beacham 1984*a*), as it is in rivers in Puget Sound, Washington. The even-year brood line is present in rivers tributary to Johnstone Strait and the northern part of Georgia Strait, but absent in the Fraser River and Puget Sound.

As a consequence of the 2-year life cycle with no gene flow between the brood lines, genetic differences are greater between the brood lines than among stocks within each brood line (Aspinwall 1974; Johnson 1979; McGregor 1982). Ihssen et al. (1981) found that in whitefish (*Coregonus clupeaformis*), protein (examined by electrophoresis) and meristic variation showed similar trends among stocks, but this was not the case for protein and morphometric variation. In pink salmon, one might then expect stocks within brood lines to be more similar to each other for meristic characters than to stocks within the alternate brood line, given a restricted geographical distribution of the stocks compared. Although variability in meristic characters in pink salmon has been examined with respect to stock identification (see reviews by Ricker 1962, Neave et al. 1967, Takagi et al. 1981), only one direct comparison has been done for meristic variability between brood lines from a restricted geographic area (Semko as reported by Ricker 1972). Significant differences were reported in meristic and morphometric characters between brood lines for Kamchatka stocks. In the present report, I compare patterns of meristic variability between and within brood lines for pink salmon stocks in southern British Columbia and Puget Sound.

Morphometric differences among stocks within a brood line have been documented for a number of Asian and North American stocks (Eniutina 1954*a*; Ricker 1962; Berg 1979; Takagi et al. 1981). The size of morphometric characters of Pacific salmon has been suggested to be correlated with physical characteristics of the natal rivers (Eniutina 1954*b*; Beacham 1984*b*). Morphometric adaptations of stocks to their natal rivers provide part of the rationale for the homing of mature Pacific salmon. Variability in morphometric characters is also compared between and within brood lines to examine possible adaptation of stocks to their natal rivers.

Materials and methods

Pink salmon were sampled on the spawning grounds from 4 stocks in 1982 and 20 stocks in 1983 (Fig. 1). All samples were taken during the latter portion of the spawning period so that all individuals were fully mature. Salmon were collected either with beach seines or by sampling fresh dead fish. The only meristic character recorded was the number of gill rakers on the left anterior gill arch. Morphometric characters recorded were postorbital–hypural length (Vladykov 1962), postorbital head length (Vladykov 1962), caudal peduncle depth, and length of the base of anal and dorsal fins (Hubbs and Lagler 1958). All meristic and morphometric measurements were recorded in the field. All morphometric characters were measured to the nearest millimetre, with either a hypural stick (postorbital–hypural length) or calipers (other morphometric characters). The sex of each individual

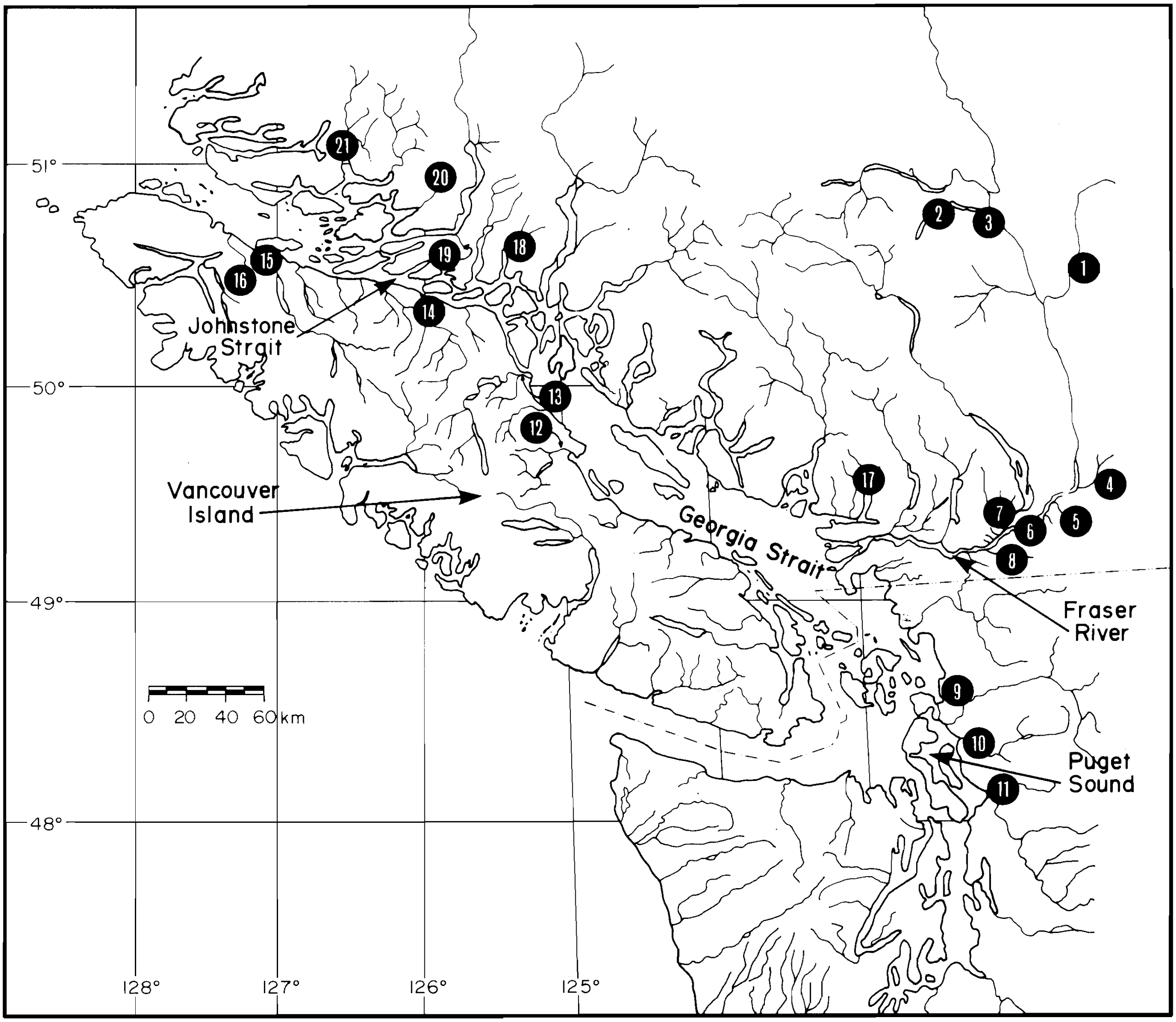

FIG. 1. Locations of pink salmon stocks sampled during 1982 and 1983. Listed in ascending order are (1) Thompson River, (2) Portage Creek, (3) Seton Creek, (4) Coquihalla River, (5) Jones Creek, (6) Fraser River, (7) Harrison River, (8) Vedder River, (9) Skagit River, (10) Stillaguamish River, (11) Snohomish River, (12) Puntledge River, (13) Quinsam River, (14) Adam River, (15) Cluxewe River, (16) Keogh River, (17) Indian River, (18) Phillips River, (19) Glendale River, (20) Kakweiken River, (21) Wakeman River.

was confirmed by internal inspection.

Preliminary analysis indicated that there were significantly different allometric growth regressions ($\log_e$ character length = $\log_e a + b \log_e$ body length) for each morphometric character between sexes and among stocks. Separate regressions for each sex and stock combination were used to standardize the morphometric measurements. All such measurements were standardized for each individual to the overall mean postorbital–hypural length of all spawning ground samples (419 mm) by the method outlined by Ihssen et al. (1981) and Beacham and Murray (1983)

$$M_t = M_o \left(\frac{\bar{L}}{L_o}\right)^b$$

where M_t = standardized character length; M_o = observed character length; $\bar{L}$ = overall mean length of males and females combined for all areas (419 mm); L_o = observed postorbital–hypural length; and b = regression coefficient of $\log_e M_o$ on $\log_e L$ for each sex and stock. The standardization of all morphometric measurements to the length of the overall sample mean minimizes variability resulting from allometric growth and differences in mean size of individuals among stocks (Gould 1966; Thorpe 1976).

Heterogeneity of gill-raker frequencies among and within stocks sampled in 1982 and 1983 was tested by the G-statistic (Sokal and Rohlf 1969). Individuals were grouped into seven classes; those having ≤ 27, 28, 29, 30, 31, 32, and ≥ 33 gill rakers. Differences in gill-raker frequencies between the sexes were tested by analysis of variance for each year separately. The model used was

$$Y_{ijk} = \mu + A_i + S_j + AS_{ij} + e_{ijk}$$

where Y = gill-raker number; μ = general mean; A = effect of stock, i = 1,4 for 1982 and i = 1,20 for 1983; S = effect of sex, j = 1,2; AS = interaction of main effects; and e = residual variance.

Morphometric characters were compared between brood lines, among stocks within brood lines, and between the sexes by analysis of variance. Linear models similar to the one previously outlined were used. I calculated mean Mahalanobis distance (Kendall 1975) between all pairs of stocks within each brood line by using the four morphometric characters previously listed. To illustrate similarities among the stocks surveyed, I used the complete linkage cluster analysis method (Sneath and Sokal 1973) with mean Mahalanobis distance as the basis for clustering. Discriminant analysis was also used to classify individuals to their respective brood lines.

TABLE 1. Mean number of gill rakers on left anterior gill arch for pink salmon stocks in southern British Columbia and Puget Sound. Standard deviations are also listed

Stock	*n*	Mean	SD
Even year (1982)	333	28.63	1.60
Glendale	99	29.42	1.36
Cluxewe	77	27.95	1.65
Quinsam	100	28.23	1.58
Puntledge	57	28.90	1.32
Odd year (1983)	2522	30.49	1.41
Puget Sound	322	30.08	1.27
Skagit	102	29.93	1.30
Snohomish	102	29.95	1.38
Stillaguamish	118	30.31	1.17
Fraser River	1300	30.50	1.35
Jones	100	29.84	1.50
Coquihalla	100	30.84	1.54
Fraser	200	30.31	1.34
Vedder	200	30.50	1.34
Harrison	200	30.89	1.26
Thompson	200	30.35	1.38
Seton	200	30.67	1.23
Portage	100	30.41	1.31
Odd year (1983)			
Mainland	500	30.59	1.23
Indian	100	30.04	1.34
Phillips	100	30.73	1.18
Glendale	100	30.91	1.26
Kakweiken	100	30.52	1.49
Wakeman	100	30.75	1.22
Vancouver Island	400	30.69	1.51
Puntledge	100	30.19	1.98
Quinsam	100	30.91	1.60
Adam	100	30.94	1.34
Keogh	100	30.72	1.44

Results

Meristic characters

Pink salmon sampled in 1982 had from 24 to 32 gill rakers (mean 28.6), and in 1983 from 24 to 38 gill rakers (mean 30.5). Males and females had equal number of gill rakers in both 1982 ($F = 0.69$; df = 1,325; $P > 0.05$) and 1983 ($F = 2.77$; df = 1,2482; $P > 0.05$). Pink salmon in the even-year brood line had significantly fewer gill rakers than those in the odd-year brood line, both between brood lines within the same river and between brood lines in separate rivers (Tables 1 and 2). Heterogeneity of gill-raker frequencies was greater between the brood lines than within each brood line ($F = 26.90$; df = 6,132; $P < 0.01$) (Table 2). Pink salmon stocks within a brood line were more similar to each other with respect to the number of gillrakers than to stocks within the alternate brood line.

Within a brood line, stocks had variable numbers of gill rakers, with the between-stock variability greater for the even-year brood line than for the odd-year one (Table 2). There was significant regional variability among stocks within the odd-year brood line. Pink salmon stocks from Puget Sound, Washington had fewer gill rakers than those from southern British Columbia. Stocks within the Fraser River drainage had significantly different numbers of gill rakers, the differences among stocks being greater than among stocks within the Vancouver Island or mainland regions. Northern stocks had greater numbers of gill rakers than did southern stocks (Puntledge River, Indian River) in the Vancouver Island and mainland regions.

TABLE 2. Results of *G*-tests for heterogeneity of gill-raker distribution between and within years surveyed, and among and within geographic regions for pink salmon stocks in southern British Columbia and Puget Sound

Source of variation	df	*G*	Standardized measure
Between years	6	436.13*	72.69
Within years	132	356.09*	2.70
1982	18	58.87*	3.27
1983	114	297.22*	2.61
Among regions (1983)	18	77.47*	4.30
Within regions	96	219.75*	2.29
Puget Sound	12	20.45	1.70
Fraser River	42	109.41*	2.61
Mainland	24	53.88*	2.25
Vancouver Island	18	36.01*	2.00
Between years within rivers	18	208.48*	11.58
Glendale	6	68.09*	11.34
Quinsam	6	107.41*	17.90
Puntledge	6	32.98*	5.50
Total	138	792.22*	

*$P < 0.05$.

Morphometric characters

Morphometric characters, standardized to 419 mm postorbital–hypural length, were compared between and within brood lines. For all stocks pooled within each brood line, male pink salmon in the odd-year brood line had significantly larger heads ($F = 139.4$; df = 1,1382; $P < 0.01$) , thicker caudal peduncles ($F = 12.3$; df = 1,1382; $P < 0.01$), and longer bases of the anal ($F = 96.4$; df = 1,1382; $P < 0.01$) and dorsal fin ($F = 131.7$; df = 1,1382; $P < 0.01$) than those in the even-year brood line (Table 3). Similar results were observed for females for postorbital head length ($F = 231.7$; df = 1,1469; $P < 0.01$), caudal peduncle thickness ($F = 50.0$; df = 1,1469; $P < 0.01$), and base length of the anal ($F = 87.1$; df = 1,1469; $P < 0.01$) and dorsal fin ($F = 108.7$; df = 1,1469; $P < 0.01$).

The morphometric characters examined were also found to be sexually dimorphic. Males had larger heads ($F = 397.0$; df = 1,2851; $P < 0.01$), thicker caudal peduncles ($F = 134.0$; df = 1,2851; $P < 0.01$), and longer base lengths of the anal ($F = 148.9$; df = 1,2851; $P < 0.01$) and dorsal fin ($F = 801.7$; df = 1,2851; $P < 0.01$). Of the four characters examined, base length of the dorsal fin was the most sexually dimorphic.

Variability in morphometric characters was also examined within brood lines. In the even-year brood line, there were significant differences among stocks for all morphometric characters for both sexes (all $P < 0.01$), with the exception of caudal peduncle thickness of male pink salmon ($F = 1.75$; df = 3,165; $P > 0.10$). Pink salmon from Quinsam and Puntledge Rivers tended to have larger heads and fins but thinner caudal peduncles than salmon in the northerly Cluxewe and Glendale Rivers stocks. In the odd-year brood line, there were also significant differences among stocks for all morphometric characters examined for both sexes (all $P < 0.01$). To examine trends in regional variability, stocks were grouped by cluster analysis based upon Mahalanobis distance between stocks. For males, there were three main groupings of the 20 stocks surveyed. One group consisted of stocks found in

TABLE 3. Postorbital head length (millimetres), caudal peduncle depth (millimetres), and length of the base of the anal and dorsal fins (millimetres) for male and female pink salmon sampled in southern British Columbia and Puget Sound

	Male					Female				
Stock	*n*	Head length	Caudal peduncle	Anal fin	Dorsal fin	*n*	Head length	Caudal peduncle	Anal fin	Dorsal fin
Even year	169	64.4 (4.5)	34.8 (3.1)	60.7 (6.5)	58.7 (6.0)	164	58.2 (4.0)	32.0 (3.1)	57.1 (6.3)	49.6 (5.1)
Glendale	67	61.5 (4.7)	35.1 (3.7)	55.4 (4.7)	54.1 (4.9)	32	55.4 (5.3)	34.2 (3.8)	52.1 (4.1)	47.7 (4.8)
Cluxewe	44	66.1 (3.8)	35.2 (2.2)	62.0 (4.7)	60.2 (4.6)	33	57.1 (3.5)	31.2 (2.5)	51.6 (5.0)	47.4 (3.8)
Quinsam	50	66.7 (2.7)	34.3 (3.0)	65.9 (4.2)	62.5 (4.6)	50	61.4 (2.3)	33.6 (2.0)	63.3 (3.8)	55.0 (3.6)
Puntledge	8	64.0 (2.7)	33.1 (1.4)	66.5 (3.8)	62.5 (5.6)	49	57.6 (2.2)	29.4 (1.6)	57.9 (3.7)	47.0 (2.8)
Odd year	1215	70.9 (7.0)	35.9 (4.1)	66.8 (7.7)	66.4 (8.6)	1307	63.9 (4.5)	33.9 (3.2)	61.2 (5.1)	53.5 (4.4)
Puget Sound	158	73.1 (6.4)	38.4 (3.8)	73.2 (6.7)	72.8 (8.0)	164	63.5 (3.1)	35.7 (2.6)	64.0 (4.0)	54.4 (3.8)
Skagit	51	71.3 (6.9)	36.8 (3.9)	71.5 (6.4)	70.8 (7.7)	51	62.7 (3.6)	34.6 (2.5)	62.4 (3.4)	53.2 (3.2)
Snohomish	47	72.9 (5.8)	37.6 (2.8)	73.2 (6.0)	72.9 (7.6)	55	63.3 (3.1)	34.8 (2.3)	63.2 (4.0)	54.2 (4.1)
Stillaguamish	60	74.8 (6.1)	40.0 (3.6)	74.8 (7.1)	74.5 (8.3)	58	64.5 (2.7)	37.5 (2.0)	66.2 (3.5)	55.8 (3.7)
Fraser River	570	73.5 (6.1)	36.7 (3.9)	68.2 (7.1)	68.4 (7.5)	730	65.7 (4.1)	34.3 (3.2)	61.9 (5.2)	54.1 (4.3)
Jones	64	70.2 (6.0)	34.0 (3.0)	64.2 (8.5)	64.9 (7.4)	36	62.1 (4.2)	31.5 (2.6)	58.7 (4.6)	51.6 (4.6)
Coquihalla	33	70.9 (5.7)	33.2 (3.1)	64.9 (6.9)	63.7 (6.9)	67	64.6 (3.7)	32.7 (4.4)	59.9 (5.1)	52.2 (3.7)
Fraser	84	73.8 (5.2)	36.5 (3.5)	68.2 (6.0)	70.6 (7.2)	116	65.9 (3.3)	34.0 (3.2)	62.4 (5.0)	55.1 (4.2)
Vedder	91	76.6 (5.1)	39.4 (3.2)	71.7 (6.9)	70.3 (6.7)	109	67.7 (3.6)	36.5 (2.4)	64.5 (5.2)	55.6 (4.5)
Harrison	102	75.3 (6.0)	39.1 (4.1)	70.1 (7.2)	72.3 (7.4)	98	66.9 (4.5)	36.1 (2.8)	62.0 (5.7)	55.0 (4.4)
Thompson	59	75.2 (6.1)	36.8 (3.2)	68.9 (6.5)	67.7 (6.8)	141	65.2 (3.8)	33.2 (2.6)	60.8 (5.2)	53.6 (4.1)
Seton	96	71.6 (6.2)	35.3 (3.3)	66.8 (6.1)	65.5 (6.6)	104	65.4 (4.2)	34.1 (2.1)	62.7 (4.5)	53.7 (3.8)
Portage	41	70.2 (4.4)	35.6 (2.5)	66.5 (4.9)	66.5 (5.7)	59	64.1 (3.3)	33.3 (2.2)	60.8 (3.5)	53.1 (4.2)
Mainland	299	67.8 (6.8)	35.3 (3.6)	63.7 (7.1)	62.9 (8.2)	201	61.6 (3.6)	34.7 (2.5)	59.0 (4.6)	53.6 (4.4)
Indian	74	70.6 (6.6)	33.9 (3.6)	63.6 (7.1)	61.0 (7.6)	26	63.7 (4.5)	33.5 (2.4)	58.8 (5.5)	50.8 (3.9)
Phillips	52	64.8 (6.0)	34.5 (3.2)	64.7 (6.7)	63.0 (7.3)	48	60.6 (4.3)	34.8 (2.6)	61.0 (4.3)	54.6 (4.4)
Glendale	59	67.3 (3.5)	35.7 (2.2)	62.5 (4.2)	61.2 (4.9)	41	62.0 (2.8)	35.5 (2.1)	58.4 (4.6)	53.1 (4.4)
Kakweikan	53	67.8 (6.3)	36.0 (3.5)	62.1 (2.9)	62.3 (8.6)	47	61.2 (2.9)	33.3 (2.0)	56.0 (3.2)	52.2 (3.6)
Wakeman	61	67.4 (8.9)	36.7 (4.6)	65.7 (8.4)	67.5 (10.0)	39	61.5 (2.9)	36.3 (2.1)	60.7 (3.7)	56.4 (3.8)
Vancouver Island	188	66.1 (5.6)	32.5 (2.8)	62.3 (6.2)	60.7 (7.3)	212	60.1 (4.5)	30.6 (2.2)	58.9 (4.5)	50.7 (3.5)
Puntledge	4	67.0 (1.4)	31.8 (1.7)	63.3 (5.7)	59.0 (4.5)	96	60.2 (4.3)	29.6 (1.8)	59.9 (4.6)	50.5 (3.8)
Quinsam	50	68.3 (3.5)	31.1 (1.5)	61.3 (5.4)	59.8 (5.0)	50	62.4 (5.8)	30.0 (2.0)	59.8 (4.4)	51.6 (3.5)
Adam	68	67.7 (6.4)	34.3 (3.1)	66.4 (6.0)	66.9 (6.4)	32	58.5 (2.7)	32.4 (1.6)	57.0 (3.7)	50.5 (3.5)
Keogh	66	62.7 (4.3)	31.9 (2.3)	58.8 (4.3)	55.2 (4.3)	34	58.2 (2.3)	32.4 (1.9)	56.7 (3.7)	49.4 (2.7)

NOTE: All measurements have been standardized to an individual of 419 mm postorbital–hypural length. Standard deviations are in parentheses.

main tributaries of the Fraser River and those stocks from Puget Sound (Fig. 2). This group was distinguished by large heads, thick caudal peduncles, and large fins (Table 3). A second group consisted of stocks found in smaller Fraser River tributaries (Jones Creek, Coquihalla River) and those from Vancouver Island. These stocks had proportionately smaller character sizes than those in the Fraser River – Puget Sound group. The final group of stocks consisted of those found in the northern mainland region, and sizes of body parts of males were intermediate between the previous two groups. Similar groupings were also apparent in the cluster analysis of female morphometric characters. Stocks from larger tributaries of the Fraser River tended to be grouped together (Fig. 3). Stocks from the northern mainland and northern Vancouver Island were also grouped. A third group consisted of a mixture of stocks from the Fraser River, Puget Sound, and Vancouver Island. When stocks were grouped as to those originating from Vancouver Island, the Fraser River, the Mainland, and Puget Sound, there were clear regional differences in sizes of body parts for both males (all $P < 0.01$) and females (all $P < 0.01$).

Brood-line comparisons

Affinities among stocks in the different brood-lines were compared for meristic and morphometric characters by grouping stocks surveyed in 1983 into four main regions and comparing them with the four stocks surveyed in 1982. Stocks in the odd-year brood line from the Fraser River, the mainland, Vancouver Island, and Puget Sound were more similar to each other with respect to gill-raker number than to stocks in the even-year brood line (Fig. 3). When morphometric characters were considered, odd-year brood-line stocks from Vancouver Island were more similar to even-year brood-line stocks (three from Vancouver Island) than to odd-year stocks from the Fraser River or Puget Sound. Morphometric characters for the pink salmon stocks surveyed appear to be selected more for local environmental conditions than are meristic characters.

Meristic and morphometric characters were both useful in classifying pink salmon to their respective brood-lines. When meristics only were used, 69.7% (n = 333) and 77.1% (n = 2522) of the even-year and odd-year brood lines were correctly classified by discriminant analysis, respectively. When both sets of characters were used, 80.8 and 82.2% of the individuals in the brood lines were correctly classified. Pink salmon stocks from the even-year and odd-year brood lines in rivers on the east coast of Vancouver Island, the mainland inlets, the Fraser River, and Puget Sound are reasonably distinctive in some selected meristic and morphometric characters.

Discussion

One of the initial objectives of this study was to examine meristic and morphometric character differences between the

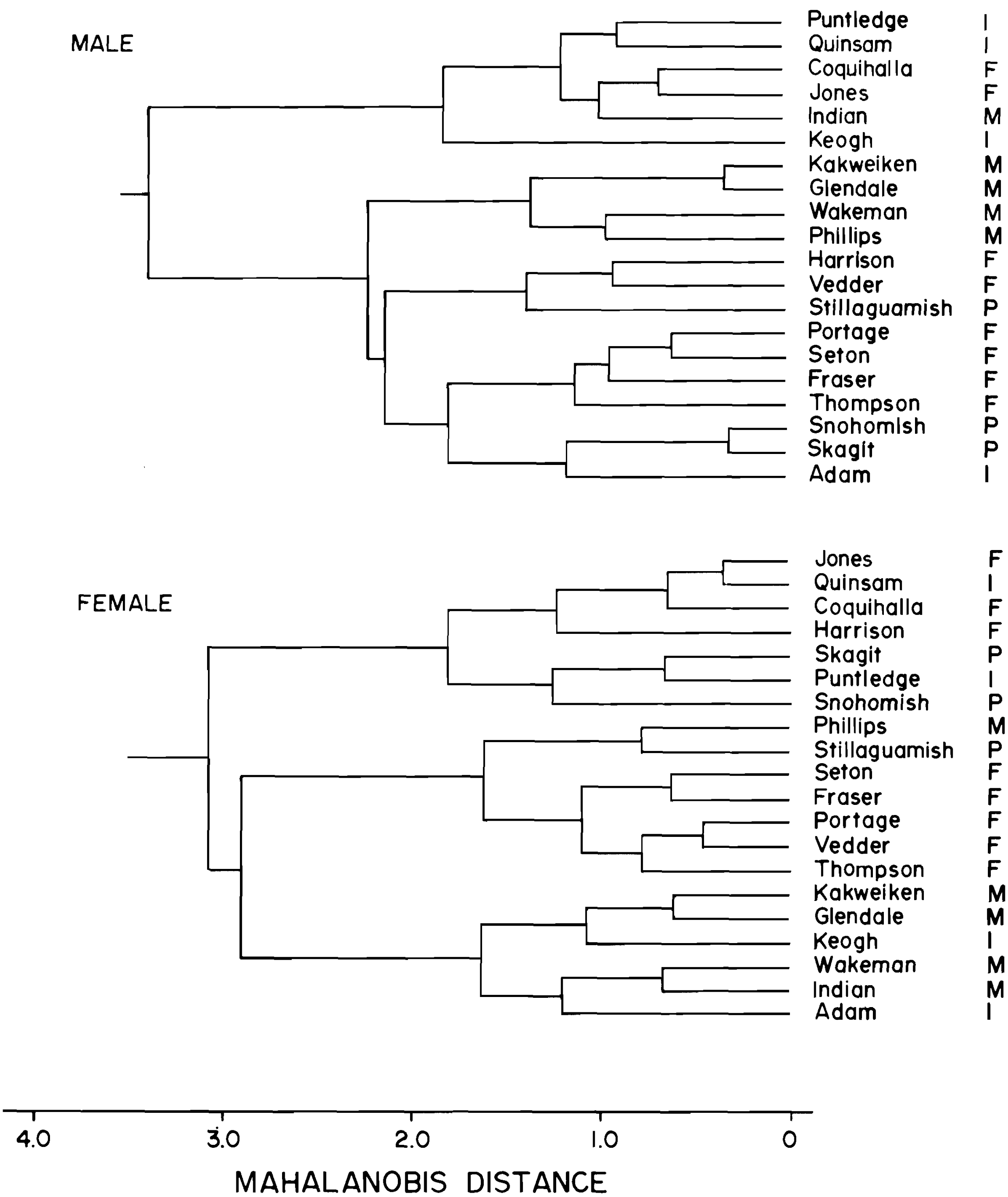

FIG. 2. Cluster analysis (complete linkage) based on Mahalanobis distance derived from four morphometric characters and compared among odd-year pink salmon stocks.

even-year and odd-year brood lines of pink salmon for stocks in a restricted geographic region. Stocks within each brood line were more similar to each other with respect to gill-raker frequencies than they were to stocks in the alternate brood line. Pritchard (1945) also surveyed gill-raker frequencies of pink salmon in British Columbia. He found that stocks in the odd-year brood line from the Fraser River had more gill rakers than stocks in the even-year brood line from the Queen Charlotte Islands, but the difference was not significant (G = 10.42, df = 6, $0.05 < P < 0.10$). Differences between the brood lines could be obscured in Pritchard's study if there is a geographic cline in gill-raker frequencies, with northern stocks having more gill rakers than southern stocks within a brood line. Geographic clines in vertebral numbers have been reported for both brood lines of pink salmon (Pearson 1966). However, it is not possible to determine from Pearson's study if stocks from one brood line in a local geographic region were more similar to each other than to stocks in the same region from the alternate brood line.

The number of gill rakers differed among stocks within a local region, as was reported by Pritchard (1945). Differences in frequencies of meristic characters have been used for stock identification, generally for classifying individuals as originating from broad geographic areas (Amos et al. 1963; Pearson 1964). In the present study, differences in gill-raker frequencies for stocks in the Fraser River, Vancouver Island,

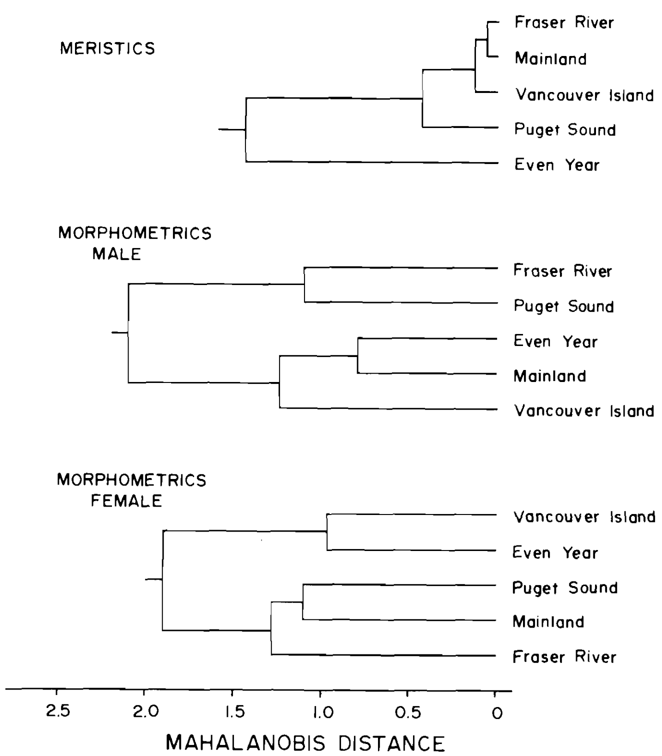

FIG. 3. Cluster analysis (complete linkage) based on Mahalanobis distance derived from meristic and morphometric characters for five groups of pink salmon stocks.

and mainland regions are not large enough to distinguish pink salmon from the three regions.

Pink salmon were sexually dimorphic for postorbital head length, caudal peduncle depth, and base length of the anal and dorsal fins for stocks in both brood lines. Sexual dimorphism for many morphometric characters is more pronounced in pink salmon than in other *Oncorhynchus* species (Davidson 1935). Berg (1979) suggested that pink salmon in Lake Superior show greater sexual dimorphism than Pacific Ocean stocks, possibly due to slower growth of the Lake Superior stock. If one considers size of morphometric characters in relation to body length, pink salmon examined in this study were more sexually dimorphic for dorsal fin base length (2.6% difference between males and females) than the Lake Superior stock for dorsal fin height (1.0% difference). The Lake Superior stock was more dimorphic for different measures of head length (2.3 vs. 1.6%) and anal fin length (6.7 vs. 1.2%). Allometric growth of morphometric characters has been generally ignored in studies of pink salmon morphometrics (Dvinin 1952; Eniutina 1954*a*; Berg 1979), making comparisons among widely separated stocks difficult. At the same body length, males usually have larger heads, larger fins, and thicker bodies than do females, although females may have longer anal fins than males (Berg 1979).

Pink salmon stocks in the even-year and odd-year brood lines from Vancouver Island were more similar to each other morphometrically than to those from Puget Sound and the Fraser River. This pattern of similarity among stocks is different than that observed when the meristic character (number of gill rakers) is examined. Ihssen et al. (1981) reported that grouping of lake whitefish stocks was similar when protein and meristic characters were compared, but different when protein and morphometric characters were compared. Genetic differences are greater between pink salmon brood lines than among stocks within each brood line (Aspinwall 1974; McGregor 1982). The results of my study suggest that for the pink salmon stocks examined, genetic (protein) and meristic differences among stocks are more closely correlated than are genetic and morphometric differences. Meristic characters appear less likely to be modified by selection in response to local environmental conditions than morphometric ones.

Pink salmon from rivers in the Vancouver Island and mainland regions generally had smaller body proportions than those from the Fraser River. However, two stocks from smaller tributaries of the Fraser River (Jones Creek, Coquihalla River) were more similar morphometrically to stocks from Vancouver Island or Puget Sound. Pink salmon stocks spawning in large rivers tend to have proportionately larger heads, caudal peduncles, and fins, which presumably is an adaptation to water flow velocity. Larger fins have been suggested to be more effective in maintaining position in a river with higher than average water flows (Riddell and Leggett 1981). Pink salmon appear to be adapted morphologically to environmental conditions they encounter as adults in their natal streams.

Pink salmon stocks differ in relative sizes of morphometric characters (Dvinin 1952; Eniutina 1954*a*; Berg 1979; Takagi et al. 1981), and many pink salmon stocks have been considered to be distinctive morphologically (Ricker 1962). Distinctive morphological characters have been interpreted to reflect adaptations to local environmental conditions, with Eniutina (1954*b*) suggesting that thick caudal peduncles of the Amgun River stock in the Soviet Union reflect increased muscle mass necessary for their longer upriver migration. Beacham (1984*b*) found that chum salmon (*Oncorhynchus keta*) from large rivers in southern British Columbia had larger heads, caudal peduncles, and fins than those from small streams or creeks in the same region. Morphometric investigations of *Salmo* have indicated that local stocks of Atlantic salmon are adapted to river flow regimes (Jones 1975; Schaffer and Elson 1975; Yevsin 1977; Riddell and Leggett 1981). In the present study, pink salmon stocks from the odd-line brood line on Vancouver Island were more similar morphologically to stocks in the even-year brood line from the same area than to odd-year stocks from the Fraser River and Puget Sound. This suggests that the stocks are adapted morphologically to environmental conditions in their natal streams and the homing of salmon to spawn in these streams allows the expression of these morphometric traits in adults to be selectively advantageous.

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