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REPORT ON PARASITOLOGICAL STUDIES OF SOCKEYE SALMON COLLECTED IN 1958 WITH SOME COMPARISONS WITH OTHER YEARS

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1. Introduction

During the past year the studies commenced in 1955 on the use of parasites of sockeye salmon (Oncorhynchus nerka) as a means of tracing the ocean distribution of North American and Asian stocks of these fish were continued and expanded.

In the laboratory 3323 sockeyes were examined from collections made in 1958, compared to a combined total of 4610 for the three previous years, 1955 to 1957, inclusive. The 1958 samples consisted of 331 seaward migrants (smolts) from North America, 614 adults from coastal North America and 2992 sockeyes from the high seas. The high-seas samples, collected from mid-May to the latter half of August, included immature (fish which would have spent at least one more year at sea before returning to spawn) and maturing fish (fish which would have spawned in the year they were caught). The localities from which samples were collected, the date of each collection and the number of sockeyes examined from each collection site are given in Tables I to III. Figure 1 also shows the distribution of coastal adult and high-seas sockeye samples.

As in the past, Japan, the United States and Canada co-operated in supplying sockeye samples from various parts of the area under study.

Three annual progress reports for the years 1955 to 1957 have previously been submitted to the INPFC. The first two reports, in addition to discussing the possible use of certain parasites in the problem of recognizing the continent of origin of sockeyes taken on the high seas, provided details on the distribution, and incidence and intensity of infection of all parasites encountered in the survey. The last report dealt entirely with the application of parasitological data to the understanding of the ocean distribution of sockeye stocks originating in North America and Asia. That report (INPFC Document 200) reviewed the pertinent data for the three years during which the studies had been in progress.

In INPFC Document 200, 4 parasites were reported as providing evidence of the origin of sockeyes taken on the high seas. Two of these were Triaenophorus crassus, a cestode found only in some western Alaska (mainly Bristol Bay) sockeye stocks, and Dacnitis truttae, a nematode found in some sockeyes of Asian origin, both of which are parasites acquired in fresh water before the young sockeyes migrate to sea. Once the fish take up their ocean residence further acquisition of these parasites becomes impossible. Since these parasites have a restricted geographical distribution in sockeye stocks they serve to identify the geographical origin of ocean-caught sockeyes infected with them. Details supporting the validity of these parasites as "natural tags" can be found in INPFC Document 200.

The other two parasites, Tubulovesicula lindbergi and Hemiurus levinseni, are trematodes acquired in the sea.

Tubulovesicula was considered to indicate North American origin of sockeyes infected with this species because of the characteristics of the distribution of sockeyes infected with it, as outlined in Document 200, and because it never occurred together with Dacnitis or Hemiurus in the same fish but was present in some sockeyes simultaneously infected with Triaenophorus.

The occurrence of Hemiurus in high-seas samples of sockeyes, other than from the Gulf of Alaska, was suggested as indicating the Asian origin of such fish because of the characteristics of the distribution of sockeyes infected with

it, as outlined in Document 200, and because it never occurred along with Triaenophorus or Tubulovesicula in the same fish, but was found in some fish also parasitized by Dacnitis.

Although in 1958 the distribution of fish infected with Tubulovesicula or Hemiurus fitted the general pattern of previous years, one sockeye was encountered which was infected simultaneously with Hemiurus and Triaenophorus, and another carried both Hemiurus and Tubulovesicula. The sockeye infected with Triaenophorus and Hemiurus was a maturing female, age 4_2, taken in the Bering Sea at 56° N, 172°30' W, and the sockeye infected with Hemiurus and Tubulovesicula was an immature male, age 4_3, taken south of the Aleutians at 50° N, 180°

Triaenophorus indicates western Alaskan origin of any sockeye infected with it and therefore the occurrence of Hemiurus along with Triaenophorus in a maturing sockeye demonstrates that Hemiurus may be found in sockeyes which are migrating to western Alaska. Consequently it can no longer be stated that every high-seas sockeye carrying Hemiurus (exclusive of those in the Gulf of Alaska) is of Asiatic origin. However, since we have rarely observed Hemiurus in sockeye samples taken near the shores or the mouths of rivers of western Alaska it is probably true that most ocean-caught sockeyes infected with Hemiurus (except those in the Gulf of Alaska) are of Asiatic origin.

The occurrence of Hemiurus and Tubulovesicula in the same fish also conflicts with the use of these parasites in identifying the continent of origin of sockeyes taken on the high seas. Although Tubulovesicula generally is associated with sockeyes of North American origin, the suggestion that it is never found in sockeyes of Asiatic origin may be doubtful, since the origin of the fish harbouring both Hemiurus and Tubulovesicula is unknown.

Where the objective is the identification of the origin of individual fish it is apparent from the foregoing that neither Hemiurus nor Tubulovesicula can be considered to be completely reliable indicators. Some revision of previously presented conclusions (see Doc. 200) on the distribution of sockeye stocks from North America and Asia are therefore necessary.

The ensuing discussion on ocean distribution of sockeyes from North America and Asia will be based only on the distribution of sockeyes infected with Triaenophorus and Dacnitis.

Of all North American sockeye stocks, the ocean distribution of those from some western Alaskan rivers only can be traced with certainty, since it is in this region alone that Triaenophorus occurs in sockeyes.

The Asiatic rivers in which the sockeyes are infected with Dacnitis are not well known because of the lack of samples from Asian rivers. However, A. K. Akhmerov, in papers published in 1954 and 1955, recorded Dacnitis from Kamchatka River sockeyes, and since we have consistently found Dacnitis in some of the sockeyes from the Sea of Okhotsk (off the southwest tip of Kamchatka) it would appear that Dacnitis also occurs in sockeyes from one or more rivers on the west coast of Kamchatka. Dacnitis therefore gives evidence of ocean distribution of some sockeyes originating from both east and west Kamchatka.

2. High-seas distribution of North American and Asiatic sockeyes in 1958 as determined by Triaenophorus and Dacnitis

A. General. In shore samples of adults from North America Triaenophorus was most prevalent in the Wood River (Nushagak River system) and was also found, but to a much lesser extent, in the Naknek River, both of which empty into Bristol Bay. It was also found in the seaward migrants from these two systems. Triaenophorus was not found in any other North American samples listed in Tables I and II. In addition to the above 2 rivers Triaenophorus was observed in previous years in one smolt from the Ugashik River, Bristol Bay and in one adult returning to spawn in the Kuskokwim River, on the west coast of Alaska, north of Bristol Bay.

Shore samples from Asia were again unavailable but some samples taken close to the east coast of Kamchatka and some from the Sea of Okhotsk off the southwest coast of Kamchatka showed the presence of Dacnitis. It was not observed in any of the North American samples listed in Tables I and II.

Figure 1 shows the distribution of sockeyes (exclusive of seaward migrants) infected with Triaenophorus or Dacnitis. From this figure it is apparent that sockeyes of western Alaskan origin (i.e. infected with Triaenophorus), which are mainly from Bristol Bay, were found as far west as 168°15' E and sockeyes of Asiatic origin (i.e. infected with Dacnitis) were found as far east as 175° W.

Since Triaenophorus and Dacnitis occur only in some of the sockeyes originating in North America and Asia, respectively, and because of sampling limitations, the range of ocean distribution of sockeyes from the two continents may be greater than indicated by these two parasites.

Table IV lists the localities at which sockeyes infected with Triaenophorus or Dacnitis were found, the date of catch, the number of fish examined at each locality, the number and percent of fish infected with Triaenophorus or Dacnitis, the age of these fish and whether they were maturing or immature. The determination of the state of maturity was based largely on the gonad development and utilized the gonad weight to body weight ratio, as proposed by H. Godfrey of the Fisheries Research Board's Biological Station at Nanaimo, in a manuscript entitled "The determination and distribution of immature and maturing salmon taken by Canadian exploratory fishing vessels in the northeast Pacific in 1957", prepared in 1959. In a few cases in which the gonad weight had not been recorded, the decision as to probable state of maturity was based on age, size of the fish, locality and date of catch.

B. Distribution of maturing sockeyes. The upper chart in Figure 2 shows the distribution of maturing sockeyes which harboured Triaenophorus or Dacnitis. Triaenophorus-infected maturing sockeyes were found as far west as 168°15' E and eastward into the Gulf of Alaska to 145° W. Dacnitis-infected maturing sockeyes were found from the Sea of Okhotsk eastward to 173°19' E.

The maturing sockeyes infected with Dacnitis were caught from mid-May to the end of July, with the earliest-caught fish generally having been taken farther to the east.

The maturing sockeyes infected with Triaenophorus (not including those taken in or near the estuaries of the home streams), with 3 exceptions, were

caught in May or June (see Table IV). The 3 exceptions were: (1) one fish taken on July 10 in the commercial fishery operating in the Shumagin Islands area, Alaska, (2) one fish taken on July 2 at 53°01' N, 175° W and (3) one fish taken on August 5 at 51°30' N, 175° W. The occurrence of a maturing western Alaska sockeye in mid-ocean as late as August 5 seems very unusual, because it is generally believed that the sockeyes returning to spawn in western Alaska have entered the rivers by the end of July or early August, but on the basis of gonad weight this sockeye definitely seems to be maturing. The fish was a female, age 4_2, with a body weight of 2140 grams and a gonad weight of 88 grams. All other sockeyes taken in the latter half of July or throughout the month of August, not only in 1958 but in other years as well, which were identified as being of western Alaskan origin because of the presence of Triaenophorus, were immatures.

It appears that most of the maturing western Alaska sockeyes leave the open ocean by the end of June, but some may remain until early July.

The majority of maturing Triaenophorus-infected sockeyes captured west of their area of origin (western Alaska) were from the Bering Sea between 175° W and and 169° W and were taken almost exclusively in the second half of June. The Triaenophorus-infected sockeyes from the area bounded by 168° E and 173° E longitude and 50° N and 52° N latitude were captured in May or early June. Assuming a more or less straight line of migration of Triaenophorus-infected sockeyes from these westernmost locations to Bristol Bay or other western Alaskan areas, they would have to pass through the Bering Sea starting roughly at about 175° E longitude. The apparent absence of Triaenophorus-infected sockeyes in the Bering Sea between 175° E and 175° W may well be due to the fact that few samples taken from this area in May or June were examined. In the Gulf of Alaska the maturing Triaenophorus-infected sockeyes were all taken in the first half of June.

Some features of the incidence of Triaenophorus in maturing sockeyes were extremely interesting. On the basis of the small samples examined from the spawning runs to the rivers of Bristol Bay an overall incidence of Triaenophorus in all Bristol Bay sockeyes (catch plus escapement) was calculated to be almost 22% (see Table V). To make this calculation it was necessary to assume that the percent incidence of Triaenophorus infection in the small samples examined from each river represented the actual per cent incidence in the total run for each river. In the samples examined from 55°04' N, 169°24' W (79 sockeyes), 53°30' N, 170°02' W (54 sockeyes), 55°58' N, 170°02' W (23 sockeyes) in the Bering Sea, and from 55° N, 155° W (72 sockeyes) in the Gulf of Alaska, the incidence of Triaenophorus was either 22% or 24% (see Table IV), which is identical or almost identical with the calculated overall per cent incidence for Bristol Bay. This suggests that the samples from these localities consisted wholly or largely of a homogeneous mixture of the various stocks of Bristol Bay sockeyes.

In the Gulf of Alaska at 55° N, 150° W, and at 55° N, 145° W, the incidence of Triaenophorus-infected sockeyes decreased to 9% and 4% respectively, and at 55° N, 135° W, none were found, indicating a progressive decrease towards the east in the number of Bristol Bay sockeyes in the samples. In the samples from 58° N, 145° W, 50° N, 145° W, and 50° N, 155° W, Triaenophorus was not found.

Except for one sample at 56° N, 172°30' W, a good series of samples of maturing sockeyes was not obtained from 170° to 175° E and therefore no data are available on the trends of Triaenophorus infection of sockeyes in this area. In the sample of 50 sockeyes from 56° N, 172°30' W, the incidence of Triaenophorus

was 8%. This decrease in rate of Triaenophorus infection as compared to the samples taken at 169° W and 170° W could mean that the sample did not consist solely of Bristol Bay sockeyes, or that the various Bristol Bay stocks were not represented in proportion to the size of their respective runs, or that a greater proportion of uninfected than infected sockeyes were represented from the stocks in which Triaenophorus occurred.

In the samples from south of the Aleutians between 173° E and 168° E only 3 maturing sockeyes out of approximately 300 examined were found infected with Triaenophorus, suggesting a large decrease in the proportion of Bristol Bay sockeyes as compared to the samples from near 169° W and 170° W in the Bering Sea. Since good samples were also available to the west of 168° E and Triaenophorus was not found, 168° E probably was close to the extreme western limit of Bristol Bay or western Alaska sockeyes, at least for the period during which the samples were collected.

The ocean distribution of maturing western Alaska sockeyes as determined by infection with Triaenophorus is strikingly similar, both qualitatively and quantitatively, to that determined by the 1958 tagging operation carried out by the United States (see Fig. 4).

C. Distribution of immature sockeyes. The upper chart in Figure 3 shows the distribution of immature sockeyes infected with Dacnitis or Triaenophorus.

Few Dacnitis-infected immature sockeyes were found in the samples. One was taken just south of the Aleutian Islands at 175° W on August 5. (This sample also contained several sockeye infected with Triaenophorus.) Another was taken in the Bering Sea at 54° N, 178° E, on July 15 and 3 were taken off the east coast of Kamchatka at 55° N, 164° E, on July 29 or August 7.

Immature sockeyes infected with Triaenophorus were represented in many of the samples from 165° W to 175° E which were collected from June 30 to August 19. One was also encountered in a sample of 95 fish from 59°18' N, 170°38' E, taken on July 31, 1959. Most of the immature Triaenophorus-infected sockeyes were taken south of the Aleutians, but some were also found in samples from the Bering Sea from 175° W to 175° E.

3. Comparison of high-seas distribution of sockeyes in 1958 with earlier years (1955-1957)

A. Maturing sockeyes. Figure 2 shows the distribution of maturing sockeyes infected with Dacnitis or Triaenophorus for the years 1955 to 1958, inclusive. The upper chart shows the 1958 results, the middle chart shows the results for 1957 and the bottom chart for 1955 and 1956.

One feature in the distribution of Dacnitis-infected maturing sockeyes, which is more or less similar from year to year is the most easterly point of capture, which is between 172° E and 175° E longitude. It is impossible to determine if there was any change in the distribution of Dacnitis-infected sockeyes from year to year because of the low incidence of Dacnitis (the number of Dacnitis-infected maturing sockeyes was never more than 11 in any one year, or from 1.6% to 4% of all maturing sockeyes taken from 175° E to the Sea of Okhotsk), and because the sampling locations, dates of sampling and the number of samples

were not the same from year to year. For example, in the Bering Sea region in 1957 Dacnitis was found at 54°51' N, 170°24' E, and 57°02' N, 169°11' E. Samples from these locations were not examined in other years.

For between-year comparisons of the distribution of maturing Triaenophorus-infected sockeyes, only 1957 and 1958 can be considered satisfactorily because of the lack or scarcity of samples in 1955 and 1956 from east of 175° E during the months of May and June.

In 1957 the qualitative distribution of Triaenophorus-infected maturing sockeyes in the Bering Sea from 175° W and eastward was similar to that in 1958, but the incidence in this area was considerably less than in 1958. Of the 263 fish examined from 166° W to 175° W, 9 or 3.4% were infected with Triaenophorus (the incidence varied from 0% to 12% in individual samples), which is close to the calculated Triaenophorus incidence of 3.5% for all Bristol Bay runs combined, in 1957 (see Table VI). The much lower overall rate of Triaenophorus infection in the Bristol Bay stocks in 1957 as compared to 1958 is therefore reflected in the incidence in Bering Sea samples. This lower per cent incidence of Triaenophorus infection in Bristol Bay sockeyes in 1957 was due to two factors: (1) The Wood River (Nushagak River system), which is the river providing the majority of Triaenophorus-infected sockeyes, comprised only approximately 10% of the 1957 Bristol Bay sockeye run, compared to about 40% in 1958, and (2) the per cent incidence of Triaenophorus in the 1957 Wood River run was apparently lower than in 1958.

The samples from the Gulf of Alaska in 1957 were taken later in the season than those from comparable locations in 1958. If maturing Bristol Bay sockeyes had been present in the Gulf of Alaska in 1957 they probably would have left the area on their homeward migration prior to the date of commencement of the sampling by the research vessels. Therefore the absence of maturing sockeyes infected with Triaenophorus from the Gulf of Alaska samples in 1957 may not indicate a real difference between 1957 and 1958.

Also, the failure to record any Triaenophorus-infected maturing sockeyes in 1957 as far west as in 1958 cannot be interpreted as indicating that western Alaskan sockeyes extended farther to the west in the latter year. In 1958, when the overall incidence of Triaenophorus in Bristol Bay sockeyes was considerably higher (about 6 times) than in 1957, only 3 Triaenophorus-infected sockeyes of 300 examined (or 1%) were found in samples collected in May or early June between 168° E and 173° E. This is about 1/20 of the overall per cent incidence for Bristol Bay for that year. If the same relative representation of Triaenophorus-infected sockeyes had prevailed in this area in 1957, then only about 0.17% (1/20 X 3.5%) or about 1 in 600 sockeyes would have been expected to be infected with Triaenophorus. However, less than 100 maturing sockeyes, taken in May or early June, from 175° E to 168° E were examined and hence the absence of Triaenophorus from these samples cannot lead to any conclusions regarding the presence or absence of Bristol Bay sockeyes in this area in 1957.

B. Immature sockeyes. Figure 3 shows the distribution of immature sockeyes infected with Dacnitis or Triaenophorus in the samples examined in the years 1956 to 1958. The upper chart represents 1958, the middle one 1957 and the bottom one 1956.

Since few Dacnitis-infected immature sockeyes have been observed in the samples there are insufficient data for a comparison between years. The most

easterly records have been at 175° W in 1956 and 1958.

A constant feature of the distribution of immature sockeyes infected with Triaenophorus is their occurrence south of the Aleutians to 175° E. The increased number of these immature sockeyes observed from 1956 to 1958 is attributable in part to the increase in numbers of fish examined, but there was also an increase in the per cent incidence of Triaenophorus in the immatures examined from samples taken from 175° E to 160° W. In 1956, 1.5% of about 200 fish were infected; in 1957, 3.3% of about 400 fish and in 1958, 5% of about 600 fish.

Whether or not the occurrence of immature sockeyes infected with Triaenophorus in the Bering Sea in 1958 indicates a real difference from other years cannot be determined because of differences in the number of fish examined and their localities and dates of capture.

Table I. Locality, date of catch, and size of sockeye smolt samples examined for parasites from 1958 collections from North America.

Locality	Date of catch	Number of sockeyes
Baker R., Washington	20-VI	13
Cultus Lake, Fraser R., British Columbia	20-IV	25
Seton Creek, Fraser R., British Columbia	5 to 12-V	25
Chilko R., Fraser R., British Columbia	1-V	25
Babine Lake, Skeena R., British Columbia	7-VI	25
Sockeye Creek, Ketchikan, southeast Alaska		40
Karluk R., Kodiak Is., Alaska	24-VI	25
Chignik R., Alaska Peninsula	11-VI	25
Ugashik R., Bristol Bay, Alaska	27,28-V	25
Brooks R., Bristol Bay, Alaska	25,26,27,29-VI and 3-VII	28
Naknek R., Bristol Bay, Alaska	29-V	25
Kvichak R., Bristol Bay, Alaska	21,22-V	25
Wood R., Bristol Bay, Alaska	31-V	25
Total		331

Table II. Locality, date of catch, and size of adult sockeye samples examined for parasites from 1958 collections from coastal North America.

	Locality	Date of catch	Number of sockeyes
A.	Columbia R. (Astoria, Oregon)	22 to 28-VI	23
B.	Fraser R., British Columbia	6-VIII	25
	Fraser R., British Columbia	8-IX	25
C.	Rivers Inlet, British Columbia	13,14-VII	25
D.	Skeena R., British Columbia	31-VII,1-VIII	25
E.	Nass R., British Columbia	8-VII	25
F.	Naha Bay (Ketchikan), southeast Alaska	17-VII	25
G.	Stikine R. (Petersburg), southeast Alaska	9-VII	25
H.	Situk-Ahrnklin R. (Yakutat), Alaska	21-VII	25
I.	Eyak R. (Cordova), central Alaska	21-VII	25
J.	Seldovia, Cook Inlet, Alaska	14-VII	25
K.	Karluk R., Kodiak Is., Alaska	26-VI	25
	Karluk R., Kodiak Is., Alaska	31-VIII	24
L.	Red R., Kodiak Is., Alaska	24-VI	25
M.	Chignik, Alaska Peninsula	1-VII	25
N.	Shumagin Is., Alaska Peninsula	10-VII	25
O.	Ugashik R., Bristol Bay, Alaska	16-VII	25
P.	Egegik R., Bristol Bay, Alaska	7-VII	25
Q.	Naknek R., Bristol Bay, Alaska	9-VII	25
	Naknek R., Bristol Bay, Alaska	19-VII	27
R.	Kvichak R., Bristol Bay, Alaska	10-VII	25
S.	Wood R., Bristol Bay, Alaska	4-VII	25
T.	Togiak R., Bristol Bay, Alaska	12,13-VII	25
U.	Kuskokwim R., northwestern Alaska	2,4-VII	15
V.	Salmon Lake, northwestern Alaska	27-VII	25
	Total		614

Table III. Locality, date of catch and size of high-seas sockeye samples examined for parasites from 1958 collections.

	Locality	Date of catch	Number of sockeyes
(1)	50°49' N, 153°07' E	5-VII	25
(2)	51°09' N, 153°40' E	25-VI	25
(3)	51°08' N, 153°45' E	15-VI	25
(4)	51°39' N, 154°10' E	15-VII	25
(5)	48°55' N, 156°28' E	5-VII	53
(6)	50°35' N, 159°50' E	19-VII	49
(7)	51°58' N, 159°51' E	26-VII	55
(8)	49°21' N, 160°27' E	16-VI	55
(9)	54° N, 163° E	2-VI	5
(10)	55°02' N, 164°02' E	4-VI	10
(11)	55° N, 164° E	7-VIII	50
(12)	55° N, 164° E	29-VII	50
(13)	56°01'N, 164°58' E	30-VI	5
(14)	58° N, 166° E	25-VI	6
	58° N, 166° E	26-VI	8
	58°02' N, 166°03' E	22-VI	4
(15)	49°35' N, 166°35 E	25-VI	54
(16)	59°01.5' N, 167° E	21-VI	18
(17)	50°41' N, 167°14' E	15-VI	51
(18)	50°10' N, 168°15' E	16-V	54
(19)	59°16.5'N, 169°03' E	17-VI	20
(20)	47°30' N, 169°41' E	26-V	55
(21)	59°18' N, 170°38' E	31-VII	95
(22)	59°20' N, 170°51' E	13-VI	5
	59°28' N, 170°54' E	12-VI	3
	59°27' N, 171°04' E	11-VI	5
(23)	51°05' N, 171°30' E	29-V	53
(24)	52°02' N, 171°35' E	5-VI	53
(25)	53° N, 172° E	2-VI	12
(26)	50°50' N, 172°30' E	7-VI	55
(27)	51°35' N, 173° E	8-VI	10
(28)	49°21' N, 173°19' E	16-V	54
(29)	54° N, 173° E	1-VI	17
(30)	55° N, 174° E	31-V	5
(31)	53°21' N, 174°58' E	22-VII	2
	54° N, 174°58' E	21-VII	3
	55°01' N, 174°58' E	20-VII	2
	55°59' N, 175°01' E	19-VII	5
(32)	49° N, 175° E	15-VII	10
(33)	50° N, 175° E	16-VII	14
(34)	52° N, 175° E	18-VII	49
	53° N, 175° E	19-VII	3
(35)	54° N, 175° E	17-VII	6
	55° N, 175° E	18-VII	16
	54°02' N, 176°28' E	16-VII	2
(36)	50°37' N, 175°02' E	8-VI	11
(37)	49°39' N, 176°11' E	14-VII	4
	50°18' N, 177°28' E	13-VII	8

Table III (cont'd)

	Locality	Date of catch	Number of sockeyes
(38)	54° N, 178° E	15-VII	17
(39)	50°59' N, 178°50' E	12-VII	49
(40)	48°33' N, 178°29' E	1-VI	3
	49° N, 180°	31-V	7
	50°03' N, 180°	29-V	8
	51° N, 180°	28-V	8
(41)	50° N, 180°	30-VI	42
(42)	53° N, 178°15' E	29-V	5
	53° N, 180°	28-V	6
(43)	54°43' N, 178°14' E	22-VI	9
	53° N, 180°	17-VI	3
	54° N, 180°	18-VI	11
(44)	53°31' N, 180°	14-VII	26
(45)	52°04' N, 178°38' W	12-VII	14
(46)	54° N, 178° W	10-VI	11
(47)	52°58' N, 175°13' W	27-VII	7
(48)	49°30' N, 175° W	8-VII	4
	50°30' N, 175° W	7-VII	15
	51°17' N, 175°53' W	6-VII	24
	50°22' N, 177°45' W	10-VII	5
(49)	53°01' N, 175° W	2-VII	7
(50)	53° N, 174°59' W	5-VIII	7
(51)	55° N, 175° W	7-VIII	13
(52)	51°30' N, 175° W	5-VIII	53
(53)	50° N, 175° W	6-VIII	77
(54)	49° N, 175° W	7-VIII	27
(55)	56° N, 172°30' W	18-VI	50
(56)	53°30' N, 170°02' W	17-VI	54
(57)	55°58' N, 170°04' W	26-VI	23
(58)	56°57' N, 168°58' W	27-VI	2
(59)	57°59' N, 169°59' W	28-VI	2
(60)	51° N, 170° W	11-VIII	52
(61)	50° N, 170° W	10-VIII	29
(62)	49° N, 170° W	9-VIII	11
(63)	55°04' N, 169°24' W	25-VI	79
(64)	52°51' N, 166° W	15-VIII	24
(65)	52° N, 165° W	17-VIII	29
(66)	51° N, 165° W	18-VIII	27
(67)	50° N, 165° W	19-VIII	27
(68)	55° N, 155° W	15-VI	72
(69)	50° N, 155° W	25-VI	25
(70)	55° N, 150° W	7-VI	54
(71)	58° N, 145° W	4-VI	50
(72)	55° N, 145° W	1-VI	25
(73)	50° N, 145° W	24-V	25
(74)	55° N, 135° W	15-VI	16
(75)	55° N, 135° W	15-VIII	15
(76)	51° N, 130° W	8-VIII	25
	Total		2378

Table IV. Incidence of Triaenophorus and Dacnitis in 1958 sockeye samples, with age and stage of maturity of the infected fish.

Locality	Date	Number examined	Infected with Triaenophorus		Infected with Dacnitis		Age[a]	Maturity[b]
			No.	%	No.	%		
Wood R., Bristol Bay	4-VII	25	14	56	-	-	$4_2(10),5_3,5_2,?(2)$	m
" " " "	31-V	25	9	36	-	-	-	smolts
Naknek R., Bristol Bay	9,19-VII	52	1	2	-	-		m
" " " "	29-V	25	1	4	-	-	-	smolts
55° N, 145° W	1-VI	25	1	4	-	-	4_2	m
55° N, 150° W	7-VI	54	5	9	-	-	$4_2(4),5_3$	m
55° N, 155° W	15-VI	72	17	24	-	-	$4_2(15),5_3,5_2$	m
Shumagin Is., Alaska	10-VII	25	1	4	-	-	5_3	m
50° N, 165° W	19-VIII	27	1	4	-	-	5_3	i
51° N, 165° W	18-VIII	27	1	4	-	-	4_2	i
52° N, 165° W	17-VIII	29	3	10	-	-	$4_2(2),5_3$	i
56°57' N, 168°58' W	27-VI	2	1	(50)	-	-	4_2	m
55°04' N, 169°24' W	25-VI	79	19	24	-	-	$4_2(9),5_3(3),5_2$ 2 oc.(5),?(1)	m
50° N, 170° W	10-VIII	29	2	7	-	-	$4_2,?(1)$	i
51° N, 170° W	11-VIII	52	3	6	-	-	$4_2,5_3,?(1)$	i
53°30' N, 170°02' W	17-VI	54	12	22	-	-	$4_2(4),5_3(2),5_2(5),6_3$	m
55°58' N, 170°04' W	26-VI	23	5	22	-	-	$4_2(3),5_3(2)$	m
56° N, 172°30' W	18-VI	50	4	8	-	-	$4_2,5_3,5_2,6_3$	m
50° N, 175° W	6-VIII	77	6	8	-	-	$3_2,4_3,5_4,4_2,5_3(2)$	i
51°30' N, 175° W	5-VIII	53	5	9	1	2	Triaen. $3_2,4_2$,2 oc.(2)	i
							Triaen. 4_2	m
							Dacnit. 3_2	i

53°01' N, 175° W	2-VII	7	2	29	-	-	5_3	m
							2 oc.	i
55° N, 175° W	7-VIII	13	1	8	-	-	4_2	i
52°58' N, 175°13' W	27-VII	7	1	14	-	-	4_2	i
52°04' N, 178°38' W	12-VII	14	1	7	-	-	1 oc.	i
50° N, 180°	30-VI	42	1	2	-	-	4_3	i
53°31' N, 180°	14-VII	26	3	12	-	-	$4_3,5_4,4_2$	i
54° N, 178° E	15-VII	17	-	-	1	6	3_2	i
49° N, 175° E	15-VII	10	2	20	-	-	$3_2,4_3$	i
52° N, 175° E	18-VII	49	3	6	-	-	$4_3(2),?(1)$	i
55° N, 175° E	18-VII	16	1	6	-	-	3_2	i
49°21' N, 173°19' E	16-V	54	-	-	1	2	5_2	m
51°35' N, 173° E	8-VI	10	1	10	-	-	7_3	m
52°02' N, 171°35' E	5-VI	53	1	2	-	-	6_3	m
59°18' N, 170°38' E	31-VII	95	1	1	-	-	5_3	i
47°30' N, 169°41' E	26-V	55	-	-	2	4	$5_2,6_2$	m
50°10' N, 168°15' E	16-V	54	1	2	-	-	5_2	m
50°41' N, 167°14' E	15-VI	51	-	-	3	6	$5_2,6_2,?(1)$	m
58° N, 166° E	22,25,26-VI	18	-	-	1	6	6_2	m
55° N, 164° E	29-VII	50	-	-	2	4	$4_2(2)$	i
55° N, 164° E	7-VIII	50	-	-	1	2	4_2	i
51°58' N, 159°51'E	26-VII	55	-	-	2	4	5_2	m
51°08' N, 153°45' E	15-VI	25	-	-	1	4	6_3	m
50°49' N, 153°07' E	5-VII	25	-	-	1	4	6_3	m

a - Numbers in parentheses following the age indicate the number of fish of that age. Where there is no number following an age it signifies that only one fish of that age was encountered. Sockeyes for which the age could not be determined, either because of poor scales or lack of scales, are indicated by ?. Where the freshwater zone of a scale could not be interpreted the ocean growth is indicated by the number of years followed by oc.

b - Fish which would have matured in the year they were caught are indicated by "m" and those that would have remained in the ocean at least one more year, i.e. immatures, are indicated by "i".

Table V. Incidence of Triaenophorus in adult sockeye runs to Bristol Bay in 1958, based on samples from each river.

River	Size of "run" (catch + escapement)	Sample size	% infected with Triaenophorus	Estimated no. infected in total "run"
Nushagak (Wood)	2,000,000	25	56	1,120,000
Kvichak	1,200,000	25	0	0
Naknek	575,000	52	2	11,500
Egegik	750,000	25	0	0
Ugashik	700,000	25	0	0
				1,131,500

Estimated incidence of Triaenophorus in total Bristol Bay run - 21.7%

Table VI. Incidence of Triaenophorus in adult sockeye runs to Bristol Bay in 1957, based on samples from each river.

River	Size of "run" (catch + escapement)	Sample size	% infected with Triaenophorus	Estimated no. infected in total "run"
Nushagak (Wood)	1,000,000	25	20	200,000
Kvichak	6,500,000	20	0	0
Naknek	1,500,000	25	12	180,000
Egegik	1,150,000	20	0	0
Ugashik	575,000	20	0	0
				380,000

Estimated incidence of Triaenophorus in total Bristol Bay run - 3.5%

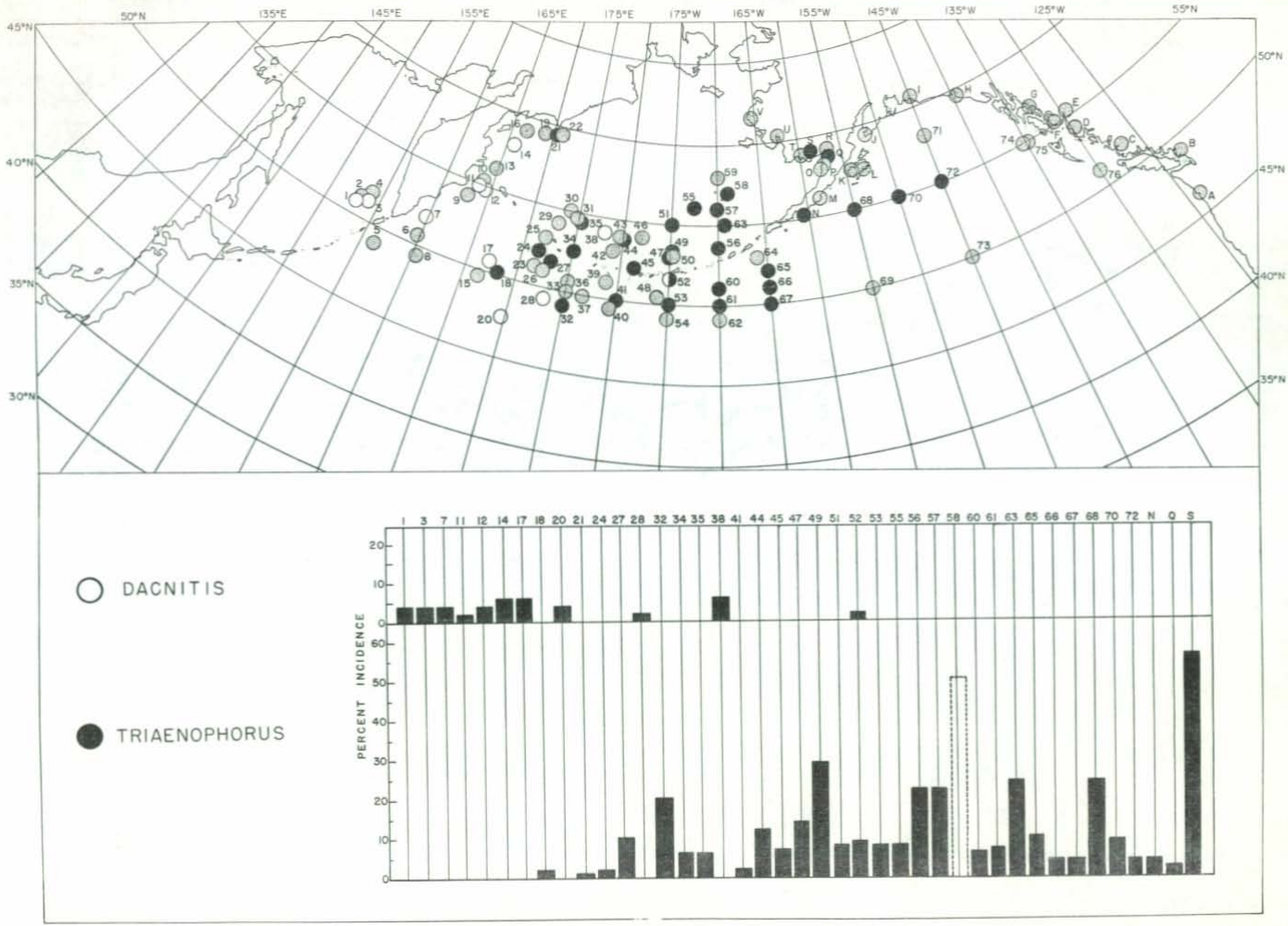

Figure 1. Distribution of sockeye salmon samples examined in 1958 and the occurrence and incidence of Triaenophorus and Dacnitis in these samples.

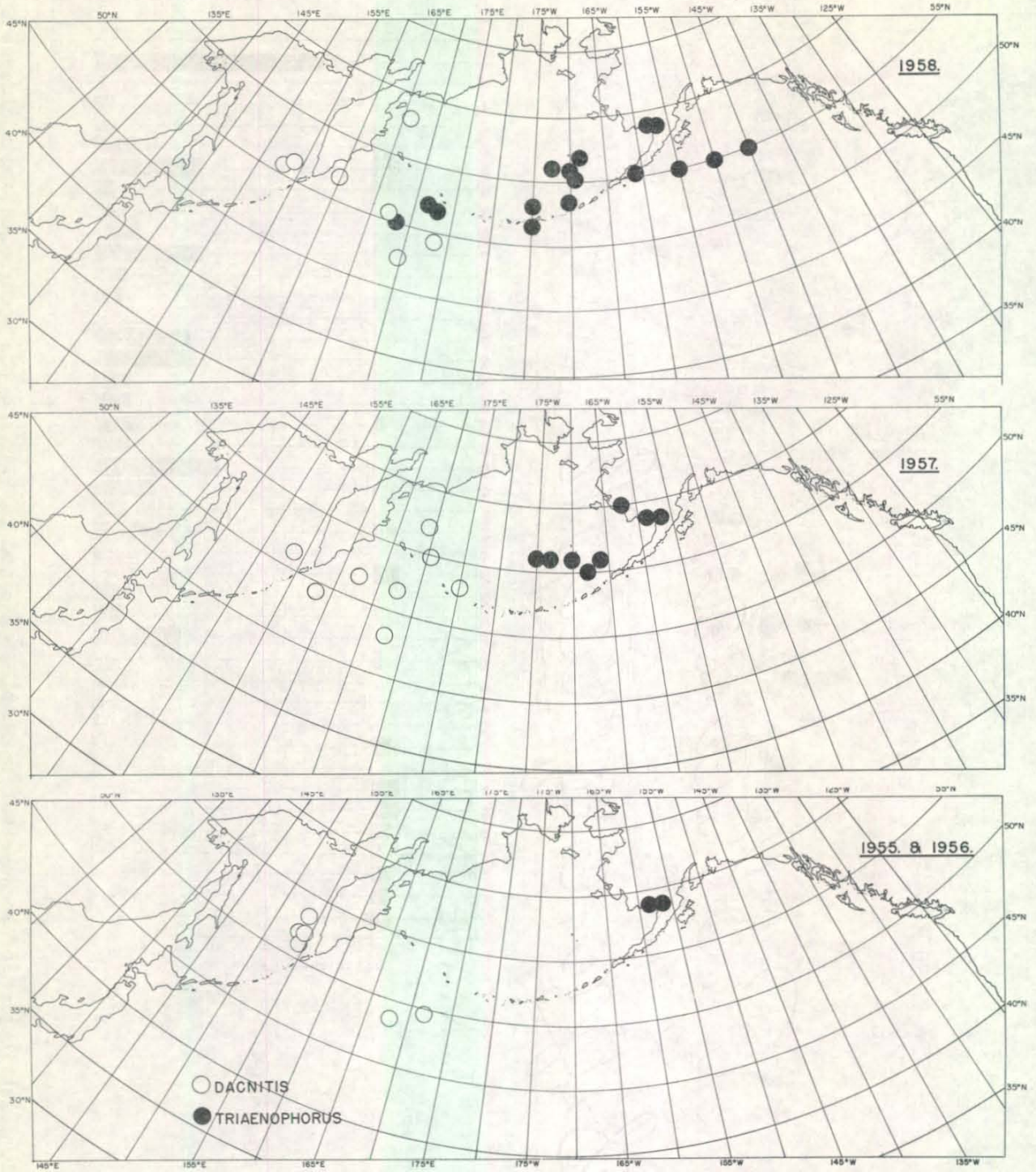

Figure 2. Distribution of maturing sockeye salmon infected with Triaenophorus or Dacnitis in the years 1955 to 1958.

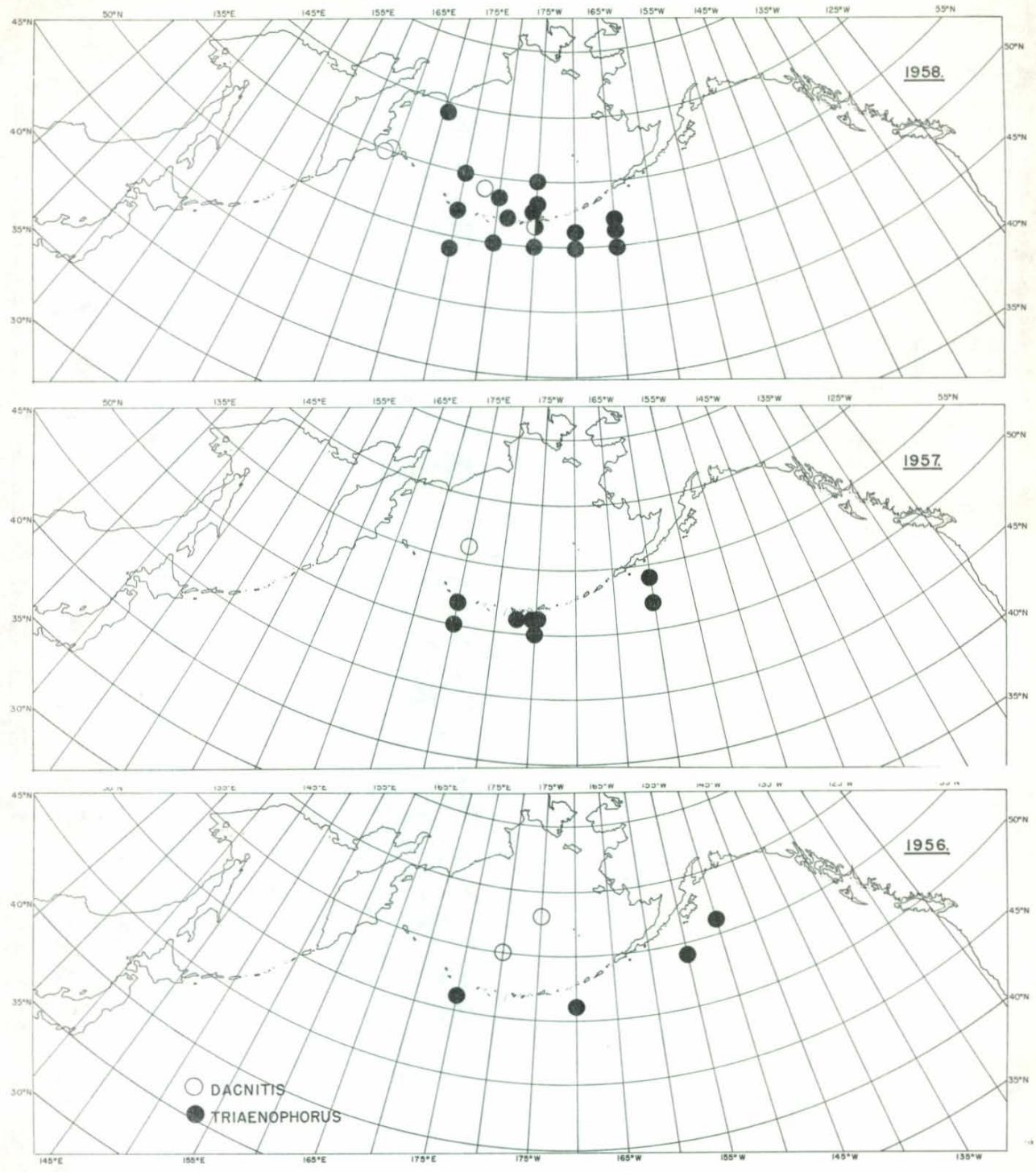

Figure 3. Distribution of immature sockeye salmon infected with Triaenophorus or Dacnitis in the years 1956 to 1958.

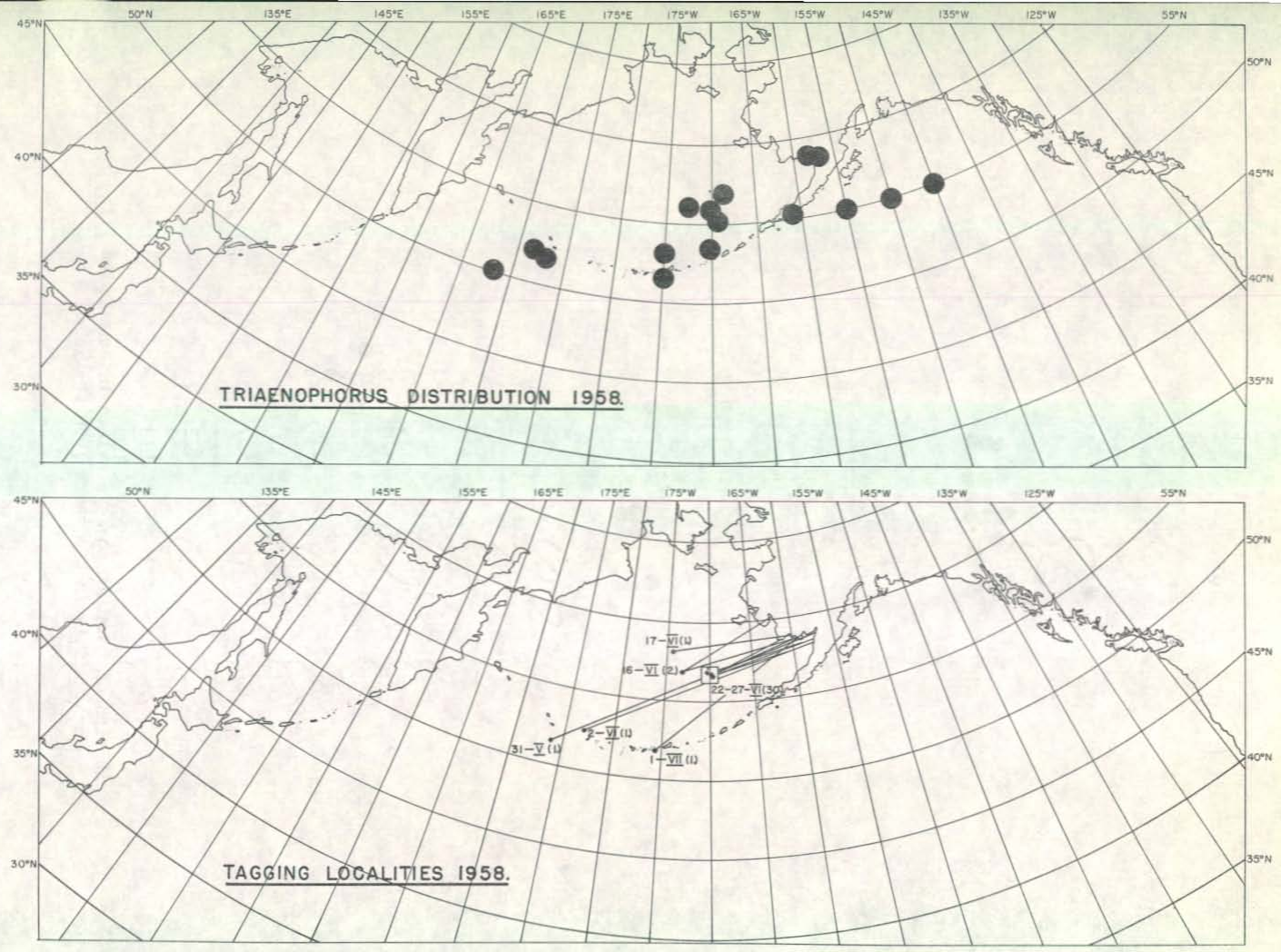

Figure 4. Comparison for 1958 of the localities of capture of Triaenophorus-infected maturing sockeyes with the United States tagging localities of sockeyes recovered in western Alaska rivers in the same year as tagged.