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CHAPTER 7

LIMNOLOGICAL INVESTIGATIONS

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INTRODUCTION

The purpose of the study was to provide limnological information on the lakes, ponds, and streams located within the Chukchi-Imuruk area of the Seward Peninsula. The short time allotted to the study and adverse weather conditions while in the field prevented extensive surveys of the physical parameters of the large lakes. Most of the time in the field was spent in the collection of algae, aquatic and terrestrial invertebrates. Information was gathered on the water chemistry of some of the lakes and streams and on the fisheries of the area. This report will discuss the various areas investigated, water chemistry, fisheries and a preliminary list of aquatic invertebrates. Most of the invertebrate and algal material has been sent to specialists; their identifications are not complete at this time.

GENERAL DESCRIPTION OF THE STUDY AREAS

Lava Lake

This lake is approximately 2.8 km long and 1.6 km wide. When approaching the lake by air one is immediately impressed by the Lost Jim lava flow which has two tongues of lava rock extending into the lake and which covers a considerable area south of the lake. Emergent vegetation is found in several shallow parts of the lake and two species of pond weed (*Potamogeton* sp.) were found in the middle of the lake.

The maximum depth measured was two meters in the center of the lake. Beach surfaces were sandy and rocky in areas where wave action was the greatest, and mucky in protected areas. The lake was slightly alkaline despite acid waters draining into it from the wet tundra and tussock areas surrounding much of the lake. Stonefly nymphs (*Plecoptera*) and caddis flies (*Tricoptera*) were found near the shores of the lake but were not abundant. Thousands of dead snails were found washed ashore in some of the bays. This is not uncommon in northern lakes and has been previously noted in lakes on the Arctic slope. The snails normally feed on the submerged aquatic plants in the lake, but die off in large numbers in the late fall and winter; the empty shells are then washed ashore in the spring.

The Lost Jim lava flow adjacent to the lake contained numerous small ponds and pools where rain water and snow melt collected. Most of these contained appreciable numbers of fairy shrimp and copepods and some were colored due to the presence of filamentous chrysophytes and diatoms.

Imuruk Lake

This lake was the largest body of water investigated, with a maximum length of 12.8 km and a width of 8 km. Maximum depths ranged from 2-1/3 to 3-1/3 m,

the bottom largely covered with sedimentary material. Wind action produced vigorous mixing of the bottom material and the lake was frequently quite turbid. Both grayling (*Thymallus arcticus*) and least cisco (*Coregonus sardinella*) were collected from the lake and trout were reported as being common (Hopkins, 1963). Grayling fishing could be very good when the lake is quiet but frequent winds in this area could greatly restrict periods of good fishing. Grayling caught by the investigator ranged in length from 15 to 33 cm. Zooplankton, which was abundant in the lake as well as in the beach pools and tundra ponds, would provide an excellent source of food for the fish.

In Granite Bay there were a number of sandy beach pools separated from the lake by a low sandy beach. During severe storms these pools were flooded by large waves. Many of these ponds contained emergent plants (*Hippurus* sp. and *Carex* sp.) and aquatic invertebrates (fairy shrimp, caddis flies, predacious diving beetles (*Dytiscidae*) and copepods). Large numbers of midges emerged from the lake and ponds early in the summer, as evidenced by the thousands of empty cases washed up on the beach. Five interconnected tundra ponds, which drain into Imuruk Lake, were also investigated. These slightly acid ponds (pH 6.5) contained emergent plants and planktonic invertebrates, as well as fish and at least one muskrat. The algal flora seemed typical of colored acid waters and contained large numbers of desmids and diatoms.

Kuzitrin Lake

This lake, which is approximately 4.8 km long and 1.0 km wide, is located on the north side of Mt. Boyan. It is fed by rains and melting snows, high winds and rain prevented any work on the lake. The winds, which could be extremely violent, seemed to blow much of the time, a fact attested to by the sand dunes and vegetation around the lake. The water in this shallow lake (6.5 m, Hopkins, 1963) is clear when still, but very turbid when mixed by the wind. Two small streams that enter the eastern end of the lake were sampled, as were several small ponds. These mountain streams were notable for the large numbers of blackfly larvae attached to the rocks. We also found mayflies (*Ephemeroptera*), crane flies (*Tipulidae*), and stoneflies (*Plecoptera*).

The shorelines of the ponds were covered with goose droppings, indicating past use by molting geese. One flock of approximately two hundred geese was observed by the ornithologist with the group. Their droppings seemed to have a definite fertilizing effect on the ponds, which contained large masses of algae and numbers of aquatic invertebrates.

Deering, Alaska, and the Inmachuk River

Two major areas were investigated, the salt marsh ponds in the tidal reach of the Inmachuk River and the river upstream to a point approximately 42 km from the coast.

The marsh ponds were extremely productive. Their bottoms were often covered with a dense layer of diatoms (Chrysophyta), and large masses of filamentous green algae (Chlorophyta). The ponds appeared to vary in salinity based upon the species present. The major tidal lagoon, directly behind the Deering sand spit, is regularly flushed by the tide and hence contained largely marine organisms, such as ctenophorons, jellyfish and marine copepods. The other ponds were flushed with saline water only during high-tide periods and contained organisms normally found in freshwater or brackish environments.

The Inmachuk River was studied intensively in two areas. The meandering river just above the area of tidal influence was characterized by a series of large riffles and pools. The riffled areas contained rocks that were slippery due to a coating of diatoms. We observed migrating salmon (chum salmon?) and grayling, although the local residents reported catching other salmoids in this area. This part of the river was downstream from the gold mining areas that were very active during the early 1900's. Since mining activity often increases siltation, this portion of the river could be adversely affected by increased mining upstream. This effect has been well documented in other areas of Alaska (Frey, 1969).

The upper Inmachuk River (above most mining activity) represents a typical mountain stream: clear and cold, with the bottom largely gravel and rubble, containing a high population of aquatic insects. Diatoms and other cold water algae were abundant, but surprisingly, there were also large quantities of filamentous blue-green algae attached to the rocks. Since these are frequently characteristic of warmer water they may be related to the presence of hot springs reported to exist 4 to 5 km upstream from the area (Moffit, 1905). Final identification of the species is necessary before any conclusions can be made. A tributary of the Inmachuk River in the same area (Hannum Creek) did not have the blue-green algae present and was also lacking in the large numbers of aquatic insects.

The many pools and side channels of the river in the mining area were frequently colored by large masses of floating and submerged algae, providing a brilliant contrast to the piles of tailings which surrounded them.

The value of the upper river as a spawning site for salmon is difficult to assess without knowing the size of the run and the species involved, but it may well need protection if additional mining activity were to develop along the river.

Serpentine Hot Springs and Hot Springs Creek

This was one of the most interesting and unique areas investigated during the field period. The present location of the Serpentine Hot Springs bath house is adjacent to one of the largest hot springs in the valley. There are numerous other small vents and drainages in the vicinity. Warm soil and hot water drainage was evident at four areas scattered along a 0.8 km reach of Hot Springs Creek. The major springs were moderately hot (61° to

72°C) while the smaller flows were somewhat cooler. The major flows were located at the bath house, in the upper hot spring area, and at the site of an earlier bath house, at the lowest site on the stream. Two intermediate areas were relatively inactive, although warm soil temperatures were still evident.

All the major hot water channels contained beautifully colored mats of blue-green algae and bacteria, resembling some of the hot spring drainages in Yellowstone National Park. Brilliant reds, orange and dark blue-green colors predominated where the water cooled as it left the source.

The major upper hot spring had a volume flow of approximately 106 liters per minute (28 gal/min). Some of this output went to a wooden bath via a pipe from the reservoir pool that enclosed the main spring. The lower spring area, where the flow of several springs is combined, had a flow of approximately 146 l per minute (38.5 gal/min).

Hot Springs Creek, which flows through the area, was a rather typical, small meandering stream above the hot springs, containing numerous aquatic insects and diatoms as well as small fish (grayling and stickleback). However, with the input of the warm water, there was an increase in the filamentous green algae as well as some blue-greens which remained in the stream as it passed through the hot springs area. Below the springs the channel became somewhat braided and the warm water species seemed to drop out as other cold streams entered. Larvae of stoneflies, mayflies, caddis flies and crane-flies were found in the stream and many of the emergent adults were also collected in the area.

One small tundra pond was also investigated. The plankton and aquatic vegetation was similar to that found in ponds examined in other areas of the Seward Peninsula.

Shishmaref, Alaska

The village of Shishmaref was visited so the investigator could discuss the fisheries of the Serpentine River with the local people as well as to collect aquatic organisms. This area was subject to fog, rain, wind, and even snow flurries (August 11, 1973) during the summer.

The upper Serpentine River is evidently not utilized as a fishery resource as the fishing is better closer to the village. The lower river is fished some, but its greatest use probably occurs during the moose hunting season when boats move into the area looking for moose. Salmon, arctic char, trout and herring were reported to occur in the lower river, while grayling were most abundant further upstream.

Aquatic invertebrates and algae were collected from several pools on the sand spit where plankton was very abundant, providing a source of food for the many shore birds in the area. Stonefly, mayfly and caddis fly larvae were also collected from the pools, including one unique caddis fly larval case which was constructed of many small seeds cemented together to form a tube.

Devil Mountain Lakes

These lakes, lie within two craters, and are surrounded by beaches of black volcanic ash and layered bluffs. The larger lake is approximately 4.8 km in diameter and the smaller lake is 1.6 km across. The two lakes were separated by a narrow sand bar composed of volcanic ash at the time of our visit in August. This lake exceeded 11 m in depth, maximum depth was not determined. The water was very clear and cold, the bottom being visible in seven meters of water even with small waves on the surface. There were no algae or other plants evident around the lake shore, probably due to the abrasive action of the ash when moved by the water during stormy periods. The lake appeared to be extremely oligotrophic, although some zooplankton were collected and a few fish were seen rising during a calm period in the middle of the night. The presence of loons on the lake indicated a fish population and many of the smaller ponds adjoining the lake contained fish (stickleback and least cisco). These ponds were connected to the lake during periods of rain and spring runoff so an interchange of organisms was most probable.

A series of five ponds south of the camp were examined and provided some rather interesting comparisons. The larger ponds were more similar to the lake: little algae and few invertebrates. The smaller ponds had bottoms covered with algae, emergent plants along the shorelines, and large numbers of invertebrates. Two of the ponds contained large numbers of diatom balls attached to the bottom. These algae formed gelatinous spheres ranging in diameter from a few millimeters to the size of a golf ball.

Several of the drainages of these ponds contained conspicuous golden-brown growths of diatoms attached to the stems of sedges (*Carex aquatilis*) growing in the channels. The Kitluk River, which drained Devil Mountain Lakes, also contained many long, flowing strands of *Tetraspora*, a tubular green algae which contrasts strongly with the black ash of the stream bottom or the golden-brown of the diatom mats occurring in the same areas.

The investigators also observed two interesting terrestrial insects in this area. A hornet (*Vespidae*) that clustered on the flat-topped flower clusters of *Angelica* sp. was seen; thirty individuals were gathered on one cluster. The reindeer warble fly (*Oestridae*), which resembles a large bee, was observed around the reindeer herds.

Whitefish Lake and North Killeak Lake

These two lakes were visited briefly by the investigators on August 15 to collect water samples for chemical analysis and plankton. Both were shallow (2 to 2.5 meters),¹ contained large amounts of plankton and a sizeable population of least cisco. The natives at Shishmaref reported fishing through

¹Editor's Note: Soundings made in the western part of North Killeak Lake on June 27, 1974 by David M. Hopkins; Paul A. Colinvault and Daniel A. Livingstone indicated a depth of 22 m; soundings of Whitefish Lake on June 25, 1974 by this same party indicated a maximum depth of 6 meters.

the ice in late fall on these lakes, but no one had utilized this resource for several years.

MATERIALS AND METHODS

Water Chemistry

A portable "Hach" kit was used in the field to analyze water samples from lakes, ponds and streams for temperature, pH, alkalinity, hardness and dissolved oxygen. Replicate water samples were also collected from some of the major lakes and ponds in the study area, placed in plastic bottles and flown to Kotzebue, Alaska, where the samples were frozen prior to shipment to the Arctic Environmental Research Laboratory of the Environmental Protection Agency, Fairbanks, Alaska. These samples were analyzed for nitrogen, phosphorous, silicates, chlorides, iron, calcium, magnesium, sodium, potassium, color and turbidity. All laboratory determinations were done as described in "Standard Methods" (13th Ed.) or methods approved by the Environmental Protection Agency.

Fish

Collections were made at several of the study areas utilizing spinning rods and gear, 1/4 inch nylon seine and a small dip net. Severe storms and the lack of a suitable boat prevented the use of larger nets on several of the lakes. All specimens were preserved in 10% formalin in the field and transferred to alcohol in the laboratory.

Plankton and Periphyton

Algae were collected from all habitats visited in the study area. Samples for diatom and blue-green algae identification were dried on cards in the field and placed in labeled envelopes for shipment. Plankton samples were collected using a standard Wisconsin plankton net. The samples were preserved in formalin (5%) for shipment and later identification. Periphyton was collected from a variety of substrates and preserved in formalin (8%). All samples were examined microscopically for diatoms. Samples containing diatoms were subdivided in the laboratory and permanent slides were prepared from the subsample using the cleaning technique described by Patrick and Reimer (1966). Identification of the algae is incomplete at this time and will be covered in a later paper.

Insects

The aquatic insect larvae and nymphs were collected by means of a Surber Sampler, dip net, Ekman dredge, and by hand; the adults by a sweep net and aerial net. These specimens were initially preserved in either 10% formalin in plastic bags or Hood's solution (FAA plus glycerin) in vials. All specimens have since been transferred to vials of 70% ethanol, and identified as completely as possible by the collector. These have been sent to specialists for confirmation and further identification. It is necessary to have a reference collection for species identification and these are not

readily available. Other aquatic phyla were preserved in a similar manner and have been identified to order and in some cases class or family.

Terrestrial invertebrates were collected with aerial nets, sweep nets, and specific searching of the ground, vegetation, beach driftwood and debris. Specimens were placed in a killing jar containing ethyl acetate. The larger specimens (bees, flies) were pinned in the field and mounted in empty egg cartons which protected them from damage. Others were placed in glassine envelopes and then in plastic sandwich boxes for storage and shipment. Dried specimens were later relaxed and pinned in the laboratory. Minute insects, such as thrips and midges, were collected and preserved in Hood's solution.

RESULTS AND DISCUSSION

Water Chemistry

The chemical analysis of water samples showed no unusual characteristics, with the concentrations of most ions similar to those reported for other arctic waters (Table 1). North Killeak and Whitefish lakes had higher values for sodium, potassium, calcium, magnesium and chlorides, but this may be related to the proximity of these lakes to the Bering Sea. Both lakes are approximately 10 kilometers from the coast and may be subject to increased levels of salts due to the strong coastal winds.

Most of the lakes and ponds sampled were relatively shallow (1 to 3-1/2 m) but a few were deeper. Maximum depths were not determined for the deepest lakes. Maximum temperatures recorded for all lakes was less than 10°C. Since all the lakes studied were in the permafrost zone of the Seward Peninsula and all were well mixed by the wind, the temperatures were typical of most shallow arctic lakes (Hobbie, 1973). Dissolved oxygen values ranged from 80 to 100 percent saturation in the waters examined.

Fish

According to Kenneth T. Alt, Alaska Department of Fish and Game (personal communication) the north side of the Seward Peninsula is one of many arctic areas where little work has been done on fish distribution. Records of the Alaska Department of Fish and Game indicate the lakes examined in this investigation had not been studied previously. Hopkins (1963) reported grayling (*Thymallus arcticus*) and rainbow trout (probably Arctic char or Dolly Varden) from the Imuruk Lake area and black fish (*Dallia pectoralis*) and nine-spined stickleback (*Pungitius pungitius*) from Lava Lake. These are the only previous records known for the area. The following list of species includes those collected during this investigation as well as those which are probably present based on previous records from adjacent areas (McPhail and Linsey, 1970; Alt, 1971, 1972).

TABLE 1. Concentration of inorganic ions (ppm), temperature, M.O. Alkalinity, color and turbidity of selected waters of the northern Seward Peninsula.

	Field Determinations				Laboratory Determinations, AERL (EPA) Fairbanks, Alaska													
	Temp °C	pH	Alkal. MO	Hardness	NH ₃ -N	NO ₂ -N	NO ₃ -N	O-P	T-P	Si O ₂	Cl	Ca	Mg	Na	K	Fe	Color	Turb
LAKES																		
Imuruk Lake 15 August 1973	8.4	7.0	6.8	17.1	.09	.001	.67	.12	.16	.10	43.0	5.1	1.5	3.9	.66	0.8	4.3	7.8
Lava Lake 15 August 1973	9.8	7.3	20.5	51.3	.97	.002	.50	.11	.18	.24	142.0	11.6	2.3	3.8	.60	0.2	8.0	6.1
North Killeak Lake 15 August 1973	9.8	8.0	129.9	444.6	.03	.001	Neg.	.19	.24	6.1	505.0	106.0	11.1	358.0	13.00	0.1	2.8	23.0
Whitefish Lake 15 August 1973	9.2	8.0	54.7	188.0	.04	.001	.01	.16	.17	1.36	201.0	27.5	4.5	110.0	4.6	0.2	12.3	5.7
Devil Mt. Lake 15 August 1973	7.6	7.5	47.9	51.3	.07	.001	.02	.11	Neg.	.24	32.0	8.4	4.4	15.0	-	0.2	3.7	1.2
TUNDRA PONDS																		
#1 - Imuruk Basin 21 July 1973	-	6.5	-	-	.07	.002	.17	.04	.07	.18	8.4	3.0	1.0	2.1	.32	2.1	31.6	2.2
#2 - Imuruk Basin 21 July 1973	-	6.5	-	-	.07	.002	.17	.07	.07	.10	4.7	2.2	1.0	2.4	.43	2.0	32.4	4.3
#3 - Imuruk Basin 21 July 1973	-	6.5	-	-	.016	.002	.12	.04	.06	.24	5.1	2.0	1.0	2.3	.15	2.0	43.9	1.5
STREAMS																		
Innachuk River 29 July 1973	8.0	8.3	76.0	188.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 1. Continued

	Field Determinations				Laboratory Determinations, AERL (EPA) Fairbanks, Alaska														
	Temp °C	pH	Alkal. MO	Hardness	NH ₃ -N	NO ₂ -N	NO ₃ -N	O-P	T-P	Si	O ₂	Cl	Ca	Mg	Na	K	Fe	Color	Turb
STREAMS (con't)																			
Hannum Creek 30 July 1973	10.5	7.7	160.0	239.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Springs Creek (Above Hot Springs) 5 August 1973	9.5	7.0	27.36	68.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Springs Creek (Below Hot Springs) 5 August 1973	15.0	7.5	27.36	34.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Whitefish, Family Coregonidae

- Coregonus clupeaformis* (Mitchell) Humpbacked whitefish
- Coregonus nasus* (Pallas) Broad whitefish
- Prosopium cylindraceum* (Passal) Round whitefish

These three species of whitefish were not collected during the course of this investigation, but were reported by Alt (1971, 1972) as occurring commonly in the Imuruk Basin, lower Kuzitrin River and probably occur in our study area.

- Coregonus sardinella* (Valenciennes) Least cisco
- Coregonus laurettae* (Bean) Bering cisco

Least cisco were collected at north Killeak Lake, Devil Mountain Lakes, and Imuruk Lake and both Least and Bering cisco were reported as commonly occurring in this area by several residents of Shishmaref, Alaska. Alt (1971) also reports both species from the southern Seward Peninsula.

Grayling, Family Thymallidae

- Thymallus arcticus* (Pallas) Arctic Grayling

This beautiful fish was abundant in Imuruk Lake and is probably common throughout the study area.

Trout, Char and Salmon, Family Salmonidae

- Salvelinus alpinus* (Linnaeus) Arctic char
- Salvelinus malma* (Walbaum) Dolly Varden

Arctic char were collected from Hot Springs Creek and the Serpentine River. Fish were also observed in the Inmachuk River and are probably common in the study area. Dolly Varden have been reported from south of the study area and are probably the species frequently mistaken for rainbow trout which does not seem to occur in this area.

- Oncorhynchus nerka* (Walbaum) Sockeye salmon
- Oncorhynchus kisutch* (Walbaum) Coho salmon, Silver salmon
- Oncorhynchus tshawytscha* (Walbaum) Chinook or King salmon
- Oncorhynchus keta* (Walbaum) Chum salmon
- Oncorhynchus gorbuscha* (Walbaum) Pink salmon

Although all five species of pacific salmon have been reported from western Alaska adjacent to the Seward Peninsula, only the pink and chum salmon are probably important in our study area. The distribution of salmon in the northern Seward is largely unknown, and should be studied carefully in any future investigation.

Smelts, Family Osmeridae

Osmerus eperlanus (Linnaeus) Boreal Smelt

Hypomesus olidus (Pallas) Pond Smelt

The boreal smelt was reported from the lower Serpentine River by eskimoes at Shishmaref, Alaska and probably occurs elsewhere in the study area. Pond smelt were not collected, but have a general distribution along the Bering Sea and may occur in this area.

Pikes, Family Esocidae

Esox lucius (Linnaeus) Northern Pike

Pike have been reported from the south side of the Seward Peninsula and the Kuzitrin and Noxapaga Rivers which extend into the study area. Further investigations are needed to confirm its distribution throughout the peninsula.

Blackfish, Family Dallidae

Dallia pectoralis (Bean) Blackfish

Hopkins (1963) reported the presence of blackfish in Lava Lake in the study area and although not collected by us, it is probably widespread in the area.

Suckers, Family Catostomidae

Catostomus catostomus (Forster) Longnose sucker

Although not collected during the present investigation, Alt (personal communication) has found it further south and suggests it probably occurs in the northern Seward.

Cods, Family Gadidae

Lota lota (Linnaeus) Burbot

One skeleton was found at Kuzitrin Lake, where adverse weather conditions prevented any attempt to collect other individuals. Alt (1971) has collected it to the south of the study area and suggests it probably occurs elsewhere on the peninsula.

Sticklebacks, Family Gasterosteidae

Pungitius pungitius (Linnaeus) Ninespine Stickleback

This was the most common fish collected by us. Specimens were collected at North Killeak Lake, Lava Lake, Devil Mountain Lakes and Hot Springs Creek near Serpentine Hot Springs. This fish is probably heavily utilized as food by several of the fish-eating birds of the area.

Sculpins, Family Cottidae

Cottus cognatus (Richardson) Slimy sculpin
Myoxocephalus quadricornus (Linnaeus) Deep water sculpin

Although we did not collect either species, both should be present in our area.

Flounder, Family Pleuronectidae

Liopsetta glacialis (Pallas) Arctic Flounder
Platichthys stellatus (Pallas) Starry Flounder

The starry flounder was found on the beach at Deering, Alaska and an immature arctic flounder was collected in freshwater one mile above Deering on the Inmachuk River. Both species are probably widespread in the coastal areas of the northern Seward.

Invertebrates

The most abundant aquatic insects collected were in the following orders: Ephemeroptera, Plecoptera, Trichoptera, and Diptera. Also abundant in most streams were freshwater Oligocheates (taxonomy to be determined). Most conspicuous by its absence was the order Odonata. No damselflies were observed or collected and only one adult dragonfly was collected (Deering, Alaska). This specimen was severely damaged and may not be identifiable. The children of Deering and Shishmaref reported seeing dragonflies, especially when there was very little wind, and one specimen was observed at Serpentine Hot Springs. No naiads were observed nor collected. One specimen of the order Amphipoda was collected in the estuary behind the Deering general store and has been identified as *Gammarus* sp.

Although mosquitoes were in abundance on the Seward Peninsula and adults were collected, no larvae were collected and relatively few pupae found. Lack of larvae can be explained by seasonal emergence and our not sampling their specific habitats.

Pools in the Lava Lake, Imuruk Lake, and Shishmaref areas contained appreciable numbers of Anostracans. This has also been observed elsewhere in Alaska (Hobbie, 1973).

One of the most interesting specimens collected from Imuruk Lake, and one which may be the first reported from the Seward Peninsula, is the freshwater polychaete *Manyunkia speciosa*. Several individuals of this species were reported from Lake George, Alaska (Swartz, 1966); but it was not mentioned by Foster (1972) as being present in Alaska.

Also not previously listed from Alaska by Williams (1972) is the genus *Lirceus* of the order Isopoda. Specimens were collected both at Lava Lake and Imuruk Lake; however, confirming identification of the specimens is needed before any definite statements can be made.

The phylum Tardigrada was found on diatom mats in the tidal flats behind Deering, Alaska along with larvae of the dipteran family Ephydriidae (shore flies).

Turbellarians were found at Serpentine Hot Springs in Hot Springs Creek above the hot springs, and also at Imuruk Lake in the ponds along the sandy beach. The three specimens collected by Ekman dredge from the beach pond appear to belong to the genus *Sphalloplana* and resemble species that have previously been reported only from caves in eastern and southern United States (Kenk, 1972). These specimens must be sent to a specialist for identification but may represent a new species or a new record for the Seward Peninsula. Specimens collected in a pond near Devil Mountain Lakes are quite unusual and may belong to the order Turbellaria, but they were severely distorted by the preservative. When living, these organisms seem to exhibit planarian-like movement, gliding over the bottoms of rocks. However, they also seemed to have egg cases either within their body or attached to the outside which does not correspond to the egg capsules or cocoons mentioned by Kenk (1972).

The aquatic Hemiptera were represented by two families in the study area, Corixidae and Gerridae, and the aquatic Coleoptera consisted of only one family, Dytiscidae. The Dytiscids, however, belong to several different genera.

The order Ephemeroptera was represented in our area by *Ephemerella* (*Ephemerella*) *aurivillii* Bengtsson, the only species in the genus with a Holarctic distribution (Jensen, 1966). The specimen we examined seemed to have the very small blunt abdominal tubercles (Jensen, 1966) characteristic of eastern populations rather than northwestern populations of North America. Specimens collected by Jensen in Idaho were of the same type and he feels that there is evidence for sub-species recognition due to geographic variation.

The insect fauna collected from Hannum Creek and the Inmachuk River suggests a more diverse fauna in Hannum Creek than in the Upper Inmachuk.

The order Neuroptera was collected at Serpentine Hot Springs, one adult spongilla fly *Sisyra* sp.; but no sponges nor larvae were collected.

Little can be said concerning the marine species in the study area since we were prepared to collect only in freshwater. However, we list in Appendix 1 a few marine families and orders that were observed and photographed.

The families and orders of terrestrial invertebrates listed in Appendix 1 are based mainly on field identification; more names will be added to the list as they are identified by specialists. Species belonging to the orders Hymenoptera and Diptera were most numerous in our collections. Specimens from the following orders were also abundant: Homoptera (leaf hoppers and aphids), Thysanoptera (thrips), Collembola, and Araneae (spiders). Spiders were found at all study areas. Vegetated areas as well as sand and silt beaches provided great numbers. Unlike the study at Cape Thompson (Watson *et al.*, 1966), turf-inhabiting invertebrates were not of major importance in our area; however, many Collembola and mites were collected while sweeping the ground vegetation. A few external parasites were collected from small mammals, birds, and aquatic insects and must be identified by specialists in those areas.

The Coleoptera were not well represented in the study area or at least were not numerous in the collection. The family Carabidae collected at Lava Lake were taken from under old oil barrels left from some previous encampment. No Orthopterans or Megalopterans were collected and only one Orthopteran was previously reported from Cape Thompson (Watson *et al.*, 1966).

The reindeer warble fly (Oestridae) was collected in the Devil Mountain Lakes area. Several specimens of these flies (which resemble large bees) were collected as they landed on members of the field party who were observing a herd of reindeer at close range. The reindeer seemed to be particularly bothered by these flies as they shook themselves violently and grouped together with their backs into the wind.

All Lepidopteran specimens (adults and larvae) that we collected were given to and identified by Dr. K. Phillips, University of Alaska (Appendix 2).

Zooplankton

Qualitative samples of zooplankton were taken from various lakes and ponds in the study area. Eleven species of Cladocera and 14 species of Copepoda (8 Calanoida, 4 Cyclopoida, 2 Harpacticoida) were identified and are listed below. Most of these species have been reported from the Cape Thompson area by Hilliard and Tash (1966) but those species not reported from Cape Thompson are marked with an asterisk.

Cladocera

- Daphnia middendorffiana* Fischer
- **Daphnia rosea* Sars emend Richard
- Daphnia pulex* Leydig emend Richard
- Daphnia longiremis* Sars
- **Alona affinis* (Leydig)
- Eurycercus lamellatus* (O. F. Muller)
- Chydorus (sphaericus?)* (O. F. Muller)
- **Eubosmina longispina* Berge
- **Polyphemus pediculus* (Linne)
- Holopedium gibberum* Zaddach
- Podon* sp. (Marine)

Copepoda (Calanoida)

- **Eurytemora affinis* (Poppe)
- Heterocope septentrionalis* Juday & Muttkowski
- Limnocalanus johanseni* Marsh
- **Diaptomus pallidus* Herrick
- Diaptomus gracilis* Sars
- Diaptomus pribilofensis* Juday & Muttkowski
- Diaptomus arcticus* Marsh
- **Acartia tonsa* Danz (Marine)

Copepoda (Cyclopoida)

**Cyclops columbianus* (Yeatman?)*Cyclops scutifer* Sars*Cyclops vernalis* Fisher

Copepoda (Harpacticoida)

Morarria duthiei (T. & A. Scott)**Attheyella (dentata?)* (Poggenpol)

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APPENDIX 1. Distribution of invertebrates collected within the Chukchi-Imuruk region. L=Lava Lake, I=Imuruk Lake, K=Kuzitrin Lake, D=Deering, Alaska, S=Serpentine Hot Springs, SMF=Shishmaref, Alaska, DML=Devil Mountain Lakes, H=Hannum Creek, IN=Inmachuk River, HSC=Hot Springs Creek.

	L	I	K	D	S	SMF	DML	H	IN	HSC
Phylum: Porifera										
Class: Demospongiae	-	-	-	X	-	-	-	-	-	-
Phylum: Coelenterata										
Class: Scyphozoa	-	-	-	X	-	-	-	-	-	-
Class: Hydrozoa										
<i>Hydra</i> sp.	-	X	-	-	-	-	-	-	-	-
Phylum: Ctenophora	-	-	-	X	-	-	-	-	-	-
Phylum: Platyhelminthes										
Class: Turbellaria										
<i>Sphalloplana</i> sp.	-	X	-	-	-	-	-	-	-	-
Unidentified	-	-	-	-	-	-	?	-	-	X
Phylum: Aschelminthes										
Class: Nematoda (several-uniden.)										
Phylum: Tardigrada	-	-	-	X	-	-	-	-	-	-
Phylum: Annelida										
Class: Polycheata										
<i>Manyunkia speciosa</i>	-	X	-	-	-	-	-	-	-	-
Class: Oligocheata	X	-	X	-	-	X	X	X	X	X
Class: Hirudinea										
Order: Rhynchobdellida										
Family: Glossiphoniidae	X	-	-	-	-	-	-	-	-	-
Unidentified	-	-	-	-	-	-	X	-	-	-
Phylum: Mollusca										
Class: Gastropoda	X	X	X	-	-	-	X	-	X	-
Terrestrial slug	-	-	-	-	-	-	X	-	-	-
Class: Pelecypoda (shells)	-	-	-	X	-	X	-	-	-	-
Phylum: Echinodermata										
Class: Asteroidea	-	-	-	-	-	X	-	-	-	-
Phylum: Arthropoda										
Class: Crustacea	-	-	-	-	X	-	-	-	-	-
Subclass: Branchiopoda										
Order: Anostraca	X	X	X	-	-	X	X	-	-	-
Order: Cladocera	-	-	-	-	-	X	-	-	-	-
Order: Copepoda	-	X	-	-	-	-	X	-	-	-

APPENDIX 1. Continued

	L	I	K	D	S	SMF	DML	H	IN	HSC
Phylum: Arthropoda (con't)										
Order: Isopoda										
Family: Asellidae										
<i>Lirceus</i> sp.	X	X	-	-	-	-	-	-	-	-
Order: Amphipoda										
<i>Gammarus</i> sp.	-	-	-	X	-	-	-	-	-	-
Class: Arachnoidea										
Order: Phalangida (Opiliones)	-	-	X	-	-	-	-	-	-	-
Order: Acarina (many-uniden.)										
Order: Aranea (many-uniden.)										
Class: Insecta										
Order: Collembola (many-uniden.)										
Order: Ephemeroptera										
Family: Heptageniidae										
Adult male-uniden.	-	-	-	-	X	-	-	-	-	-
<i>Cinygmula</i> sp. McDunnough	-	-	X	-	-	-	-	X	X	X
<i>Epeorus</i> (Iron) sp. Eaton	-	-	-	-	-	-	-	-	X	X
Family: Ephemerellidae										
<i>Ephemerella</i> (<i>Ephemerella</i>) <i>aurivillii</i> Bengtsson	-	-	-	-	-	-	-	-	X	-
<i>Ephemerella</i> (<i>Serratella</i>) <i>tibialis</i> McDunnough	-	-	-	-	-	-	-	X	-	-
Family: Siphonuridae										
<i>Siphonurus</i> sp. Eaton	-	-	-	-	-	-	-	X	X	X
<i>Parameletus columbiae</i> ? McDunnough	-	-	-	-	-	-	-	X	X	-
Family: Baetidae										
Adult male-uniden.	-	-	-	-	-	-	-	-	X	-
<i>Baetis</i> sp. Leach	-	-	-	-	-	X	X	X	X	X
Order: Odonata	-	-	-	X	X	X	-	-	-	-
Suborder: Anisoptera										
Order: Plecoptera										
Suborder: Filopalpia										
Immatures	X	X	X	X	-	X	-	-	-	-
Family: Nemouridae										
<i>Nemoura</i> sp. Pictet	X	X	X	-	-	-	-	-	-	-
Family: Capniidae										
<i>Capnia</i> sp. Pictet	-	-	-	X	-	-	X	-	-	X
Suborder: Setipalpia										
Family: Perlodidae										
<i>Isoperla</i> sp. Banks	-	-	-	-	-	-	-	-	-	X
Family: Chloroperlidae										
<i>Alloperla</i> sp. Banks	-	-	-	-	X	-	X	X	X	X
Order: Mallophaga	-	-	X	-	X	-	-	-	-	-
Order: Thysanoptera	-	X	-	X	X	-	X	-	-	-

APPENDIX 1. Continued

	L	I	K	D	S	SMF	DML	H	IN	HSC
Order: Hemiptera										
Family: Corixidae										
Immatures	-	-	-	-	-	-	X	-	-	-
<i>Corisella</i> sp. - based on 5th instar nymphs	-	-	-	-	-	-	X	-	-	-
Family: Gerridae										
<i>Gerris</i> sp.	-	X	-	-	X	-	-	-	-	-
Family: Miridae										
Family: Lygaeidae										
Family: Saldidae										
Order: Homoptera										
Family: Cicadellidae										
Family: Delphacidae										
Family: Psyllidae										
Family: Aphididae										
Order: Neuroptera										
Family: Sisyridae										
<i>Sisyra</i> sp. (adult)	-	-	-	-	X	-	-	-	-	-
Order: Coleoptera										
Family: Carabidae	X	-	-	-	-	-	-	-	-	-
Family: Dytiscidae (larvae)										
<i>Agabus</i> sp. ?	X	-	X	-	-	-	-	-	-	-
<i>Bidessus</i> sp. Sharp	-	X	-	-	-	-	-	-	-	-
<i>Hydroporus</i> Clairville and	-	-	-	-	-	X	-	-	-	-
<i>Hygrotus</i> Stephens										
<i>Rhantus</i> Dejean and <i>Colymbetes</i>	-	X	-	-	-	-	-	-	-	-
Clairville										
<i>Oreodytes</i> Seidlitz (in part)	-	-	-	-	-	-	X	-	-	-
and <i>Deronectes</i> Sharp										
Unidentified larvae	-	X	-	-	-	-	-	-	-	-
Unidentified adults	X	X	-	X	-	-	X	-	-	-
Family: Curculionidae	-	X	and North Killeak Lake							
Family: Staphylinidae ?										
Order: Trichoptera										
Empty cases	-	X	-	X	X	X	-	-	-	-
Unidentified adults	-	X	-	-	-	-	-	-	-	-
Unidentified Pupa	-	-	-	-	X	-	-	-	-	-
Family: Rhyacophilidae										
<i>Rhyacophila</i> sp.	-	-	-	-	-	-	-	X	-	-
Family: Psychomyiidae	X	-	-	-	-	-	-	-	-	-
Family: Phryganidae	-	X	-	-	-	-	-	-	-	-

APPENDIX 1. Continued

[illegible]

APPENDIX 2 - PART I. Butterflies collected by D. D. Gibson and E. A. Graham on the Seward Peninsula, 28 June - 21 July 1973 and identified by Kenelm W. Philip, are listed by locality.

North Killeak Lake, 28 June:

Papilio machaon
Pieris napi
Boloria frigga
Erebia rossii
disa

Lava Lake, 9-10 July:

Papilio machaon
Colias palaeno
Vacciniina optilete
Boloria frigga
freiija
distincta
chariclea
Coenonympha mixturata
Oeneis bore
Erebia disa
fasciata

Shishmaref, 11 July:

Boloria chariclea

Imuruk Lake, 13-19 July:

Papilio machaon
Pieris napi
Colias palaeno
Boloria napaea
frigga
chariclea
Coenonympha mixturata
Oeneis bore
jutta
Erebia rossii

Devil Mountain Lake, 14 July:

Boloria chariclea

Kuzitrin Lake, 21 July:

Boloria chariclea

In all, 61 specimens of butterflies were obtained, belonging to 15 species. Six specimens of moths were obtained as well, undetermined as yet.

One new species for the Seward Peninsula was found, *Oeneis jutta* at Imuruk Lake, (see Part II for listing of previous Alaska Lepidoptera Survey records from the Seward Peninsula). This species is common in Alaska but not usually found in tundra habitats. Both the Imuruk basin and the Killeak Lakes were totally uncollected areas, and it is very useful to have some idea as to their butterfly fauna. The specimen of *Boloria distincta* from Lava Lake (caught on

the lava) was of particular interest, since it was the first specimen from the Seward Peninsula outside of the area near Nome. It appears to belong to the same undescribed dark race as the Nome specimens, quite distinct in appearance from "normal" specimens from the Yukon Territory and Eagle Summit.

PART II

Alaska Lepidoptera Survey butterfly records from the Seward Peninsula, through 1972, by locality.

Nome vicinity (west to the Feather River, east to mile 46 Council Road, north to mile 50 Kougarok Road):

Parnassius evermanni
 phoebus
Papilio machaon
Pieris occidentalis
 napi
Colias hecla
 thula
 philodice
 palaeno
 nastes
Euchloe creusa
Vacciniina optilete
Agriades aquilo
Boloria napaea
 frigga
 improba
 polaris
 freiija
 distincta
 chariclea
 eunomia
Coenonympha mixturata
Oeneis bore
 melissa
 polixenes
Erebia rossii
 disa
 fasciata
 mackinleyensis
 youngi
 dabanensis?

Shishmaref Inlet:

Pieris napi
Colias hecla
Boloria freiija
 chariclea
Oeneis polixenes
Erebia rossii

Espenberg River:

Colias palaeno
Coenonympha mixturata

Serpentine Hot Springs:

Vacciniina optilete
Boloria frigga

Darby Mountains (exact locality not recorded):

Lycaena phlaeas

Elephant Point/Buckland:

Pieris napi
Colias palaeno
Vacciniina optilete
Boloria frigga
freiija
chariclea
Coenonympha mixturata
Erebia disa

Harris Dome vicinity:

Parnassius evermanni
Papilio machaon
Pieris napi
Colias hecla
thula
palaeno
nastes
Euchloe creusa
Glaucopsyche lygdamus
Vacciniina optilete
Agriades aquilo
Boloria napaea
frigga
improba
polaris
freiija
chariclea
eunomia
Coenonympha mixturata
Oeneis bore
melissa
polixenes
Erebia rossii
disa
fasciata
youngi
dabanensis?

The Nome area has produced 31 species to date, and the Harris Dome locality had 27 species during the brief period (1-2 July 1971) that it was intensively collected. The Seward Peninsula west of treeline has produced a total of

33 species of butterflies - a rather large number of species for tundra habitats. Collecting in the taiga at the base of the peninsula will almost certainly turn up additional species.

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