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目 次

下田 和孝・中島美由紀・伊藤 富子 北海道石狩北部の濃昼川下流域における魚類群集の月変化	1-9
伊藤 富子・工藤 智・下田 和孝 炭素窒素同位体判別法により推定した北海道への移入種 オオクチバスの食性変移	11-20
ふ化場試験報告・水産孵化場研究報告 総目録・要旨 第1巻第1号～58号 (1946～2004)	21-170
著者索引 (1946～2004)	171-177

北海道石狩北部の濃昼川下流域における魚類群集の月変化

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Monthly Changes of Fish community in the Lower Reach of the Gokibiru River, Northern Ishikari, Hokkaido, Japan

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Abstract

Dynamics of the diadromous fish community and their stomach contents in the lower reach of the Gokibiru River, Hokkaido, Japan, were investigated from April to October in 2001 on a monthly basis. Biomass and population density of the community changed three to four times in ranges by the diadromous migration of floating goby (*Gymnogobius* sp. 2), the passage of masu salmon smolts (*Oncorhynchus masou*) or spawning adults of Japanese dace (*Tribolodon hakonensis*) and the up stream migration of tyuman river sculpin juvenile (*Cottus hangiongensis*) from the sea. Composition and quantity of floating goby, masu salmon, Japanese dace and tyuman river sculpin in the stomach contents changed every month. The four fish species had a species specific dietary composition. These results suggests that the ecosystem of the lower reach of the Gokibiru River was a dynamic community based on the migration of diadromous fishes.

Key words: 下流域, 魚類群集, 通し回遊魚

北海道の淡水魚相は、本州以南の地域と比べて純淡水魚の比率が低く通し回遊魚や周縁性淡水魚の比率が高いという特徴を持ち、自然分布種のうち約92%の魚種が河川と海洋にまたがって生活するか、あるいは過去に海洋を通じて分布域を形成した陸封魚に属している(後藤・中野, 1993)。特に、下流域はハゼ科魚類やカジカ科魚類など河川と海洋とを行き来する通し回遊魚の種数が多く(例えば、後藤, 1982; 水野ら, 1982; 河村, 1982; 後藤ら, 1978)、また、サケ科魚類など中・上流域を再生産の場とする魚種は、河川と海洋とを行き来する際に下流域を通過する。したがって、北海道の河川下流域における魚類群集は、その構

成種や個体数、現存量が経時的に変動していると予想される。しかしながら、種毎の動態についてはいくつか報告があるものの(例えば、後藤, 1981; 酒井・後藤, 1982)、魚類群集全体の動態についてはこれまで調べられていない。本研究は北海道の小河川下流域における魚類の生息密度、現存量および食性について、春季から秋季にかけての動態を記載し、その特徴を明らかにすることを目的とする。

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材料および方法

調査地の概要

調査は北海道中部日本海に注ぐ濃昼川の河口から上流約100mの地点で行った (Fig. 1)。濃昼川は流域面積19.9km²、流程5.7km、平均勾配6.8%の河川である。濃昼川の流域面積のうち98%は落葉広葉樹林で覆われているが、河口から約0.5km上流までの河畔は草地または畑地で、調査地点の河畔はイネ科の草本やオオイトドリ *Polygonum sachinensis* から成る草地である。平水時の調査地点は川幅3.5mから5.9m、流路延長34.2mで、流心部の水深は0.2mから0.7mである(2001年8月31日測定)。川床には長径20cm程度の浮き石が散在し、これらの表面には付着藻類と糸状藻類が繁茂する。濃昼川にはサクラマス *Oncorhynchus masou*, シロサケ *Oncorhynchus keta*, ウグイ *Tribolodon hakonensis*, カンキョウカジカ *Cottus hangiongensis*, ハナカジカ *Cottus nozawae*, シマウキゴリ *Gymnogobius* sp. 2, ミミズハゼ *Luciogobius guttatus*, ヌマチチブ *Tridentiger brevispinis* およびルリヨシノボリ *Rhinogobius* sp. CO の4科7属9種の魚類が分布する (下田ら, 2004)。このうち調査地点ではハナ

カジカ以外の8種が確認され、これらはすべて通し回遊魚である。本研究ではシマウキゴリ, カンキョウカジカ, ウグイおよびサクラマスの4種を調査対象とした。これら4種は濃昼川下流域で確認された魚類の総個体数の94~99%を占める (下田ら, 2004)。

魚類の体サイズ, 生息密度および現存量

2001年4月から10月の各下旬に魚類の生息個体数を調査した。調査にはエレクトロフィッシャー (Smith-Root, Model12) を用い、除去法 (Cowx, 1983) により魚類の生息個体数を求めた。除去の回数は3回とした。生息個体数を調査面積で除して1m²当たりの生息個体数を求めた。この調査の際に採集された魚類の全長 (ただし、ウグイおよびサクラマスでは尾叉長) を1mm単位で測定し、これを濃昼川で採集した標本により別途求めた全長と体重との関係式 (Table 1) を使って体重に変換した。魚種毎に平均体重を求め、生息個体数と平均体重との積により現存量を求めた。生活史ステージを推定する際の参考とするために、採集した魚類の外観上の特徴を記録し、一部の個体については中性ホルマリン水溶液で固定して持ち帰り、生殖腺の観察を行った。また、サクラマスについては耳石から年齢を査定した。

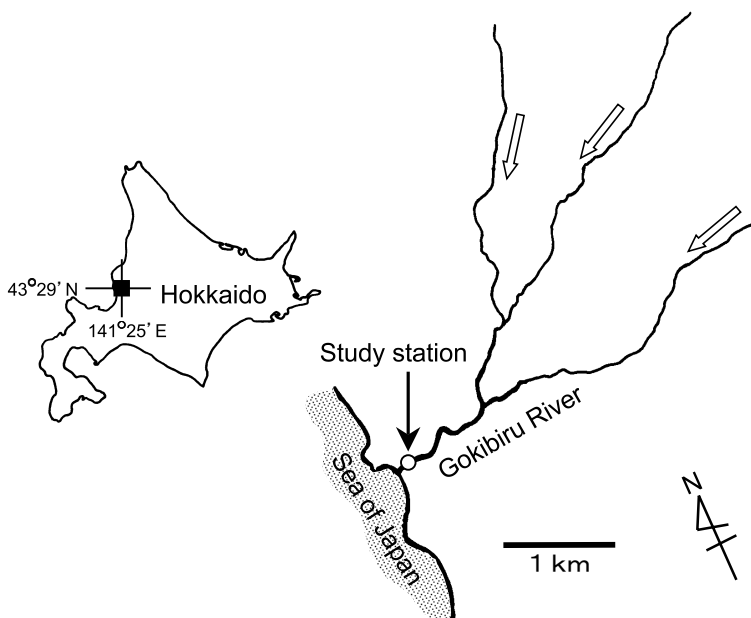


Fig. 1 Map of the study station. Open arrows indicate flow direction.

Table 1 Regression formula between body weight(g) and body length(mm).

Species	Formula	Correlation coefficient	Sample size
<i>G. sp.2</i>	$y=2.90x-4.85$	$r^2=0.965$	163
<i>C. hangiongensis</i>	$y=3.18x-5.23$	$r^2=0.986$	71
<i>T. hakonensis</i>	$y=2.87x-4.66$	$r^2=0.979$	100
<i>O. masou</i>	$y=2.93x-4.76$	$r^2=0.990$	56

y:Log₁₀(BW), x:Log₁₀(BL)

魚類の食性

各魚種の食性を消化管内容物の分析により調べた。ウグイは無胃魚のため消化管の第一屈曲部までの内容を分析対象とし、他の3種は胃の内容物を分析対象とした。消化管内容物分析用のサンプルは生息個体数調査の際に採集した個体のうち各月3~11個体を用いた。採集数が3個体未満の場合には、消化管内容物の分析は行わなかった。サンプルは採集後直ちに10%中性ホルマリン水溶液で固定し、後日、実体顕微鏡下で消化管内容物を分類した。消化管内容物の分類群ごとの湿重量はサンプル表面の水分を約10秒間濾紙で吸い取った後に0.01mg単位で測定した。この方法による湿重量の測定値の誤差は±6%以内とされている(Kawaguchi and Nakano, 2001)。消化管の摘出前に魚体重の湿重量を0.01mg単位で測定した。この値から消化管内容物の総重量を差し引いた値を魚体重とした。各分類群の重量を魚体重で除して単位魚体重あたりの消化管内容物重量を求めた。魚種間における消化管内容物組成の類似性をMorisita (1959)のC_s指数を用いて検討した。C_sの算出には小椋(2001)の付属ソフトを用いた。C_s指数は0から1の間をとり、2魚種間の消化管内容物を比較した際、両種の餌の出現分類群組成が類似する場合、または同じ特定の餌の出現数量がともに多い場合に1に近い値を示す。

結果および考察

下流域に生息する魚類の生活史ステージと食性

シマウキゴリ、カンキョウカジカ、ウグイおよびサクラマスは月別体長分布および消化管内容物をそれぞれFig. 2とFig. 3に、消化管内容物の魚種間におけるC_s指数をTable 2に示した。

北海道のウキゴリ類の産卵は5月初旬に始まり、ほぼ2か月間続くとされている(石野, 1987)。本調査に

おいても、5月末と6月末の調査時にシマウキゴリの卵と孵化直後の仔魚が確認された。なお、これらの卵と仔魚は定量的に調査することが困難であったことから、本調査のデータに含めなかった。ウキゴリ類は両側回遊型の生活史を示し、河川で孵化した仔魚は直ちに降海し、しばらくの間海洋で生活した後、河川に遡上する(石野, 1987)。本調査では8月末に全長3.5~4.0cmのモードが新たに出現し(Fig. 2)、このモードが河川遡上した当歳魚であると推定される。したがって、濃昼川のシマウキゴリは5月末から6月末に産卵し、孵化仔魚は約1~2か月間の海洋生活の後、8月に河川遡上すると考えられる。本種は濃昼川中流の砂防ダム付近にも生息することから(下田ら, 2004)、河川遡上後は中・下流に広く分散して生活すると考えられる。産卵期に当たる5月末の全長分布が4つのモードから成る多峰型を示しことから(Fig. 2)、本種の寿命は満5年程度であると推定される。シマウキゴリの消化管内容物は4月末~5月末に多く、その40~70%がカゲロウ目幼虫であった(Fig. 3)。6月末にはカゲロウ目幼虫の出現重量が減少し、ハエ目幼虫が消化管内容物の約70%を占めた。同時に消化管内容物の総量も5月末の約30%にまで減少した(Fig. 3)。7月末になるとハエ目幼虫もほとんど出現しなくなり、消化管内容物は5月末の10%以下となった。8月末以降、消化管内容物にヨコエビ類や魚類が出現するようになり、内容物の総量は徐々に増加した(Fig. 3)。

カンキョウカジカの全長分布は、4月末は全長5~6cmにモードを持つ群と全長11cm以上の大型群に分離していた(Fig. 2)。全長5~6cmにモードを持つ群は調査期間を通じて追跡できるが、全長11cm以上の群は5月末以降、各月0~5個体が確認されるだけとなった(Fig. 2)。北海道におけるカンキョウカジカの産卵期は4~5月とされ(後藤, 1989)、産卵期になると中流域で生活していた個体も下流域へと移動して繁殖

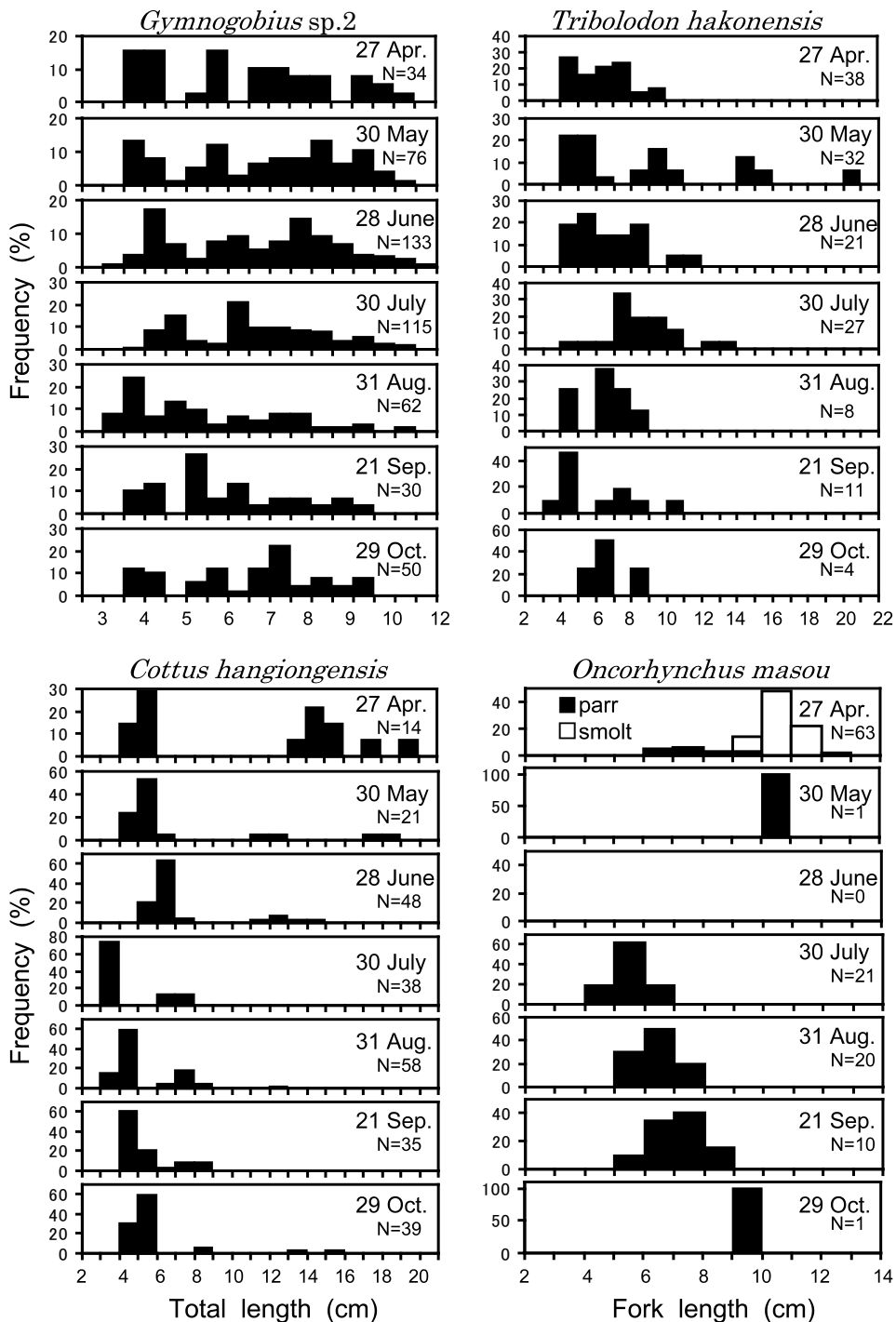


Fig. 2 Body length frequencies in monthly collections of *Gymnogobius* sp.2, *Cottus hangiongensis*, *Tribolodon hakonensis* and *Oncorhynchus masou* from the Gokibiru River in 2001.

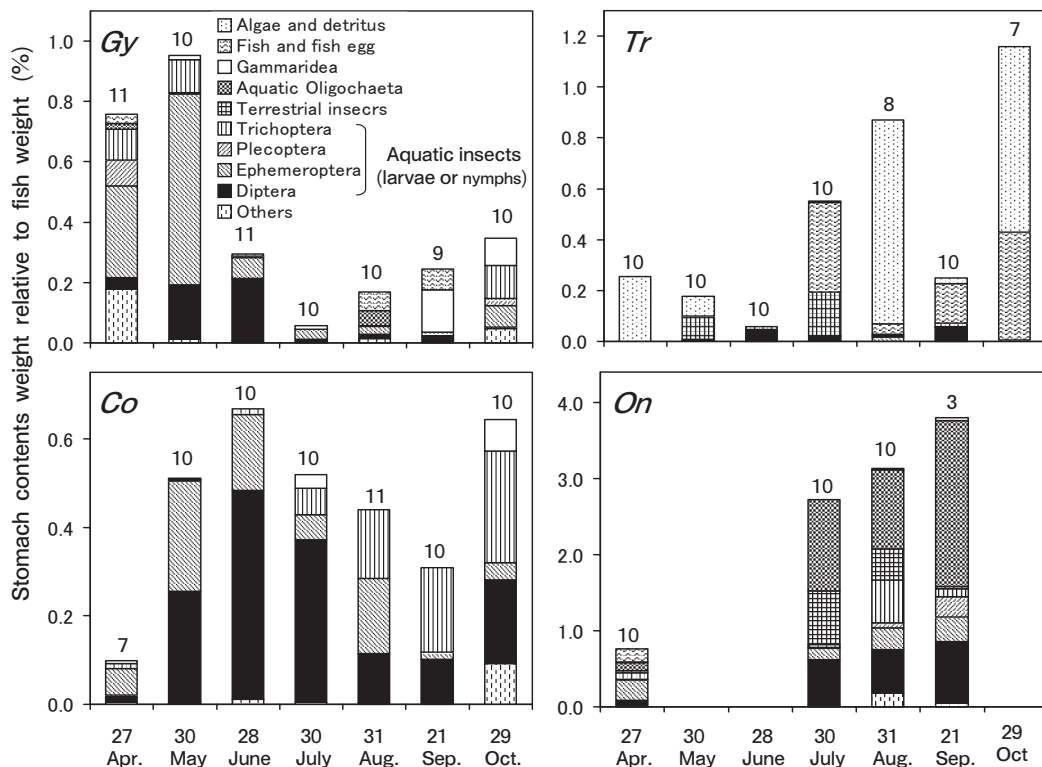


Fig. 3 Dietary composition in stomach contents of *Gymnogobius* sp. 2 (*Gy*), *Cottus hangiongensis* (*Co*), *Tribolodon hakonensis* (*Tr*) and *Oncorhynchus masou* (*On*) from the Gokibiru River in 2001. Figures on the columns are sample size.

に参加する (Goto, 1987)。本調査でも、4月末に採集した全長11cm以上の個体のうちの3個体の生殖腺を観察し、産卵直前の卵を持つことを確認した。これらのことから、本調査で4月末に確認された大型群は繁殖のために中流域から下流域へと移動してきた成熟個体であると推測される。カンキョウカジカの両側回遊型の生活史を示し、孵化した仔魚は直ちに降海して、約1か月の海洋生活の後に河川に遡上する (後藤, 1989)。本調査では7月末に全長3~4cmのモードが出現し、これらが河川遡上した当歳魚であると推定される。本種は濃昼川中流にも分布することから (下田ら, 2004)、河川遡上後は中・下流域に広く分散すると考えられる。カンキョウカジカの消化管内容物の総量は4月末に最少、6月末に最多となり、両者の差は約7倍であった (Fig. 3)。7月末以降、消化管内容物の総量は減少したが、10月末には再び増加した (Fig. 3)。消化管内容物組成は、7月末まではカゲロウ目幼虫とハエ目幼虫が総量の80%以上を占めたのに対し、8月

末以降はこれらに加えてトビケラ目幼虫の出現量が多くなった (Fig. 3)。カンキョウカジカの消化管内容物組成は水生昆虫が主である点でシマウキゴリと共通するものの目レベルの組成が異なり、両種間のC_i指数は最高でも6月末の0.370であった (Table 2)。

ウグイは5月末に尾叉長14cm以上の大型個体が確認された (Fig. 2)。これらは婚姻色を呈していたことから、繁殖個体であると判断できた。北海道のウグイは遡河回遊型の生活史を示し (後藤・中野, 1993)、この生活型のウグイは、孵化後1年から数年を河川で生活してから降海し、1年から数年の海洋生活の後、繁殖のため河川に遡上する (酒井, 1989)。濃昼川においては中流域で繁殖することから (下田, 未発表)、5月末に下流域で採捕された繁殖個体は、海洋から繁殖域へと遡上する途上であったと考えられる。ウグイの尾叉長分布は8月末になると4~5cmにモードが出現し (Fig. 2)、当歳魚が中流域にある繁殖場から下流域へと分散してきたことが確認された。調査期間を

Table 2 C_i index (Morisita, 1959) of stomach contents between fish species.

	<i>C. hangiongensis</i>	<i>T. hakonensis</i>	<i>O. masou</i>
27 Apr.			
	<i>G. sp.2</i> 0.127	0.000	0.051
	<i>C. hangiongensis</i>	0.000	0.107
	<i>T. hakonensis</i>		0.000
30 May			
	<i>G. sp.2</i> 0.066	0.004	
	<i>C. hangiongensis</i>	0.014	
28 June			
	<i>G. sp.2</i> 0.370	0.250	
	<i>C. hangiongensis</i>	0.191	
30 July			
	<i>G. sp.2</i> 0.179	0.005	0.172
	<i>C. hangiongensis</i>	0.014	0.234
	<i>T. hakonensis</i>		0.114
31 Aug.			
	<i>G. sp.2</i> 0.064	0.014	0.272
	<i>C. hangiongensis</i>	0.006	0.218
	<i>T. hakonensis</i>		0.003
21 Sep.			
	<i>G. sp.2</i> 0.029	0.164	0.045
	<i>C. hangiongensis</i>	0.062	0.130
	<i>T. hakonensis</i>		0.071
29 Oct.			
	<i>G. sp.2</i> 0.101	0.000	
	<i>C. hangiongensis</i>	0.000	

通じて4~10cmの個体が常に採集されたことから、下流域はウグイにとって幼・稚魚期の生活の場であると考えられる。ウグイの消化管内容物組成は4月末、8月末および10月末に藻類とデトリタスの出現量が多く、7月末および9月末は魚類とその卵の比率が高かった (Fig. 3)。これらの餌料は他の3魚種の消化管からはほとんど出現しないものであり、ウグイと他種間での C_i 指数は0または非常に低い値を示した (Table 2)。

サクラマス尾叉長分布によると、4月末はスマルト (smolt, 降海期の個体) が主体であった (Fig. 2)。これらのスマルトのうち10個体を抽出し年齢を査定したところ、いずれも1⁺であった。濃昼川のサクラマス幼魚は中・上流域に多く分布することから (下田ら, 2004)、これらのスマルトは降海するために中・上流域から移動してきたものと考えられる。7月末になる

と尾叉長4~7cmの当歳魚が加入したが、これらは10月末にはほとんど確認されなくなった。したがって、サクラマスは幼魚期の夏季、および河川と海洋とを行き来する際に通過する以外、下流域を生活の場としないものと推測される。ただし、北海道南部の河川では翌春降海するサクラマスの幼魚が下流域で越冬することが確認されており (小林, 私信)、今回調査対象としなかった11月末から3月末の冬期間に、こうした個体が下流期に分布していた可能性もある。サクラマスの消化管内容物の総量は4月末には魚体重の1%以下であったが、7月末以降顕著に増加し8月末には魚体重の3%に達した (Fig. 3)。消化管内容物組成は主に水生ミミズ類、陸生昆虫、ハエ目幼虫およびカゲロウ目幼虫であった (Fig. 3)。ハエ目幼虫やカゲロウ目幼虫が含まれる点ではシマウキゴリやカンキョウカジカと、

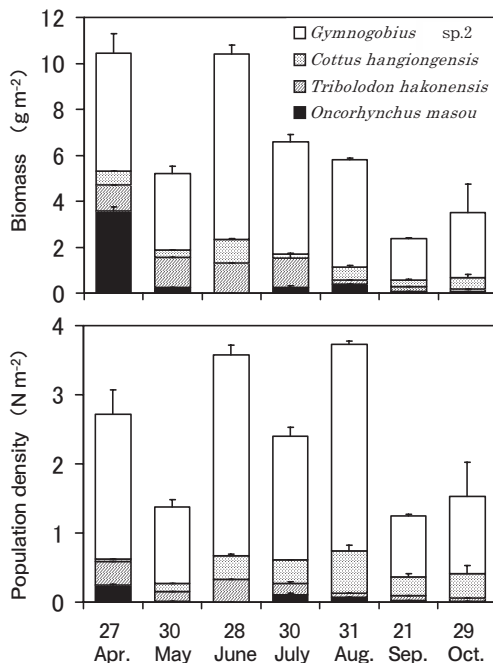


Fig. 4 Biomass and population density of *Gymnogobius* sp. 2, *Cottus hangiongensis*, *Tribolodon hakonensis* and *Oncorhynchus masou* in the Gokibiru River in 2001. Error bars indicate 95% confidence intervals.

陸生昆虫が含まれる点ではウグイと組成が重複したが (Fig. 3), C_s 指数は最高でも8月末のシマウキゴリとの間の0.272に止まり (Table 2), 種間の類似性は低かった。

魚類群集の月変化

下流域における魚種別の現存量と生息密度の月変化を Fig.4に示した。

4月末の魚類群集の特徴は、サクラマスが現存量の40%を占め、魚類群集全体の現存量が調査期間中で最大となったことである (Fig. 4)。これは中・上流域で生活していたサクラマスの幼魚が降海する途中、下流域の魚類群集に加入したためと考えられる。5月末になるとサクラマスはほとんど見られなくなり、魚類群集全体の現存量は4月末の約半分に減少した (Fig. 4)。5月末の魚類群集はシマウキゴリとウグイが現存量と個体数の90%以上を占めた。

6月末にはシマウキゴリの現存量と個体数が前月の約2倍に増加し、魚類群集全体の現存量と個体数も同様に増加した (Fig. 4)。一方、7月末になるとシマウキゴリは現存量、個体数ともに6月末の約60%に減少

した (Fig. 4)。シマウキゴリが増減する原因として、6月末は繁殖に伴い中流域で生活していた成熟個体が下流域へと移動してきたのに対し、繁殖期の終了に伴いこれらが7月末までに移出または死亡したことが考えられる。

8月末になるとシマウキゴリの個体数が7月末と比べ個体数で約40%増加した (Fig. 4)。8月末はカンキョウカジカの個体数も多く、魚類群集全体の約20%を占めた (Fig. 4)。体長分布 (Fig. 2) から、増加分の多くは海洋から遡上した稚魚であると考えられる。ただし、これらの稚魚は体サイズが小さいため、現存量の増加には繋がらず、さらに、7月末まで現存量の10~20%を占めたウグイが減少したことから、魚類群集全体の現存量は前月よりも約10%減少した (Fig. 4)。

9月末以降、シマウキゴリおよびカンキョウカジカの個体数および現存量は8月末の40%以下に減少し、魚類群集全体の個体数および現存量も調査期間中で最低となった (Fig. 4)。両種は中流域にも分布することから (下田ら, 2004), 8月末までに河川遡上した稚魚が中流域に分散したことで下流域の生息数が減少したものと考えられる。また一般に、魚類は仔・稚魚期

の死亡率が高いことから、初期減耗も関係しているかもしれない。

以上の結果および考察から、通し回遊魚によって構成される濃昼川下流域の魚類群集は、月単位の短い期間で変動する極めて動的な群集であると特徴づけられる。魚類群集の規模と構成員は、現存量の50~80%、生息数の70~80%を占めるシマウキゴリの移出入を中心に变化し、これにサクラマスのスモルトの通過や、カンキョウカジカ稚魚の河川遡上、ウグイの増減などが加わって、群集全体の現存量と個体数は最大で約3~4倍の変動幅を示した (Fig. 4)。各魚種の消化管内容物には月変化が認められると同時に、魚種間における C_p 指数は常に低い値を示すことから、それぞれの魚種の食性は固有の季節性を持つものと考えられる。近年の研究によると、生態系間での生物や物質の移出入は生物群集の動態に大きな影響を及ぼすことが明らかにされている (例えば, Nakano et al, 1999; Nakano and Murakami, 2001)。本研究の結果は、北海道の河川下流域の生物群集の構造や捕食関係が、通し回遊魚の移出入の影響を受けて短期間に大きく変化していることを示唆し、群集生態学の重要な研究対象になるものと考えられる。

要 約

1. 通し回遊魚から構成される魚類群集の動態を知るために、北海道石狩北部の濃昼川下流域でシマウキゴリ、カンキョウカジカ、ウグイおよびサクラマスの現存量、個体数密度および消化管内容物の月変化を調べた。
2. 現存量および個体数ともにシマウキゴリが最も高かった。下流域魚類群集の月変化は本種の河川-海洋間移動や河川内移動を中心に变化し、これにサクラマスのスモルトの通過や、カンキョウカジカ稚魚の河川遡上、ウグイの増減などが加わって、群集全体の現存量と個体数は最大で約3~4倍の変動幅を示した。
3. 各魚種の消化管内容物組成には月変化が認められた。魚体重量当たりの消化管内容物総量は最大で10倍の変動幅を示した。消化管内容物組成の魚種間における類似性を示す C_p 指数の値はすべての魚種の組み合わせで常に低く、各魚種は固有の食性を持つこ

とが示された。

4. これらの結果から、通し回遊魚から構成される北海道の河川下流域魚類群集は月単位の短い期間で変動する極めて動的な群集であると考えられた。

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炭素窒素同位体判別法により推定した北海道への移入種 オオクチバスの食性変移

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Transformation of an Ecological Niche of a Nonnative Black Bass, *Micropterus salmoides* Found in Some Aquatic Systems in Hokkaido, as Studied by $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$

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Abstract

The ecological niche of a carnivorous black bass, *Micropterus salmoides*, was studied by stable carbon and nitrogen isotope analyses. The black bass could have been introduced very recently in Hokkaido, northern Japan, because it had not been found until recently. The carbon and nitrogen isotopic discrimination on feeding process were estimated by laboratory culture of *M. salmoides* using a monotonous diet. The isotopic enrichment factors between diet and fish muscles were estimated to be 2 and 4.5 for carbon and nitrogen respectively. When the isotope composition of diets was changed from the initial condition in the beginning of the culture, ^{13}C and ^{15}N of muscles were gradually shifted adapting to the new diet during six months. The turnover time of carbon and nitrogen in the fish muscle were observed to be 1.5, 0.5 and 0.1 month⁻¹ for carbon and 0.9, 0.7 and 0.2 month⁻¹ for nitrogen in each two months during the six months culture, respectively. Based on these experimental results and comparison with the isotope composition of aquatic organisms from the same ecosystem, we estimated the elapsed time after introduction of *M. salmoides* which were caught in two local aquatic environments. Seven specimens of *M. salmoides* collected from Yoichi Dam, Yoichi-cho, in 2002, might be released to the dam in a few months. On the other hand, *M. salmoides* collected from Nanporo Pond, Nanporo-cho, 2002-2004, was separated into two groups; one which might have been released a few months earlier and the other which might be released more than a half year before.

キーワード: オオクチバス, 生態的地位, 食性, 安定同位体比, 濃縮係数, ターンオーバータイム

Key words: *Micropterus salmoides*, niche, Stomach content, Stable isotope ratio, enrichment factor, turn over time.

北アメリカ原産の肉食魚, オオクチバス属魚類(通称ブラックバス)の日本での歴史は約80年前に始まった。オオクチバス *Micropterus salmoides* は1925年に神奈川県芦ノ湖へ導入されて以来, 1980年代までに沖縄と北海道を除く全国に広がった(中井, 2002)。

1925年に芦ノ湖への導入に失敗したコクチバス *M. dolomieu* も, 1990年代になって福島県や長野県の比較的寒冷な湖沼で確認されたのを皮切りに, 生息確認水域が増え続けている(中井, 2002)。北海道では, 2001年森町の大沼国定公園内の円沼(Fig. 1, ○印)

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で初めてオオクチバスとコクチバスの生息が確認された(工藤, 2002)。本州各地ではオオクチバス属魚類による漁業被害が顕在化していることから、北海道庁は2001年10月、北海道内水面漁業調整規則の一部改正を行い、オオクチバス属魚類とブルーギルの移植放流を禁止した。しかし、2002-2004年にも、余市町余市ダム (Fig. 1) と南幌町親水公園の池 (Fig. 1) でオオクチバスが新たに確認された (工藤, 2003)。現在までに円沼と余市ダムでは自治体によりほぼ完全な駆除がなされたが、南幌親水公園では今もお調査のつど、ほとんど毎回、オオクチバスが捕獲される状態であり、今後も違法な密放流による生息域の広がりとその生態系への影響が懸念される。

本研究は、余市ダムと南幌町親水公園において捕獲したオオクチバスの食性を調べ、オオクチバスおよび生息魚介類の炭素および窒素安定同位体比を分析して、当該水域におけるオオクチバスの履歴および生態的地位を推定することを目的とした。また、その解析に用いるため、室内飼育実験によりオオクチバスの同位体濃縮係数とターンオーバータイムを測定した。

方 法

1. オオクチバスの食性

余市ダムと南幌親水公園において刺し網でオオクチバスを捕獲し、その胃内容物を調べた。捕獲年月日は余市ダムにおいては2002年9月2日-3日、南幌親水公園池においては2002年9月15-19日および2003年6月29日-10月19日である。胃内容物の重量を1mg 単位で分類群毎に測定し、これを魚体重で除して単位魚体重当たりの胃内容物重量に換算した。オオクチバスのサンプルは当歳 (体重15g 以下) の群と2歳以上 (体重700g 以上) の群に分け、それぞれの群について胃内容物重量の平均値と標準誤差を求めた。

2. 飼育実験による濃縮係数とターンオーバータイムの測定

実験に用いたオオクチバスは、2002年7月にブラックバス養殖業者から入手した。入手時の平均体重は約4gであった。オオクチバスには人工飼料 (テトラアロワナ, ドイツテロラベルケ社; 主原料: エビ, カニ, オートミール, フイッシュミール, イースト, 海藻他) を与えて, FRP 飼育槽 (60cm×40cm×深さ50cm)

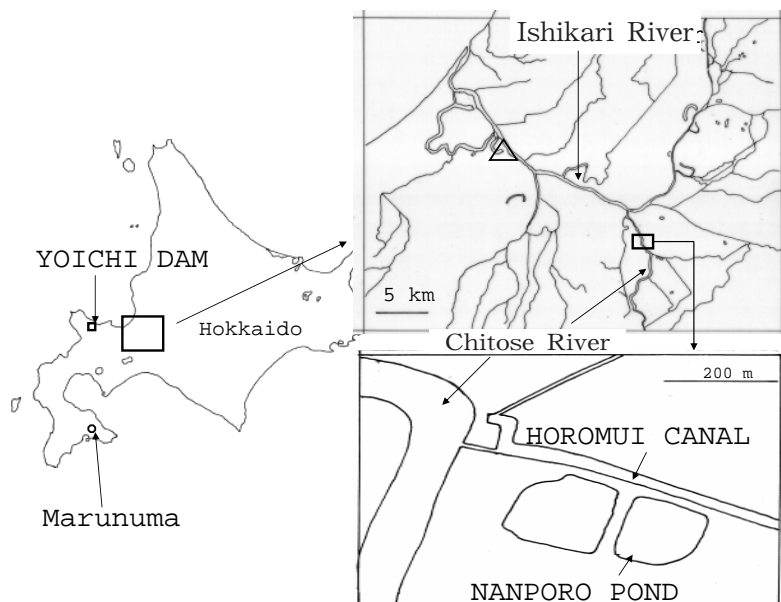


Fig. 1 Map of the study station. Open arrows indicate flow direction.

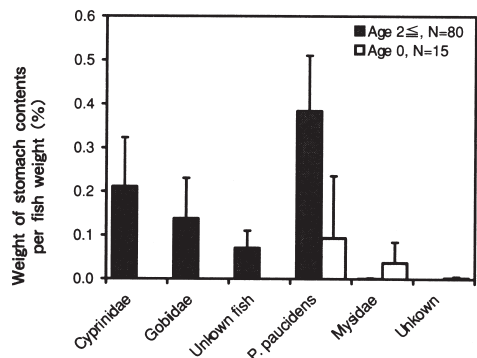


Fig. 2 Dietary composition of stomach contents of *M. salmoides* from Nanporo Pond. Each hinge bar shows range of standard error.

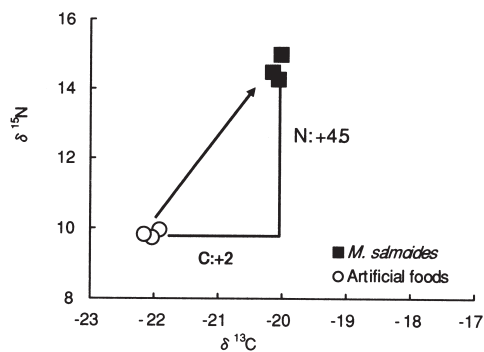


Fig. 3. The isotopic enrichment of carbon and nitrogen associated with feeding process obtained by laboratory culture experiments of *M. salmoides*.

で飼育した。水槽の水深は40cmとし、毎分約600mlの水をかけ流し、エアレーションを十分に行なった。実験室に配管されている約8°Cの湧水をヒーターで加温した。その結果、水温は8-10月には15.5-17°C、12-2月には14°Cに保たれた (Fig. 4A)。

購入から約1年後の2003年8月に、摂餌による濃縮係数の測定のため、オオクチバス (平均体重24g) を冷凍して死亡させ、人工飼料と合わせて安定同位体比を測定した。

ターンオーバー実験は、2003年8月末に供試魚数約50個体で開始し、餌として石狩古川 (Fig. 1, △印) で漁業者が捕獲した体重1.5-2.5 gのスジエビ *Palaemon paucidens* を毎日20-30尾与え、翌年2月末まで6ヶ月間飼育した。分析に用いたオオクチバスの平均体重は実験開始時には約35 g、終了時には約95

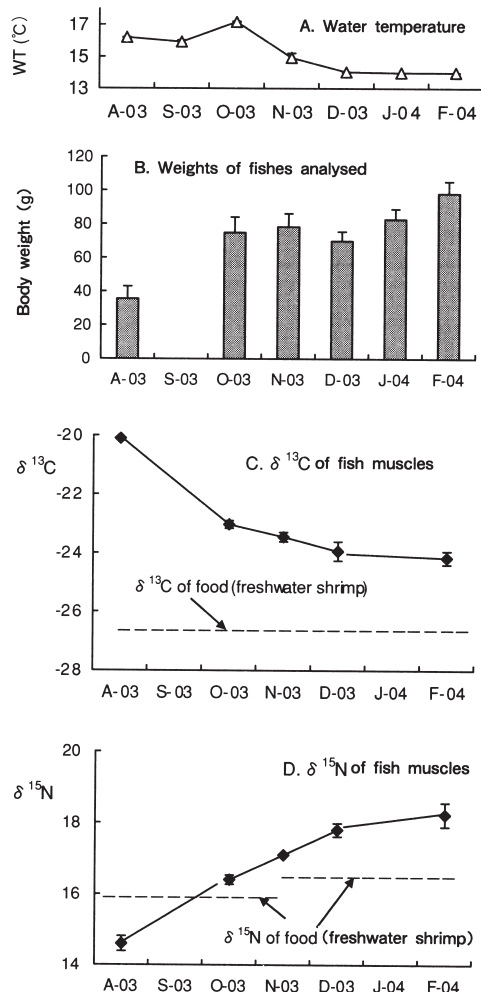


Fig. 4. Time course of culture experiment of *M. salmoides*; (A): water temperature, (B): body weights of fishes, (C): $\delta^{13}\text{C}$ of fish muscles, and (D): $\delta^{15}\text{N}$ of fish muscles. The mean and the standard error of each data are shown for each point.

gであった (Fig. 4B)。オオクチバスとスジエビはほぼ1か月おきにサンプリングし、分析するまで冷凍庫に保存した。

なお、自然界へのオオクチバスの流出を防ぐため、飼育排水は活性汚泥の浄化槽を通して河川に放流した。

3. 余市ダムと南幌親水公園におけるオオクチバスの採捕と生息魚介類

余市ダム (Fig. 1; 43° 9' 16'' N, 140° 40' 57'' E) は、余市町ヌッチ川の最上流に位置する灌漑用ダムで、

平水時の湛水面積0.08 km²である。2002年8月にオオクチバス稚魚が確認された。その後同年10月までの間に捕獲したオオクチバス（体重6–360g），その胃内で確認されたスズエビ，および餌となる可能性のあるニジマス *Oncorhynchus mykiss*，アメマス *Salvelinus leucomaenis*，ハナカジカ *Cottus nozawae*，フナ *Carassius* sp. の安定同位体比を測定した。

南幌親水公園池（Fig. 1; 43° 4' 17'' N, 141° 35' 43'' E）は，石狩川水系千歳川下流部の河跡湖を利用して作られた溜池で，面積0.079 km²である。2002年9月に4尾のオオクチバスが初確認され，2003年6–9月にも95尾のオオクチバスが捕獲された。ここでは，オオクチバスの胃で確認されたスズエビ，コイ科魚類（フナ，タイリクバラタナゴ *Rhodes ocellatus ocellatus*，モツゴ *Psuedorabora parva*，ウグイ属の1種 *Tribolden* sp.），ハゼ科魚類（ジュズカケハゼ *Rhodoniichthys laevis*，ウキゴリ属の1種 *Chaenogobius* sp.），および池に多数生息しているイシカリワカサギ *Hypomesus olidus* を採集し，安定同位体比を測定した。

4. 同位体サンプルの前処理と分析

オオクチバスおよび他の魚類は冷凍庫から取り出して，体長と体重を測定した後，背びれに近い体側筋を約1cm³切り取った。筋肉は50°Cで24時間乾燥した後，乳鉢で粉碎し，メタノールとクロロホルムを用いて Folch 法で脱脂した。脱脂後はろ紙（ワットマン，GF/F）でろ過して溶剤を除き，室温で24時間乾燥した。人工飼料は冷凍庫から取り出した後，魚肉と同様に処理した。スズエビは冷凍庫から取り出して，湿重量を測定したあと，キチン質を除去し，魚肉と同様に処理したが，脱脂は行なわなかった。スズエビと人工飼料は，粉碎時に2–3個体を混合して1サンプルとした。胃に入っていたスズエビについてはキチン質を除去せずに丸ごとと粉碎し，1個体を1サンプルとした。なお，2004年5月19日に石狩古川で捕獲したスズエビについて，キチン質つきの場合とキチン質を除いた場合の分析値を比較したところ， $\delta^{15}\text{N}$ では有意差は認められなかったが， $\delta^{13}\text{C}$ ではキチン質を含む場合が約1%低かった（N=3，t検定）。

安定同位体比の測定には元素分析計（EA1110，

Thermo Electron 社）と質量分析計（Delta plus Advantage, Thermo Electron 社）を直結したガス化導入装置を用いた。安定同位体比は，標準物質に対する千分偏差として次式によって示した。

$$\delta^{13}\text{C} \text{ or } \delta^{15}\text{N} = [(R \text{ sample}/R \text{ standard}) - 1] \times 1000$$

ここで，Rは¹³C/¹²Cまたは¹⁵N/¹⁴Nを示し，標準物質は炭素ではPDB，窒素では大気中の窒素とした。

分析した魚介類の採集場所，採集日，体長，体重を，Appendix 1 に示した。

結果および考察

オオクチバスの食性

南幌親水公園池で捕獲したオオクチバスの魚体重量当たりの胃内容物重量を Fig. 2 に示した。各年齢群ともスズエビの出現重量が最も高かった。これに次いで年齢2歳以上の群ではコイ科魚類とハゼ科魚類の出現重量が高く，年齢0歳の群では甲殻類のアミ科が高かった。なお，2歳以上群の2個体の胃中からはごく少量（魚体重の0.006%以下）の水生昆虫（ユスリカ科オオユスリカ種群幼虫）が見つかったが，これについては Fig. 2 に示していない。余市ダムで捕獲したオオクチバスのうち，胃内容物の分析に用いた個体はすべて年齢0歳の群に含まれた。これらの胃中からはスズエビのみが確認され，その量は平均で魚体重の0.313%（標準誤差 0.449；N=10）に相当した。

北海道におけるオオクチバス属の食性は，工藤（2002）が北海道南部の沼で捕獲されたコクチバスの胃中からスズエビを確認したものが唯一の報告であり，今回の調査結果が2例目となる。一方，本州各地においては数多くの報告があり，例えば，淀（2002）は三重県の青蓮寺湖においては，ハゼ科のヨシノボリ *Rhinogobius* sp. とエビ類が多く食べられていると報告している。また，東（2002）は長崎県の川原大池においては，ハゼ科のチチブ *Tridentiger obscurus* とゴクラクハゼ *Rhinogobius giurinus* が主食であると報告している。さらに，オオクチバスは小型のコイ科魚類やその幼魚を捕食することや（例えば，高橋，2002），昆虫類を捕食した例（苅部，2002）も報告されている。今回の調査結果によると，南幌親水公園池と余市ダムのオオクチバスの胃内容物組成は，これらの報告例と一致し，北海道においても本州と同様の食

性を示すものと考えられる。オオクチバス属による捕食は在来の生物群集に大きな影響を及ぼし、例えば、滋賀県の琵琶湖をはじめ京都市深泥池や宮城県伊豆沼ではオオクチバスの増加に伴って魚類群集が劇的に変化したとされている（中井，2002）。北海道の淡水域には13種のハゼ科魚類と5種のコイ科が自然分布する（後藤・中野，1993）。また、スジエビは北海道の淡水域に広く分布する（稗田，1984）。北海道においてオオクチバスの分布域が拡大した場合、これらの魚類や甲殻類を捕食することによって、淡水生物群集に重大な影響を与える可能性がある。

濃縮係数とターンオーバータイム

2年間人工餌で飼育したオオクチバスおよび人工餌料の安定同位体比を Fig. 3 に示した。バスの同位体比は $\delta^{13}\text{C}$ 約 -19% 、 $\delta^{15}\text{N}$ 約 15% であり、人工餌料に比べ C で約 2% 、N で約 4.5% 高い値を示した。これがオオクチバスの濃縮係数と考えられる。一般に水生動物の濃縮係数は、C でおよそ $1.5-2.0$ 、N でおよそ $3-4$ とされている（Fry, 1988; Hesslein et al., 1993; 南川, 1997）。また、著者の一人・下田は、北海道の溪流に生息するサクラマス稚魚について、炭素 2.0% 、窒素 4.3% という濃縮係数を算出している（下田ら，投稿中）。バスについては著者らの知る限り、濃縮係数の研究例はない。

飼育実験におけるバス体側筋の同位体比の変化を、スジエビの同位体比とともに、Fig. 4 に示した。炭素安定同位体比、窒素安定同位体比ともに、個体による差はわずかであり、オオクチバスによるスジエビの摂食は順調であったことがうかがえる。

平均炭素安定同位体比は、実験当初は -20.1% であったが、2ヵ月後には -23.0% 、4ヵ月後には -23.9% 、6ヵ月後には約 -24.2% と推移した（Fig. 4C）。ターンオーバー率は、最初の2ヶ月には $1.5 \cdot \text{月}^{-1}$ 、次の2ヶ月は $0.5 \cdot \text{月}^{-1}$ 、その次の2ヶ月は $0.1 \cdot \text{月}^{-1}$ であり、4ヵ月以後は $\delta^{13}\text{C}$ の変化は小さかった。従って、 $\delta^{13}\text{C}$ は飼育開始後6ヵ月でほぼ平衡状態に達したとみることができる。

窒素安定同位体比は、実験開始時には 14.5% であり、2ヵ月後には約 16.5% 、その2ヵ月後には 17.8% 、更にその2ヵ月後には 18.2% と推移した（Fig. 3D）。ターンオーバー率は、最初の2ヶ月には $0.9 \cdot \text{月}^{-1}$ 、次

の2ヵ月は $0.7 \cdot \text{月}^{-1}$ 、その次の2ヵ月は $0.2 \cdot \text{月}^{-1}$ であり、 $\delta^{15}\text{C}$ の場合と同様に、最初の変化が急で、徐々に緩やかになる傾向がみられた。しかし、 $\delta^{15}\text{N}$ の濃縮係数は約 4.5 であるので（Fig. 3）、最終的な $\delta^{15}\text{N}$ 値は19前後になるものと考えられる。従って、バス筋肉の窒素安定同位体比が平衡状態に達するまでには、ターンオーバー率が今後低下しないとしても、この条件下では今後約4ヵ月かかると考えられる。

実験の後半にターンオーバー率が低下する理由として、通常考えられるのは魚体の大型化であり、本実験においてもその可能性が高い（Fig. 4B）。しかし、後半には水温の低下もみられたので（Fig. 4A）、低温のために代謝が不活発になったことも一因となっている可能性がある。

余市ダムにおけるオオクチバスの生態的地位

余市ダムにおけるオオクチバスと生息魚介類の安定同位体比を Fig. 5 に示した。バスの分析値は主に炭素安定同位体比の相違により、大きく3つのグループ、2002年7月と10月に採集された $\delta^{13}\text{C}$ の $-27-28.5\%$ のものと -30% 近いもの、2002年9月に採集された $-25.5-26.0\%$ のもの、に分かれた。それらの窒素安定同位体比は $8.2-9.5\%$ の範囲にあり、明瞭な不連続はみられなかった。余市ダムに生息していてオオクチバスに食われる可能性のあるニジマス、アメマス、ハナカジカ、フナ、スジエビの炭素安定同位体比は $-23.7-28\%$ 、窒素安定同位体比は $5.3-7.5\%$ の範囲にあった。

前項で求めた濃縮係数に基づき、3つのグループのそれぞれの分析値から、炭素でマイナス2、窒素でマイナス4.5の方向へ矢印をたどると、炭素安定同位体比は $-28-32\%$ 、窒素安定同位体比は $4-5\%$ の範囲になり、生息している魚介類、特に胃内に確認されたスジエビの安定同位体比（Fig. 5, ○印）と大きく異なる。従って、余市ダムで採集されたオオクチバスは、この水域の魚介類を食べて成長したとは考えにくく、比較的最近ダムに違法放流された可能性が高い。また、 $\delta^{13}\text{C}$ のターンオーバータイムは、体重 100g のオオクチバスで約6ヵ月である（Fig. 4）ので、2002年余市ダムで採捕されたオオクチバスのうち、少なくとも体重 10g 以下の小型の個体（Appendix 1）は、放流されてから6ヵ月は経過していないものと推定される。

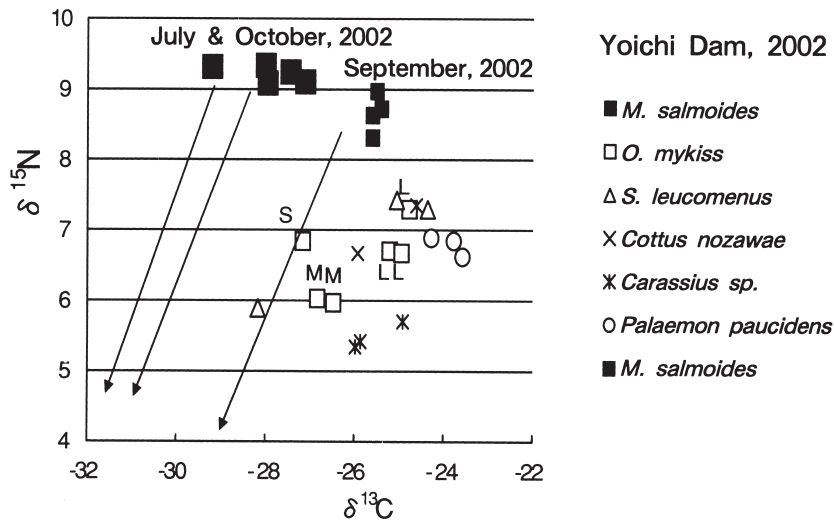


Fig. 5. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of *M. salmoides*, other fishes and shrimp collected from Yoichi Dam in 2002. Arrows show $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of estimated natural diets for *M. salmoides* based on the enrichment factor obtained by the culture experiment. L, M and S of *O. mykiss*: see Appendix 1.

南幌親水公園池とその周辺におけるオオクチバスの生態的地位

2002—2003年の事例. 2002—2003年に南幌親水公園で採集したオオクチバスと生息魚介類の安定同位体比を Fig. 6A に示した。公園の池に生息するフナ、タイクバラタナゴ、イシカリワカサギ、ジュズカケハゼ、ウキゴリ属の1種、モツゴ、ウグイ属の1種、スジエビの安定同位体比は、窒素で7—14.5 ‰、炭素で-22—-29 ‰の範囲にあった。

バスは、主に炭素安定同位体比により体重約100gのもの、体重500—700gのものとの2つのグループに分かれ、それぞれ-24 ‰、-26.5—-27.5 ‰を示した。窒素安定同位体比は全個体が約14‰であった。

体重500—700gのオオクチバスについて、炭素で2、窒素で4.5の濃縮係数を逆にたどると、餌の炭素安定同位体比は-26 ‰と-28.5—-29.5 ‰、窒素安定同位体比は10 ‰前後と推定された。この餌の推定値は親水池に生息する魚介類の値に囲まれており、体重500—700gのオオクチバスはこれらの魚介類を混合して食べて成長したと考えられる。飼育実験によると、成長に伴ってターンオーバー率が低下したことから、体重500—700gのバスは、長期間この池に生息していた可能性が高い。

一方、体重約100gのオオクチバスについてみると、

その食べてきた餌の炭素安定同位体比は-29.5 ‰前後、窒素安定同位体比は10 ‰程度と推定される。2003—2004年の採集ではそのような値を示す魚介類は確認されていないことから、体重約100gのオオクチバスは、この池に生息している魚介類とは別の餌を長い間食べていたものが、比較的最近この水域に放流されたものと考えられる。また、放流された時期は、余市ダムの小型の個体と同様の根拠により、採捕された時点から6ヵ月以内と推定される。

2004年5月1日の事例. 2004年5月1日に、南幌親水公園の池と増水時につながる幌向運河 (Fig. 1) で採集されたオオクチバス (体重693g) とその胃内容物の安定同位体比を Fig. 6B に示した。バスの安定同位体比は、炭素-24 ‰、窒素14 ‰であり、Fig. 6A の体重500—700gのグループとほとんど同じであった。また、胃に入っていたスジエビ3個体と魚 (体色と体サイズからモツゴと推定されたが、消化が進んでいて種名を確定できなかった) の安定同位体比は、濃縮係数から推定した餌の安定同位体比、炭素-26 ‰、窒素9.5 ‰の周辺の値を示した。このことから、このオオクチバスは、南幌親水公園で2003年に採集された体重500-700gのオオクチバスと同じ起源のものであり、比較的長い間この水域に生息していたものと推定された。このことは、南幌親水公園付近でオオクチバスが

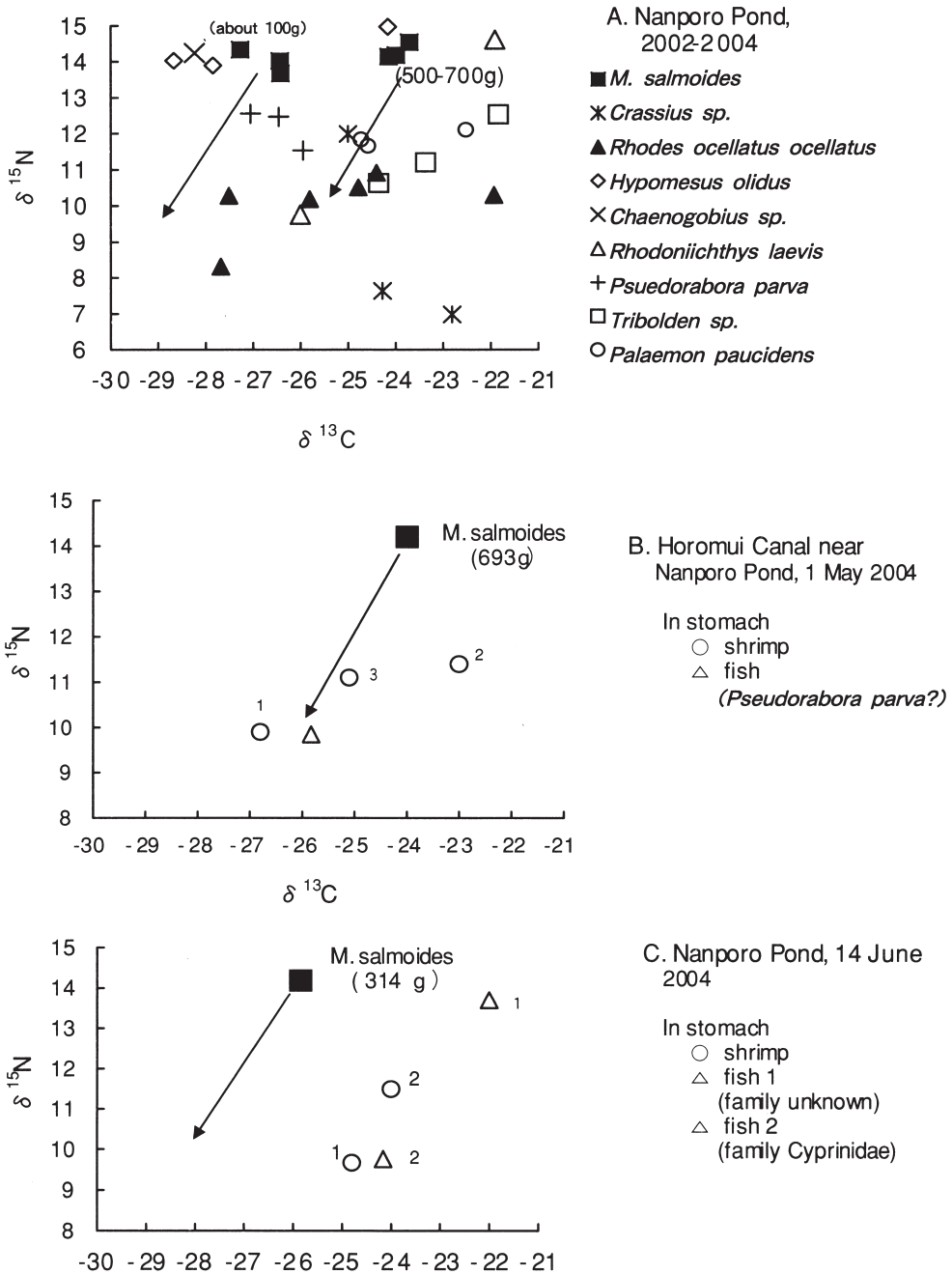


Fig. 6. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of *M. salmoides*, other fishes and shrimp collected from A: Nanporo Pond in 2003-2004, B: $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of *M. salmoides* and its stomach contents collected from Horomui Canal near Nanporo Pond on May 1, 2004, and C: $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of *M. salmoides* and its stomach contents collected from Nanporo Pond on June 14, 2004. The numbers shown in parentheses are the body weights for *M. salmoides*. The arrows show $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of estimated natural diets for *M. salmoides* based on the enrichment factor obtained by the culture experiment. The small figures in B and C: see Appendix 1.

Appendix 1. Collecting data of aquatic animals shown in Figs. 3-6

Fig	Scientific name	size *	和名	Locality	Date	Body Weight g	Body length cm**	Remarks
3	<i>Micropterus salmoides</i>		オオクチバス	Laboratory	12 Aug. 2003	23.1		
	"		"	"	"	24.4		
	"		"	"	"	23.7		
4	<i>Micropterus salmoides</i>		オオクチバス	Laboratory	12 Aug. 2003	35.6±7.3		mean ± SE
	"		"	"	31 Oct. 2003	74.8±9.2		
	"		"	"	30 Nov. 2003	78.3±7.9		
	"		"	"	31 Dec. 2003	69.9±5.5		
	"		"	"	31 Jan. 2004	82.8±6.1		
	"		"	"	29 Feb. 2004	98.2±7.0		
5	<i>Micropterus salmoides</i>		オオクチバス	Yoichi Dam	19 July 2002	359.0	26.5	female
	"		"	"	"	368.0	27.6	female
	"		"	"	23 Oct. 2002	9.6	8.9	
	"		"	"	"	7.7	8.5	
	"		"	"	"	6.4	7.9	
	<i>Oncorhynchus mykiss</i>	S	ニジマス S	"	08 Aug. 2002	3.1	6.4	
	"	M	" M	"	"	175.7	23.5	
	"	M	" M	"	"	165.6	23.5	
	"	L	" L	"	"	448.1	30.8	
	"	L	" L	"	"	390.3	31.0	
	"	L	" L	"	"	429.1	32.0	
	<i>Salvelinus leucomaenis</i>		アメマス	"	"	224.3	26.5	
	"		"	"	"	271.6	26.5	
	"		"	"	"	324.7	29.5	
	<i>Cottus nozawae</i>		ハナカジカ	"	"	45.1	13.5	
	"		"	"	"	68.0	16.5	
	<i>Carassius</i> sp.		フナ	"	"	270.4	23.7	
	"		"	"	"	254.8	23.5	
	"		"	"	"	113.1	18.2	
	<i>Palaemon (P.) paucidens</i>		スジエビ	"	"	about 2		
	"		"	"	"	"		
	"		"	"	"	"		
	<i>Micropterus salmoides</i>		オオクチバス	"	02 Sept. 2002		about 10	
"		"	"	"		"		
"		"	"	"		"		
"		"	"	"		"		
6A	<i>Micropterus salmoides</i>		オオクチバス	Nanporo Pond	19 Sept. 2002	489.7	31.8	male
	"		"	"	29 June 2003	694.2	34.7	male
	"		"	"	16 Aug. 2003	940.5	37.5	female
	"		"	"	19 Aug. 2003	about 10		
	"		"	"	"	"		
	"		"	"	"	"		
	<i>Carassius</i> sp.		フナ	"	26 Aug. 2003	70.6		
	"		"	"	"	17.2		
	"		"	"	"	18.3		
	<i>Rhodes ocellatus ocellatus</i>		タイリクバラタナゴ	"	"	2.6		
	"		"	"	"	3.3		
	"		"	"	"	2.5		
	"		"	"	19 May 2004	4.2	6.2	
	"		"	"	"	4.1	6.0	
	"		"	"	"	2.6	5.0	
	<i>Pseudorabara parva</i>		モツゴ	"	26 Aug. 2003	4.0		
	"		"	"	"	3.8		
	"		"	"	"	3.5		
	<i>Tribolden</i> sp.		ウグイ属の1種	"	"	9.4		
	"		"	"	"	8.4		
	"		"	"	"	9.3		
	<i>Hypomesus olidus</i>		イシカリワカサギ	"	19 May 2004	6.0	9.5	
	"		"	"	"	4.8	8.7	
"		"	"	"	7.0	9.3		
<i>Rhodonichthys laevis</i>		ジュズカケハゼ	"	"	2.9	7.1		
"		"	"	"	2.4	6.5		
<i>Chaenogobius</i> sp.		ウキゴリ属の1種	"	"	25.2	12.6		
<i>Palaemon (P.) paucidens</i>		スジエビ	"	26 Aug. 2003	2.6			
"		"	"	"	1.9			
"		"	"	"	1.8			
6B	<i>Micropterus salmoides</i>		オオクチバス	Horomui Canal	01 May 2004	692.3		male
	<i>Pseudorabara parva?</i>		モツゴ?	"	"	2.3		in stomach
	<i>Palaemon (P.) paucidens</i>		スジエビ1	"	"	1.5		"
	"		" 2	"	"	0.9		"
"		" 3	"	"	2.0		"	
6B	<i>Micropterus salmoides</i>		オオクチバス	Nanporo Pond	14 June 2004	314.1		male
	fish 1 (famly unknown)		魚1(科不明)	"	"	0.8		in stomach
	fish 1 (famly unknown)		魚1(科不明)	"	"	0.5		"
	<i>Palaemon (P.) paucidens</i>		スジエビ1	"	"	2.2		"
	"		" 2	"	"	0.9		"

* S: small, M: middle, L:large. ** Total length was shown for *Micropterus salmoides*.

越冬できることを示唆している。

2004年6月14日の事例. 2004年6月14日に、南幌親水公園の池で採集されたオオクチバス（体重314 g）とその胃内容物の安定同位体比を Fig. 6C に示した。オオクチバスの安定同位体比は、炭素-26 ‰、窒素14 ‰であり、2003年に同じ池で採集された2つのグループ (Fig. 6A) のどちらとも、やや異なっていた。濃縮係数から推定したこのオオクチバスの食べてきた餌の安定同位体比は、炭素-28 ‰、窒素9.5 ‰となる。一方、胃に含まれていたスズエビ2個体、魚2個体（内1個体はコイ科）の炭素安定同位体比は-22～-25 ‰の範囲にあり、推定される食餌のそれとは大きく異なっていた。このことから、この日採集されたオオクチバスは、比較的最近この水域に違法放流された可能性が高いと推定される。

要 約

北海道では、2001年に大沼公園内円池でオオクチバスとコクチバスが、2002年に余市町余市ダムでオオクチバスが、2002-2004年に南幌町親水公園池でオオクチバスが、それぞれ捕獲された。余市ダムおよび南幌親水公園におけるオオクチバスの生態的地位と履歴を解明する目的で、オオクチバスの食性を調べると共に、オオクチバスと餌生物の炭素および窒素同位体の分析を行った。また、同位体分析結果の解明のため、オオクチバスの同位体濃縮係数とターンオーバータイムの測定を試みた。その結果、余市ダムのオオクチバスは最近違法放流されたものと推定された。一方、南幌親水公園池では、比較的長い間この水域に生息していた体重500 g 以上のものと最近放流された体重100 g 以下の個体の両者が含まれていると推定され、2004年6月に採集された体重300g 余の個体は新たにごく最近違法放流されたものであると考えられた。

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佐野誠三・久保達郎 (1-12)

2, 櫻鱒の蓄養催熟

五十嵐眞一 (13-18)

3, 鮭孵化行程上に於ける低温の影響に就ての考察

山本喜一郎 (19-34)

4, 北海道に於ける流水養鯉試験

江口 弘 (35-38)

5, 遡河鮭中通称ギンケ鮭に関する調査 (予報1)

佐野誠三 (39-44)

6, 阿寒湖に於けるワカサギの養殖数量に就て

三原健夫 (45-50)

7, 各種河川魚の鮭鱒稚魚食害に就て

久保達郎 (51-55)

第2巻第1号 (1947)

1, 淡水に接した鮭卵受精力減衰の機構に就て

山本喜一郎 (1-11)

2, 千歳養鱒場内内別川水質の季節的变化

江口 弘・原 茂 (12-15)

3, 鱗相より見た鮭の生態 (1)

久保達郎 (16-25)

4, 虹鱒稚魚の斃死率に及ぼすビタミンBの影響

田中道敏 (26-34)

5, 黒頭鰈調査 (1)

山本喜一郎・石田力一 (35-40)

6, 遡河鮭中通称ギンケに関する調査 (2)

佐野誠三 (41-45)

7, 鮭鱒卵数の計算に就いて

末武敏文 (46-50)

8, 北海道各河川遡河鮭の生態調査

佐野誠三・久保達郎 (51-58)

9, 摩周湖に於ける虹鱒の生態に関する研究 (1)

三原健夫 (59-68)

第3巻第1号 (1948)

1, 網走湖の研究特にプランクトン相に就て (1)

元田 茂・石田昭夫 (1-12)

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江口 弘 (13-15)

3, 黒頭鰈の地方的差異に就て

石田力一 (16-22)

4, 鮭脳下垂体による虹鱒の産卵促進に就て

西野一彦 (23-28)

5, 支笏湖に於けるヒメマス生態

大東信一・久保達郎・大久保正一 (29-32)

6, 鮭鱒類の生態並びに養殖孵化に関する文献目録
佐野誠三 (33-34)

第3巻第2号 (1948)

7, 北方産魚類の生態調査
山本喜一郎 (35-55)

8, 網走川に於ける鮭標識放流試験に就て
久保達郎 (56-59)

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佐野誠三 (60-65)

第4巻第1号 (1949)

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元田 茂・石田昭夫 (1-9)

2, 養魚池水質調査 (I)
江口 弘・大久保正一 (10-15)

3, 北方産魚類の生態調査
山本喜一郎 (16-26)

4, 鮭卵受精並びに初期発生に対する溶存酸素不足の影響に就いて
大久保正一 (27-29)

5, 鮭脳下垂体による櫻鱒産卵促進に就いて
石川 博・橋本武三郎・高橋嘉夫 (30-32)

第4巻第2号 (1949)

6, サケ及マスの卵の受精方法に就ての考察
山本喜一郎 (33-46)

7, 網走湖に於けるワカサギの食性に関する研究

石田昭夫 (47-56)

8, 北海道美々川に於けるウグヒの食性
犬飼哲夫 (57-61)

9, 黒頭鱈 (Limanda schrenki Schmidt) 調査報告
第III報
石田力一 (62-72)

10, ニセコ附近の高山池沼について
江口 弘 (73-75)

11, 支笏湖におけるヒメマス of 生態 (1)
大東信一・大久保正一 (76-78)

12, 鱗相より見た鮭の生態 (2)
久保達郎 (79-94)

13, 鮭脳下垂体による鮭の成熟促進について
西野一彦 (95-97)

第5巻第1号 (1950) 湖沼特集号

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直移動の観察
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4, 網走湖の研究 磷酸塩その他の成層状態に就て
石田昭夫 (113-117)

5, 北海道陸水の水質資料 (1)

江口 弘・原 茂 (118-126)

6, 噴火湾の魚相に就いて (1)

疋田豊彦 (127-139)

7, 黒頭鰈調査 第三報

黒頭鰈の体長と採卵可能卵数及び体長との関係に就いて

石田力一 (140-144)

8, 石狩川の研究 (第1報)

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(145-162)

第6巻第1・2号 (1951)

1, 日本近海産鮭の系統と回帰生

佐野誠三 (1-10)

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(11-26)

3, 北海道に於ける鮭鱒漁況の変動に関する研究 (第1報) 鮭の漁況について

三原健夫・伊藤 繁・蜂谷俊雄・市川美代枝
(27-134)

4, 礼文島の鱈に就いて

坂野栄市
(135-144)

5, 黒頭鰈調査報告

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大久保正一
(145-150)

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岡本 剛・大藏 武・大竹好美・香山 勳・大藏 翠
(151-166)

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北海道鮭遡上主要河川の遡上期に於ける水質

江口 弘
(167-172)

8, 北海道産クロガシラガレイの卵及仔魚の形態とマコガレイとの Synonym 問題に就ての一考察

山本喜一郎
(173-180)

9, 湖沼甲殻類プランクトンの定量採集と水平分布についての二三の観察

石田昭夫
(181-190)

10, 噴火湾の魚相に就いて (II)

疋田豊彦
(191-209)

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三原健夫
(11-60)

3, 鮭の天然蓄養殖に関する研究 豫報

佐野誠三
(61-68)

4, 灌漑溝の水質と魚態の総合調査

江口 弘・疋田豊彦
(69-92)

5, 春季ニシン漁場に於けるホツケの食性に就いて

田村 正・大久保正一
(93-104)

- 6, 能取湖産魚類及び水産動物に就いて (11-20)
 疋田豊治
 (105-126)
- 7, 網走湖の研究 浅い湾内での甲殻類プランクトンの昼夜移動の観察
 石田昭夫
 (127-132)
- 8, 黒頭鯨の發生に就いて
 疋田豊治
 (133-144)
- 9, 湖沼観測資料
 石田昭夫
 (145-156)
- 10, 厚岸湾の鯨に就いて (1)
 坂野栄市
 (157-162)
- 11, 黒頭鯨調査報告第VI報 耳石より見た能取湖産黒頭鯨の生長について
 大久保正一
 (163-182)
- 12, 網走水系の研究
 香山 勳・大藏武 ・岡本 剛・大竹好美・諸住
 (183-187)
- 第8巻第1・2号 (1953)**
- 1, 遊樂部川に於ける樺太鱒 (*Oncorhynchus gorbuscha* Walbaum) の回帰に就いて
 佐野誠三 (北海道さけ・ますふ化場) ・小林哲夫 (北海道さけ・ますふ化場)
 (1-10)
- 2, 北海道における人工孵化鮭鱒族の稚魚に就いて特に鮭鱒類稚魚の区別について
 疋田豊彦 (北海道さけ・ますふ化場)
- 3, 北海道西海岸に於ける春ニシンの天然産卵の観察 第1報
 田村 正 (北大水産学部) ・大久保正一 (北海道さけ・ますふ化場)
 (21-32)
- 4, ヤマベとギンケヤマベの鰓上皮の細胞組織学的比較
 西田秀夫 (北海道大学理学部)
 (33-38)
- 5, 北海道陸水の水質資料 (3)
 北海道鮭鱒遡上主要河川の遡上期の於ける水質
 江口 弘 (北海道立水産孵化場) ・進藤 宏 (前調査課員)
 (39-46)
- 6, 鮭鱒親魚蓄養中に發生する病気の細菌学的研究 (第1報)
 西野一彦 (北海道さけ・ますふ化場)
 (47-58)
- 7, オーレオマイシン含有飼料添加剤利用による養鯉餌料の研究
 江口 弘 (北海道立水産孵化場) ・甲斐哲夫 (北海道立水産孵化場)
 (59-62)
- 8, サケの孵化に関する細胞組織学的研究 I 孵化腺, 粘液腺及卵膜溶解について
 西田秀夫 (北海道大学理学部)
 (63-70)
- 9, さけ稚魚の生態調査 (2)
 標識放流試験に於けるさけ稚魚の移動と成長について
 佐野誠三 (北海道さけ・ますふ化場) ・小林哲夫 (北海道さけ・ますふ化場)
 (71-80)
- 10, さけ稚魚の生態調査 (3)
 さけ稚魚の降下について 考察1

小林哲夫（北海道さけ・ますふ化場）
（81-86）

11, 岩内, 様似, 砂原産のスケトウダラの相対成長及び脊椎骨数の比較に就て

坂野栄一（北海道さけ・ますふ化場）
（87-94）

12, 鯀寄子に関する調査（第二報）

田村 正（北大水産学部）・大久保正一（北海道さけ・ますふ化場）
（95-108）

13, 噴火湾に見られる一卵分布に就いて（予報）

大東信一（北海道立水産孵化場）・藤田 忠（北海道立水産孵化場）
（109-118）

14, 各種消毒剤による鯉卵の孵化効果について（予報）

甲斐哲夫（北海道立水産孵化場）
（119-124）

15, 根室沿岸産黒頭鱈について

伊藤小四郎（北海道立水産孵化場）
（125-130）

第9巻第1・2号（1954）

1, 択捉島湖沼調査報告

高安三次（元北海道水産試験場）・近藤賢蔵（元北海道水産試験場）・大東信一（元北海道水産試験場）・亘理信一（元北海道水産試験場）
（1-86）

2, 鮭受精卵に於ける窒息死の様相（第1報）

岡田 雋（北海道大学農学部）
（87-94）

3, 北海道西海岸に於ける春ニシンの天然産卵の観察
第2報

潜水調査による産卵床の観察

田村 正（北大水産学部）・大久保正一（北海道さけ・ますふ化場）・藤田 忠（前北海道立水産孵化場）・広部武男（北海道立水産試験場）

（95-112）

4, 河川間の鮭浜上形態の類似性について

大屋善延（北海道立水産孵化場）
（113-126）

5, 賦活された鮭未受精卵胚盤の形態変化について

岡田 雋（北海道大学農学部）
（127-132）

6, 人工孵化による鮭稚魚の生産量について

I 鮭卵の減耗について

II 収容卵の算定について

坂野栄一（北海道さけ・ますふ化場）
（133-136）

7, 北日本近海に産する鮭鱒並に近似種の方言に就いて

疋田豊彦（北海道さけ・ますふ化場）
（137-146）

8, サケの口腔に見られる腺組織について

西田秀夫（北海道大学理学部）
（147-150）

9, 北海道と南千島におけるサケの孕卵数の比較

江口 弘（北海道立水産孵化場）・疋田豊彦（北海道さけ・ますふ化場）・西田秀夫（北海道大学理学部）
（151-160）

10, 支笏湖施肥試験（豫報）

江口 弘（北海道立水産孵化場）・黒萩 尚（北海道さけ・ますふ化場）・吉住喜好（北海道立水産孵化場）・佐々木正三（北海道さけ・ますふ化場）
（161-176）

11, 厚岸湾の鯀について（2）

坂野栄一（北海道さけ・ますふ化場）
（177-182）

12, 摩周湖に於ける虹鱈の年令と成長について
甲斐哲夫 (北海道立水産孵化場)
(183-193)

第10巻第1・2号 (1955)

1, 鮭の産卵に就いて (産卵環境)

佐野誠三 (北海道さけ・ますふ化場) (1-6)

Observations on the natural spawning of the salmon, *Oncorhynchus keta*. Conditions of the spawning Bed.

Seizo Sano

This reported on the result of observations on the natural spawning of the keta salmon which have been done at the following rivers; Shiriuchi, Moheji, Yurappu and the tributaries of Tokachi. In Hokkaido the salmon which come up streams gather in certain spot in the river in order to spawn at almost definite time of the season. The spawning place is selected by the fish on the river bed where there abound medium sized gravels measuring 0.5cm-3.0cm in diameter but the muddy or of finer sand bed is rarely utilized. Naturally there is a close relation between the constitution of the river bed and the spawning. Generally the water temperature at the spawning season in Hokkaido lowers down to 1°C-2°C and the water is frozen partly. However, around this season the temperature inside of the spawning bed ranges from 4°C to 11.5°C showing the difference of 6.6°C on the average from the surrounding water. Though the eggs in the natural spawning bed are somewhat deformed by the stress of the gravels there occurs no retardation of the development, the form being recovered gradually by the stage of the eye development (with the black spot visible from outside). The hatched out fry which locates in the finer sand bed is often brought to death being prevented the crawling out. We find in one spawning bed

745±211.8 (M±t.05 Sx) eggs in number on the average. The vitality of the egg in the natural bed is shown as 93.2±1.87% (M±t.05 Sx).

2, 北海道産鮭の卵に関する二・三の観察

特に卵の大きさより見たる鮭の系統について

渡辺宗重 (北海道大学水産学部) (7-20)

Some observations on the eggs of the mature salmon (*Oncorhynchus keta*) in Hokkaido, with special reference to the race of salmon as characterized by the size of their eggs.

Muneshige Watanabe

So many studies have been published on the autumn salmon (*Oncorhynchus keta*), which run up the rivers of Hokkaido to spawn, that their races or groups have become pretty clear. In the present study an attempt is made to compare the sizes of the eggs of the mature autumn salmon from nine Hokkaido rivers (Fig. 1). Also some observations on the salmon eggs are set down. The mean diameter of the eggs of each salmon was calculated from the volume of all the eggs of each fish. One can get more appropriate value of the diameter of the salmon egg by this method than by measuring it with a micrometer under the microscope. The results obtained are summarized as follows:

1. A tendency can be recognized for the number of eggs of a salmon generally to increase in proportion to the size of the fish (Fig. 2).
2. Another tendency can be recognized that number of eggs per unit body weight of a salmon generally is greater in small fish and it decreases proportionally in larger ones (Fig. 3).
3. The size of the salmon egg generally increases in proportion to the body length.
4. There is a difference of about 1 mm or so between the minimum and maximum diameter among the entire production of eggs of a salmon (Table 6).
5. It seems that the number of eggs of a salmon

is in inverse proportion to the size of the eggs of that fish.

6. Comparing the egg-sizes of the salmon from the nine rivers in Hokkaido, there is no distinct difference worth special discussion among the salmon in the seven rivers (Shikiu, Yurappu, Shiriuchi, Amano, Shubuto, Teshio and Abahiri) though more or less differences may be found among them (Table 7 and Fig. 4).

7. The eggs of the salmon in the Tokachi River are especially large and those in the Chitose River are especially small. In these two are found remarkable egg-sizes compared with the others (Table 7 and Fig. 4).

8. In this point of view, at least among the salmon of the nine rivers considered in this study, the salmon in the Tokachi and the Chitose will be recognized respectively as separate or peculiar salmon groups.

3, 鮭人工孵化に於ける不受精現象の研究 第一報 精子の活力と受精力について

岡田 雋 (北海道大学農学部) ・ 伊藤哲司 (北海道大学農学部) (21-32)

On the activity and fertilizing capacity of sperm in dog-salmon (*Oncorhynchus keta*)

Shun Okada and Tetsushi Ito

The spermatozoon of dog-salmon has a long tail measuring more than ten times of head length, showing about 36 microns in total length (see Fig. 1.). It remains immovable in the sperm. When the sperm is diluted by tap water, the active movement of the spermatozoa appease within about 30 seconds and then the activity decreases gradually until it becomes immovable after about 60 seconds. The preferable period of the activity of the sperm after stripping out of the fish body differs much with the temperature. For instance, it is about 4 hours at 33°C and about 7 days at 5°C. Within the range of these temperatures, there seems to exist a certain correlation between

the grade of the temperature (x) and the preservable period of the activity of the sperm (y), being represented by an equation $x(y+a)=k$, provisionally $x(y+1.1)=45$. The rule, however, is inapplicable to the temperature below about 5°C. (see Fig. 2. Abscissa; storage temperature [°C] of sperm. Ordinate; preservable period [day] of activity of sperm.) The stored sperm exhibits good fertilizing capacity even just before the lost of activity. For instance, the sperm stored at 0°C for 7 days could inseminate about 90 per cent of eggs. When the sperm is stored in the condition of air interception, the preferable period shortens remarkably, e.g. the activity is extinguished after the storage for 40 minutes at 20°C, for 60 minutes at 11°C and for 180 minutes at 0°C. The activity of the sperm is recovered gradually when the sperm is exposed to the fresh air. If the, period of air interception lasts the longer and the storage temperature is the higher, the recovery of the activity of the sperm takes the longer, and more exhibits almost a linear relation between the period of air interception and the duration of recovery at each temperature. Beyond certain limit of the period of air interception, the recovery of the activity occurs no longer. (See Fig. 3. Abscissa; period [minute] of air interception. Ordinate; period [minute] of recovery of the sperm activity) the above tendency was observed also in the sperm in a killed fish body. The sperm the body loses the activity after 60-90 minutes at 15°C of body temperature. When this sperm exposed to the air, the activity of the sperm is recovered gradually unless the sperm is kept in the body excessively long. The sperm which has recovered its activity shows good fertilizing capacity just like the fresh one (96 per cent). Strange to say, the sperm which does not yet recover and shows any activity retains also the fertilizing capacity though naturally it shows very low percentage (46 per cent).

4, サケのウロコ大いさの測定方法に関する検討

小林哲夫 (北海道さけ・ますふ化場) (33-42)

A consideration on the method of measuring the scale size of the salmon (*O.keta*)

Tetsuo Kobayashi

The fact that the growth of the scale of the salmon is proportional to the growth of the body has been ascertained since long ago. However, it is generally recognized that the growth of the scale is easily affected by the living environment. Therefore, many researchers have attempted to identify the strain of the salmon judging from the feature of the scale growth which might be influenced by the circumstances it exposed. The method of the measurement of the scale is varied according to the worker and there has been arisen some uncertainty in the result. On the chum salmon the author has, therefore, tried to find the most reliable method of the measurement having examined carefully the methods employed by others. The most reasonable site of the measurement of the scale radius should be on the line which connects between the center of the scale (N) and the middle point of axis (M) formed by the both outside margin of last resting zone on the juncture of the exposed and covered portions of the scale. The author has also made clear that the feature of the growth of the scale is not the same under all circumstances. On one and the same individual the size and the growth ratio of the scale show much difference with the place of it sampled giving statistically significant values. According the computed body length might be different in accordance with the place of the scale sampled. From the above reason it is necessary to select the portion of the scale to be measured when we intend to judge the life history and the strain of the salmon from it.

5, サケ胚の卵黄内に見られる血球細胞

西田秀夫 (北海道学芸大学) (43-52)

Morphological and histochemical studies on the blood cells finding in the yolk of salmon embryo.

Hideo Nishida

Histochemical observation of the salmon embryo, *Oncorhynchus keta*, revealed the occurrence of remarkable and abundant blood cells in the yolk of embryo. The blood cells distribute in single or in mass adjacently to the oil drops. The nature of the blood cells was observed applying Lison's benzidine reaction to peroxidase technique. The results of the observations with the above technique showed that the nature of the blood cells was indicated by, 1) absence of the cell division, 2) the cytoplasm fused into the yolk in some cases, 3) the cytoplasm is positive to the peroxidase reaction as same as the nucleus, but not positive to methyl green.

6, 鮭鱒稚魚標識放流試験 (I) 鮭標識魚の再捕結果 (昭和29年度)

坂野栄市 (北海道さけ・ますふ化場)・原 茂 (北海道さけ・ますふ化場) (53-62)

Marking experiments of young salmon in Hokkaido. (I) Results recaptured in 1954.

Eiichi Sakano and Shigeru Hara

7, 北洋で捕られた鮭の奇型個体の考察及び鮭鱒族奇型の数例について

疋田裕雍 (旧名 豊彦) (北海道さけ・ますふ化場) (63-72)

On an aberrant form of chum salmon taken from the northern Pacific Ocean and some examples of salmonoid fishes in Hokkaido.

Hirochika Hikita (Former name; Toyohiko)

Abnormal materials in this paper were collected by the Ginyo Maru Fleet of the Hokkaido Fishery Co. Ltd., during fishing seasons in northern Pacific on June 14, 1954 and by local officers in various rivers of Hokkaido. Among the latter was involved some examples of the lack of

adipose fin, acute sharpe of teeth, curvature of vertebral column and strong dwarfish form and so on. On these above abnormalities the author was discussed morphologically.

8, 光電管利用の鮭鱒親魚通過数記録装置 (豫報)
末武敏夫 (北海道さけ・ますふ化場根室支場) (73-82)

On the recording equipment taking a count of salmon-numbers by the utilization of photoelectric cell. (Preliminary note)

Toshio Suetake

9, 明治32年 (1899) より昭和30年 (1955) に至る支笏湖姫鱒親魚 (*Oncorhynchus nerka*) の体長, 体重, 肥満度の出現並にその変動に対する一考察
三原健夫 (北海道立水産孵化場) ・江口 弘 (北海道立水産孵化場) (83-104)

A consideration on the frequency of length, weight, condition factor and on the secular variation of kokanee salmon (*Oncorhynchus nerka*) in Lake Shikotsu. (1899~1955)

Tateo Mihara and Hiroshi Eguchi

10, 生きた陸棲植物の魚巢えの利用について
江口 弘 (北海道立水産孵化場) ・大屋善延 (北海道立水産孵化場) (105-108)

A study on the use of pine-tree for carp-nests.

Hiroshi Eguchi and Yoshinobu Oya

11, マラカイト・グリーンに依る鯉卵消毒試験
大屋善延 (北海道立水産孵化場) (109-114)

The effect of the disinfection of malachite green upon the carp egg.

Yoshinobu Oya

12, 北海道西海岸に於ける春ニシンの天然産卵の観察
第3報 1955年春季の群来状況並に苫前地区に於ける天然産卵床の潜水観察

田村 正 (北大水産学部) ・大東信一 (北海道立水産孵化場) ・広部武男 (北海道立水産試験場) (115-132)

Some observations on the natural spawning of the spring herrings along the western coast of Hokkaido. III. Fishing condition of spring herring in 1955 and underwater observations on the natural spawning ground of the herring at Tomamai. Tadashi Tamura, Shinichi Ohigashi and Takeo Hirobe

The present investigation was carried out at Tomamai on the northwestern coast of Hokkaido in the spring of 1955. The amounts of spring herring catch in 1955 were very little than heretofore. Recently, natural spawning grounds of the herrings in Hokkaido are gradually becoming narrower than before.

Year 1952 1953 1954 1955

Length of spawning grounds in km. 62 29 38 6

Amount of fishing herring (×1,000 kan.) 7258
5632 2974 721

The number of the herring eggs from the natural spawning ground counted from 222,100 to 4,287,160 per square meter.

13, 噴火湾に見られる一卵分布について II

伊藤小四郎 (北海道立水産孵化場) ・藤田 忠 (前事業課員) ・林 成治 (北海道立水産孵化場) ・安川雅夫 (北海道立水産孵化場) (133-144)

On the egg distribution of Alaska pollack (*Theragra chalcogramma*) observed in Funka (Uchiura) bay, 1954. II

Koshiro Ito, Tadashi Fujita, Seiji Hayashi and Masao Yasukawa

14, 噴火湾に見られる一卵分布について III

伊藤小四郎 (北海道立水産孵化場) ・倉橋澄雄 (北海道立水産孵化場) (145-160)

On the egg distribution of Alaska pollack (*Theragra chalcogramma*) observed in Funka (Uchiura) bay, 1955. III

Koshiro Ito and Sumio Kurahashi

15, 噴火湾産スケトウダラ稚魚について

大東信一(北海道立水産孵化場)・伊藤小四郎(北海道立水産孵化場)(161-168)

On the Alaska pollack juvenile (*Theragra chalcogramma*) taken from the Funka bay.

Shinichi Ohigashi and Koshiro Ito

16, 国後島湖沼調査報告

高安三次(元北海道水産試験場)・近藤賢蔵(元北海道水産試験場)・大東信一(元北海道水産試験場)・黒田久仁男(元北海道水産試験場)(169-216)

Limnological studies on the lakes of Kunasiri island.

Mitsugu Takayasu, Kenzo Kondo, Shinichi Ohigashi and Kunio Kuroda

This report is the result of the investigations carried on 6 lakes in Kunasiri Island (Kurile Islands) during summer seasons in 1934 and 1935. The items of investigations are as follows,

(1) Morphological survey of lakes Depth Area Rivers (inflow and outflow) etc.

(2) Physical and chemical observations Water temperature Air temperature Water analysis Biological investigations Zoo- and phytoplankton Algae Fishes and other animals Authors deduced from limnological observations, the fish productivity of these lakes, and mentioned on a plan of fish culture in these lakes.

17, 摩周湖の湖沼学的研究(1954年6月の性状)

黒萩 尚(北海道さけ・ますふ化場)・吉住喜好(北海道立水産孵化場)・甲斐哲夫(北海道立水産孵化場)(217-230)

Limnological study of Lake Mashu. Conditions on June 1954.

Takashi Kurohagi, Kiyoshi Yoshizumi and Tetsuo Kai

18, 水産用水よりみた石狩川(旭川-江別)水質に対する一考察(生化学的酸素要求量B. O. D. の測定)江口 弘(北海道立水産孵化場)・吉住喜好(北海道立水産孵化場)(231-238)

A consideration on the chemical contents in the Ishikari River (Asahigawa to Ebetsu) observed from fish-cultural water. (Measurement of biochemical oxygen demand: B.O.D.)

Hiroshi Eguchi and Kiyoshi Yoshizumi

On March 30, 31, 1955. The authors have investigated the Chemical contents of water (Measurement of Bio-Chemical Oxygen Demand: B.O.D.) in 10 stations of Ushubetsu River (Asahigawa) and Ishikari River (Asahigawa to Ebetsu). The consumption of 5 day B.O.D. ranged from 0.9-120 ppm. More than 5 ppm of B.O.D. consumption was shown in water in Ushubetsu (B.O.D. 21-120 ppm) and Ishikari (B.O.D. 6.45-24.0 ppm). It is apparent the fact that water is polluted by the wastes of industrial locating along the Ushubetsu River.

19, 石狩川水質の季節的変化について

吉住喜好(北海道立水産孵化場)(239-258)

The seasonal observations on the chemical contents of the Ishikari River.

By Kiyoshi Yoshizumi

20, 工業薬品の魚族に及ぼす影響に関する試験(第2報)

高安三次(北海道立水産孵化場)(259-281)

On the influence of several chemical compounds upon fishes (II)

Mitsugu Takayasu

In this paper the author presents a series of experiments on the influence of several constituents of industrial wastewater upon fishes, in order to obtain some data to estimate the injurious effect of industrial sewage on fishery. In these experiments salmonoid fishes were used that is most important commercial fish in Hokkaido and has close connection with river pollution. Experiments were carried out as follows:

(1) Lethal doses. In several glass vats,

containing 2 or 3 liters of chemical solutions of different concentrations, test fishes are taken in, and the time of survival of the fishes are recorded. As lethal dose, for convenience sake, decided the minimum doses in which fishes die completely within 24 hours.

(2) Minimum abhorrent doses. Specially designed troughs of running water type were used. In these troughs two different flows of water, practically not intermixed, were made and test fishes could be able to swim from one flow to other freely. Chemical solutions that to be tested were added to one of the flow and observed whether fish abhor or not the chemicals and minimum abhorrent doses were applied. From these results, taking into consideration with those of the previous report, author presents some data of minimum harmful doses of 44 chemicals and some industrial wastewaters.

第11号 (1956)

1, さけ稚魚の生態調査 (4) 灌漑溝に流入するさけ稚魚について

小林哲夫 (北海道さけ・ますふ化場) ・尾崎豊志 (北海道さけ・ますふ化場) ・伊藤嘉郎 (北海道さけ・ますふ化場) (1-6)

An ecological study on the salmon fry, *Oncorhynchus keta* (4). Some observations on the chum salmon fry entered into an irrigation canal. Tetsuo Kobayashi, Yasuji Ozaki and Yoshio Ito

2, 鮭人工孵化における不受精現象の研究 (第2報) 精子及び卵子の生存能力について

岡田 雋 (北海道大学農学部) ・石川嘉郎 (北海道さけ・ますふ化場) ・木村義一 (北海道さけ・ますふ化場) (7-18)

On the viability of the sperm and the egg left in the dead body of dog-salmon, *Oncorhynchus keta* (WALBAUM)

Shun Okada, Yoshio Ishikawa and Gi-ichi

Kimura

In the most of the hatcheries in Hokkaido, artificial fertilization of the dog-salmon is performed using the sperm and the egg stripped from the dead fish which are killed with blows at the first step of the procedure. The present experiment has been carried out to ascertain the viability of the sperm and the egg from the killed salmon. The sperm in a dead body preserves its fertilizability comparatively long when the body is kept at low temperature, though it reduces quickly at high temperature. For instance, the sperm can fertilize fresh eggs with good result until about 90 minutes when a dead fish is kept at 11-12°C. However, the fertilizability of the sperm begins to decline even after about 30 minutes when the body is kept at 18-19°C. [See Fig. 1. Abscissa; Time kept in dead bodies (hour), Ordinate; Percentage of fertilized eggs, Δ 11-12°C, \square 13-14°C, \circ 18-19°C; Temperature of male dead fish, Cont; control] The fertilizable period of the egg kept in the dead body also varies with the temperature of the body, but it is remarkably long as compared with that of the sperm. For instance, when the body temperature of the killed fish is kept at 11-12°C, eggs can be fertilized with fresh sperm with good result even after about 8 hours. The eggs kept in the body at 17-18°C are fertilizable normally for about one hour. [See Fig. 2. Abscissa; Time kept in dead bodies (hour), Ordinate; Percentage of fertilized eggs Δ 11-12°C, \square 13-14°C, \circ 17-18°C; Temperature of female dead fish, Cont; control] In order to interpret the difference of fertilizable period between the sperm and the egg, the oxygen consumption of each was measured by means of Warburg's manometer. At the temperature of 18.7°C, one c.c. of the sperm consumes 94 mm³ of oxygen for 60 minutes, on the other hand, the same volume of the egg only 5 mm³. At the temperature of 10.8°C, the sperm consumes 21 mm³, the egg only 2

mm³. [See Fig. 3. Abscissa; Time measured (minute), Ordinate; Consumption of oxygen, mm³. ○ 18.7°C, △ 10.8°C, ♂ sperm, ♀ egg, each volume 1 c.c.] From this fact, the sperm loses its fertilizability faster than the egg in the body of killed fish, because of the reason that the former consumes remarkably much quantity of oxygen as compared with the latter.

3, サクラマスの子魚の変態と成長に及ぼす光の影響
久保達郎 (北海道大学水産学部) (19-24)

The effect of the control of light upon the rate of smoltification and the growth of body of juvenile masu salmon.

Tatsuro Kubo

The life history of masu salmon (*Oncorhynchus masou*) is like that of coho salmon (*Oncorhynchus kisutch*), but large number of masu salmon parr, in contrast to coho salmon parr, do not metamorphose to smolt. It is conceivable that the rate of smoltification might be related to maturation and growth, and might be modified by some features of the environment. The author examined how a control of light modify the rate of smoltification and the growth of juvenile masu salmon. Equal number of fish were reared for one year, in three ponds, which received similar care with the exception of the control of light. One of three ponds was lighted also at night; the second pond was 2/3 covered; and in the third pond, the fish were normally reared as control. In the total body length, the fish in the lighted group were largest, the fish in the control group were in the middle, and the fish in the shaded group were smallest; but the mode of polygon of the body length was not unique in each group. It suggests that each group was intermingled from a fraction of matured large fish and that of immature small fish. In the rate of smoltification, the control group was highest, the lighted group was in the middle, and the shaded group was least. The account for

such a difference of the rate of smoltification between each group, it is assumed that the light treatment continued might be effectual to growth and maturation of parr in the autumn of the first year of life, and might control the thyroid function to prevent smoltification, and that the shade treatment might be disadvantageous to growth of parr which must have its influence to some extent upon smoltification.

4, 北海道沿岸及び河川で捕られる太平洋鮭鱒類
疋田裕雍 (北海道さけ・ますふ化場) (25-44)

Pacific salmon (genus: *Oncorhynchus*) known to occur in coasts and rivers within Hokkaido.

Hirochika Hikita

There are three species of pacific salmon which have been abundantly captured as commercial fishery from all the coast of Hokkaido and its adjacent water, though there are six species belonging to Genus *Oncorhynchus* in northern hemisphere. They include only one native near Japan and the five common species in Alaska, Canada and North America coasts, and the biologists have hitherto attracted the attention to them. In Hokkaido, chum, masou and pink salmon among them migrate to the coastal water to feeding or spawning during summer and early fall, especially every year chum ascends the many rivers to spawn during fall and winter. They are mostly captured by the use of set-net and gill-net in coastline as well as salmon-weir setting into rivers. The silver or coho salmon is rarely found in Hokkaido and the examination was made on some specimens taken from Yurappu and Shokotsu rivers. The king and sockeye salmon are also rare to migrate in Hokkaido, less than chum, but they are sometimes taken along the Pacific coast during warm summer seasons. Therefore it is of almost no commercial value as to those species. The species for the artificial propagation are *keta*, *masou*,

gorbuscha and “hime-masu” so well known as land-locked form of nerka. A considerable number of their fry which was artificially hatched is released from hatcheries where located throughout Hokkaido. The purpose of this paper is primarily to introduce the general consideration of diagnostic features, sexual characters, distribution, fish products and discussion of various measuring methods of the pacific salmon.

5, 鮭鱒稚魚標識放流試験 (II) 鮭及び樺太鱒標識魚の再捕結果 (昭和30年度)

坂野栄市 (北海道さけ・ますふ化場) (45-58)

Marking experiments of young salmon in Hokkaido. (II) Results recaptured in 1955.

Ei-ichi Sakano

6, 鮭稚魚集団斃死の細菌学的研究 (I) 斃死稚魚より分離した桿菌について

西野一彦 (北海道さけ・ますふ化場)・尾崎豊志 (北海道さけ・ますふ化場) (59-64)

Bacteriological investigations on the death in groups of salmon fry. (I) Observations on the bacillus isolated from dead salmon fry.

Kazuhiko Nishino and Yasuji Ozaki

7, 北海道に於ける鯉の解剖と発生について

疋田豊治 (65-96)

On the anatomy and development of carp in Hokkaido.

Toyoji Hikita

8, 農薬24-Dが鯉卵及び鯉稚魚に及ぼす影響について
江口 弘 (北海道立水産孵化場)・甲斐哲夫 (北海道立水産孵化場) (97-100)

Effect on the tolerance of carp egg and fry in some 24-D solutions.

Hiroshi Eguchi and Tetsuo Kai

9, マラカイトグリーン (Malachite Green) に関する二, 三の試験

高安三次 (北海道立水産孵化場) (101-108)

Some experiments on malachite green.

Mitsugu Takayasu

The use of malachite green solution as fungicide for control of water molds, growing often around salmon eggs of hatchery, is now usually adapted to all the most of hatcheries. Salmon eggs, which are protected with thick capsule, can resist to some extent of considerably high concentration of malachite green, but the same concentration cannot be considered to be harmless to fry. On account of the necessity of arranging equipments, drainage of hatchery troughs in many hatcheries flows down directly into the succeeding rearing ponds. Accordingly, it may be necessary to know previously the harmful concentration of the waste fungicide solution to fry. From this reason the author presented on this paper some data of bioassay upon the effect of malachite green to fishes. According to the results obtained, salmon fry and gold fishes are lethal within 24 hours in 1/800,000~1/1,000,000 solutions of malachite green and within 5~15 hours in 1/500,000~1/600,000 solutions. It is true that fry tolerate one hour or two in the water of some such concentration as 1/500,000 or so of malachite green, but from the fact that they have been killed in the course of 5~15hours, there is no gainsaying the toxicity of these concentrations. To reduce the toxicity of malachite green, an addition of a small amount of sodium sulphite solution to the waste fungicide solution proved to be best efficient. The addition of 14~15c.c. of 8% solution of sodium sulphite (anhydrous) to 180 liter (1 “Koku”) of waste solution is mostly efficient to neutralize the toxicity of malachite green.

10, 水産用水の水質標準について (概報)

高安三次 (北海道立水産孵化場)・江口 弘 (北海道立水産孵化場) (109-112)

On the standalization of water used as fish-cultural water. (General consideration)

Mitsugu Takayasu and Hiroshi Eguchi

11, 阿寒湖に於ける生産見込数と事業的生産力の関係
についての検討

江口 弘 (北海道立水産孵化場)・長内 稔 (北海道
立水産孵化場) (113-118)

The comparative investigation in relation to the
estimated fish crop and productivity of fishing
interest in Lake Akan.

Hiroshi Eguchi and Minoru Osanai

12, 阿寒湖ワカサギの甲殻類餌料プランクトンの季節
的变化

長内 稔 (北海道立水産孵化場) (119-128)

The seasonal observation in some feeding plank-
ton crustacea of pond-smelt, *Hypomesus olidus*
(Pallas) in Lake Akan.

Minoru Osanai

13, チミケツブ湖の水質について

吉住喜好 (北海道立水産孵化場)・麓 龍司 (北海道
さけ・ますふ化場) (129-134)

The chemical contents of Lake Chimikeppu.

Kiyoshi Yoshizumi and Ryuji Fumoto

14, 鷹泊人工湖の陸水学的観察結果

黒萩 尚 (北海道さけ・ますふ化場) (135-154)

A limnological survey of Takadomari reservoir.

Takashi Kurohagi

15, 北海道各河川及びそれら河口附近に産する魚類と
水産動物

疋田裕雍 (北海道さけ・ますふ化場) (155-170)

List of marine-and fresh-water fishes and aquatic
animals found in some streams and their mouth'
s vicinities in Hokkaido.

Hirochika Hikita

This is a brief survey of the fresh-water fishes
in various rivers and marine fishes in the vicinity
of the estuary of their rivers throughout Hokkaido.
Most of the collections upon which this paper is

based were made from 1950 to 1954. Among 86
species of fishes and aquatic animals, 77 species
are fresh-water and marine fishes. Fishes can be
divided into 4 types, namely - fresh-water,
brackish, marine and anadromous fishes, by their
habitats. The writer is also considered to have
two forms in the dace, *Tribolodon hakonensis*
and one of char, *Salvelinus leucomaenis*, such as
land-locked and sea-run forms of masou and
sockeye salmon. From the distributional stand
point, some kinds of fresh-water fishes found in
Hokkaido are more widespread to northern areas
as Saghalin, Kamchatka, Maritim Province of
Soviet Russia and Alaska, and a few of them re-
semble to that of Korea. The most common spe-
cies live on almost every river sheds and have no
particular differences from the fish-fauna, with
the exception of some specific rivers in Hokkaido.

16, 能取湖産黒頭鰈 (*Limanda schrenki* Schmidt)

の体長組成, 肥満度並びに卵数算定について

皆川 久 (北海道立水産孵化場) (171-180)

On the computation of body-length composition,
length-weight relationship and egg-number of a
flounder (*Limanda schrenki* Schmidt) in Lake
Notoro, Hokkaido.

Hisashi Minagawa

17, 北海道西海岸における春ニシンの天然産卵の観察
第4報 1956年春季の群来状況並びに天然産卵の外
見的観察

大東信一 (北海道立水産孵化場)・内山正昭 (北海道
立水産孵化場) (181-202)

Some observations on the natural spawning of
the spring herrings along the western coast of
Hokkaido. IV. The observation on the fishing
condition and the spawning condition of spring
herring in 1956.

Shinichi Ohigashi and Masateru Uchiyama

As the continuing work of the previous year,
the spawning and fishing conditions in

conjunction with their environmental factors of spring herrings were observed in 1956 along the western coast of Hokkaido. The catch of the herring in 1956 was the poorest since 1938. The herrings which spawned in shallow waters were very scarce, spawning area having extended only about 8 km. along the coast.

Year 1952 1953 1954 1955 1956

Length of spawning grounds in km 62 29 38 6 8

Amount of fishing herring (× 10,000kan) 7258
5632 2974 727 433

The catch by fixed net was less in amount than that by gill net. In the northern fishing ground, from the fact that the spawned herring were caught by gill nets at the considerable depth (90~120m.), it is considered that the spawning might occur at decent depth off the shore. The actual spawning of the herring in the deep water, however, were not confirmed on account of the turbidity caused by the milt at the time of spawning.

第12号 (1957)

1, 明治32年 (1899) より昭和30年 (1955) に至る支笏湖姫鱒親魚 (*Oncorhynchus nerka*) の各年次に於ける平均体長と平均採卵数との関係について

三原健夫 (北海道立水産孵化場) ・江口 弘 (北海道立水産孵化場) (1-6)

On the relationship between the average body-length and the average number of adopted eggs of Kokanee Salmon (*Oncorhynchus nerka*) observed during the period from 1899 to 1955.

Tateo Mihara and Hiroshi Eguchi

2, 藻琴湖水質調査

高安三次 (元北海道水産試験場在勤技師) ・近藤賢蔵 (元北海道水産試験場在勤助手) ・黒田久仁男 (元北海道水産試験場在勤助手) (7-18)

Limnological studies in Lake Mokoto.

Mitsugu Takayasu Kenzo Kondo Kunio Kuroda

3, 桂沢人工湖の予察調査 (養殖適地調査)

江口 弘 (北海道立水産孵化場) ・皆川 久 (北海道立水産孵化場) (19-28)

A preliminary observation of the Katsurazawa reservoir, with special regard to its suitability for pisciculture.

Hiroshi Eguchi and Hisashi Minagawa

4, 最近に於ける北海道, 阿寒湖の初夏及び秋のプランクトンについて

黒萩 尚 (北海道さけ・ますふ化場) ・長内 稔 (北海道立水産孵化場) (29-38)

Recent observations on net plankton of early summer and autumn in Lake Akan, Hokkaido.

Takashi Kurohagi and Minoru Osanai

A total of 75 species and 3 varieties of net plankton including animal and plant forms obtained from five observations in the early summers and autumns of lake Akan, Hokkaido, 1954-1956 were identified. In early summer, the zooplankton in which *Bosmina coregoni* and *Daphnia longispina* were dominant was very abundant, while the phytoplankton, the majority of which was *Dinobryon cylindricum*, was poor. In autumn, the zooplankton which was mainly consisted of *Bosmina coregoni* and *Mesocyclops hyalinus* was abundant, and phytoplankton, the majority of which was *Fragilaria crotonensis*, was also very abundant.

5, 澱粉工場廃水浄化方法の研究

高安三次 (北海道立水産孵化場) ・麓 龍司 (北海道さけ・ますふ化場) ・黒田久仁男 (北海道立水産試験場) (39-56)

A method to purify wastewaters from starch factories.

Mitsugu Takayasu, Tatsushi Fumoto and Kunio Kuroda

Waste-waters of starch factory are known to

render strongly the river pollution. As the active period of starch factories coincides with the season of spawning migration of salmon in Hokkaido, the terrible effect of the waste-waters for the propagation of the salmon is the serious problem. Since many of the starch factories in Hokkaido are in rather small scale, it seems to be difficult to order to prepare the complete installation for the waste-waters. Strong pollutions to the important rivers of the salmon propagation increase year by year, so the authors carried on an investigation on the wastes treating plant in the simple and low cost as possible. From the result of the investigation, it has been proved that the use of modified, simplified trickling filter is fairly effective to defect against wastewaters. The authors present here the plan of the wastes treating plant, and wish to be accepted this method by many starch factories in Hokkaido.

6, 常呂川水質の季節的变化について

吉住喜好 (北海道立水産孵化場) (57-78)

Seasonal observations on the chemical substances of water in Tokoro River in 1955 to 1957. Kiyoshi Yoshizumi

7, チカの生態調査 1. 計測値よりみた尾袋沼 (根室国) 産チカについて

伊藤小四郎 (北海道立水産孵化場) (79-82)

Ecological studies of *Hypomesus japonicus* (Brevoort). 1. A morphometric study in Odaito in Nemuro Province.

Koshiro Ito

8, チカの生態調査 1. 生殖巣及び卵卵数について

伊藤小四郎 (北海道立水産孵化場) (83-88)

Ecological studies of *Hypomesus japonicus* (Brevoort). 1. On the genital glands and the number of mature ovarian eggs.

Koshiro Ito

9, 養魚餌料の研究 I (鯉稚魚の成長並びに斃死率の

及ぼすビタミンB剤添加餌料の効果)

甲斐哲夫 (北海道立水産孵化場)・江口 弘 (北海道立水産孵化場) (89-94)

Studies on the fish-culture food. I On the growth and mortality of carp-fry cultured with the food containing Vitamin B groups.

Tetsuo Kai and Hiroshi Eguchi

10, 養魚餌料の研究 II (鯉稚魚並びに鯉2歳魚の成長に及ぼす抗生物質及びビタミンB剤添加餌料の効果について)

甲斐哲夫 (北海道立水産孵化場)・江口 弘 (北海道立水産孵化場) (95-100)

Studies on the fish-culture food. II On the growth of carp fry and its yearling cultured with the food containing antibiotic and Vitamin B groups.

Tetsuo Kai and Hiroshi Eguchi

11, 養魚餌料の研究 III (パルプ酵母利用による養魚餌料の効率試験)

江口 弘 (北海道立水産孵化場)・甲斐哲夫 (北海道立水産孵化場) (101-105)

Studies on the fish-culture food. III On the effect of culture foods added with pulp yeast upon the growth of yearling carp.

Hiroshi Eguchi and Tetsuo Kai

第13号 (1958)

1, 北海道沿岸に出現するサケ稚魚の生態について

三原健夫 (北海道立水産孵化場) (1-14)

An ecological study on the salmon fry, *Oncorhynchus keta*, in the coastal waters, Hokkaido.

Tateo Mihara

2, 石狩川河水の濁度について (河水の透入光量百分率の測定)

江口 弘 (北海道立水産孵化場) (15-18)

On the turbidity of water in Ishikari River.

Measurement of percent of light penetrating into river water.

Hiroshi Eguchi

3, 北海道陸水の水質資料 (IV)

吉住喜好 (北海道立水産孵化場) (19-22)

Data on the studies of chemical composition of inland waters in Hokkaido (IV).

Kiyoshi Yoshizumi

4, 魚卵の粘着度についての試験 (I) ワカサギ卵について

皆川 久 (北海道立水産孵化場) ・内山正昭 (北海道立水産孵化場) (23-30)

An experiment on the adhesion of fish egg. I. On the egg of pond smelt, *Hipomesus olidus* Pallas.

Hisashi Minagawa and Masateru Uchiyama

5, 魚卵の粘着度についての試験 (II) チカ卵について
寺尾俊郎 (北海道立水産孵化場) (31-38)

An experiment on the adhesion of fish egg. II. On the egg of *Hypomesus japonicus* (Brevoort).

Toshiro Terao

6, 柳葉魚 (シシャモ) *Spirinchus lanceolatus* (Hikita) の発生について

疋田豊治 (39-50)

On the development of long finned smelt, *Spirinchus lanceolatus* (Hikita).

Tyoji Hikita

7, 日高沿岸のシシャモの計測値について

伊藤小四郎 (北海道立水産孵化場) (51-58)

Morphometrical studies of *Spirinchus lanceolatus* (Hikita) taken from Hidaka coasts, Hokkaido.

Koshiro Ito

The present paper gives some morphometric measurements of *Spirinchus lanceolatus* collected in Mukawa and Monbetsu, Hidaka coasts in 1957. The results are as follows:

1. The body length in spawning season ranges from 118 to 121 mm. in the female and from 134 to 135 mm. in the male; thus the male is longer by about 15 mm. than the female in length. The female is weighed 22.9 gr. and the male 30.5 gr. in average.

2. The proportion of the head length to the body length indicates as 24.7% in both sexes. The percentage of the pectoral fin length to the body length shows 22.1% in the female and 21.2% in the male. The maxillary length is 47.1% in the female and 46.1% in the male. No difference is observed by sex.

3. In general, the lower caudal lobe is longer slightly than that of the upper one.

4. The number of gill rakers in first gill arch indicates 38 (12+26) in general.

5. The stomach is v-shape in form. The pyloric appendages shows a finger like shape, its number ranging from 3 to 6, and 4 being most frequent. Of these appendages, one extends specially over the posterior end of the stomach.

6. The gonad is asymmetrical. Right gonad is larger than that of the left.

7. In the test of positional differences and slope differences for the linear regression of interovarian eggs to body length, no significance is demonstrated between Mukawa and Monbetsu specimens.

8. The vertebral number distributes from 59 to 63, 61 to 62 being most abundant. There is no difference in the according to the sex and localities from which the materials are originated.

8, 孵化器の改良試験 (I) 簡易型孵化器による虹鱒卵の孵化並に稚魚飼育試験

江口 弘 (北海道立水産孵化場) ・皆川 久 (北海道立水産孵化場) ・林中信男 (北海道立水産孵化場千歳支場) ・倉橋澄雄 (北海道立水産孵化場千歳支場) (59-64)

Test on the improvement of hatching box. I. On incubation of eggs and rearing of alevin of

rainbow trout by use simple vertical hatching box.

Hiroshi Eguchi, Hisashi Minagawa, Nobuo Hayashinaka and Sumio Kurahashi

9, 最近に於ける北海道雨竜人工湖の湖沼条件について
江口 弘 (北海道立水産孵化場)・黒萩 尚 (北海道
さけ・ますふ化場) (65-76)

Recent observation on limnological conditions at
Uryu reservoir, Hokkaido.

Hiroshi Eguchi and Takashi Kurohagi

10, 養魚餌料の研究 (IV) 鯉稚魚に対する脱脂粉乳添
加餌料の効率試験

寺尾俊郎 (北海道立水産孵化場)・江口 弘 (北海道
立水産孵化場) (77-82)

Studies on the fish-culture food. IV. On the effect
of culture food added with skim milk upon to
growth of carp-fry (*Cyprinus carpio*).

Toshiro Terao and Hiroshi Eguchi

11, 養魚餌料の研究 (V) S P 飼料利用による養鯉餌
料の効率試験

江口 弘 (北海道立水産孵化場)・寺尾俊郎 (北海道
立水産孵化場) (83-87)

Studies on the fish-culture food. V. On the effect
of culture food added with sp. food upon to
growth of yearling carp (*Cyprinus carpio*).

Hiroshi Eguchi and Toshiro Terao

第14号 (1959)

1, 湧水川の河川条件について (養殖適地調査)

江口 弘 (北海道立水産孵化場) (1-12)

On the physico-chemical conditions in the spring
water, with special regard to its suitability for
pisciculture.

Hiroshi Eguchi

2, 斜里川水系の水質並びに底質の季節的变化について
吉住喜好 (北海道立水産孵化場) (13-24)

Seasonal observations on the chemical sub-
stances of water and mud in Shari river in 1957
to 1959.

Kiyoshi Yoshizumi

3, 北海道釧路海域の水質調査成績

江口 弘 (北海道立水産孵化場) (25-28)

A report on the water components of coastal
water in Kushiro province, Hokkaido.

Hiroshi Eguchi

4, 着色水に対する鮭鱒親魚の忌避行動に関する試験

高安三次 (北海道立水産孵化場)・麓 龍司 (北海道
さけ・ますふ化場北見支場) (29-36)

An experiment on the abhorrent motion of adult
salmon against colored industrial-waste water.

Mitsugu Takayasu and Tatsushi Fumoto

5, 網走湖 (網走川及びその沿岸), 藻琴湖並びに濤沸
湖のワカサギの形態学的比較

大東信一・伊藤小四郎 (37-46)

On the comparisons of some morphological char-
acters of the pond smelt, *Hypomesus olidus*
(Pallas) taken from three lakes in Okhotsk Sea
coast.

Shinichi Ohigashi and Koshiro Ito

6, シシャモの生態調査 I 孕卵数の計測方法の比較
並びに体長、年齢と孕卵数の関係について

伊藤小四郎 (北海道立水産孵化場) (47-56)

Ecological studies of the long finned smelt,
Spirinchus lanceolatus (Hikita). I. On the meas-
uring comparison of egg-number from several lo-
calities, and relationship between body lengths,
age mature ovarian egg.

Koshiro Ito

7, 桂沢人工湖のワカサギ生態調査 (第1報)

寺尾俊郎 (北海道立水産孵化場)・今井 輝 (三笠市
役所) (57-66)

Ecological survey of pond smelt, *Hypomesus*
olidus Pallas, in Katsurazawa reservoir . (1)

Toshiro Terao and Akira Imai

8, 北海道に於けるシナイモツゴの新棲息地とその形態について

正田豊彦（北海道さけ・ますふ化場）・寺尾俊郎（北海道立水産孵化場）（67-72）

Notes on a new locality and some morphological observations of a cyprinoid fish, *Pseudorasbora parva pumila* Miyadi, in eastern Hokkaido.

Toyohiko Hikita and Toshiro Terao

9, カハシンジュガイ *Margaritifera margaritifera* (L.) の生態研究（第1報）

岡田 雋（北海道大学農学部動物学教室）・石川嘉郎（北海道さけ・ますふ化場千歳支場）（73-82）

The biological study of fresh-water peal mussel, *Margaritifera margaritifera* (L.). (1)

Shun Okada and Yoshio Ishikawa

10, 山間奥地での「無人孵化器」使用による姫ます卵埋没試験

外崎 久（北海道立水産孵化場）（83-88）

Experimental test of the method used in the artificial spawning of kokanee salmon eggs in Lake Panke, eastern Hokkaido.

Hisashi Tonosaki

11, 養魚餌料の研究（VI）S P 飼料利用による養鯉餌料の効率試験

江口 弘（北海道立水産孵化場）・寺尾俊郎（北海道立水産孵化場）（89-94）

Studies on the fish-culture Food. VI On the effect of culture food used of SP. food upon to growth of yearling carp (*Cyprinus carpio*).

Hiroshi Eguchi and Toshiro Terao

12, 養魚餌料の研究（VII）鯉稚魚に対するビタミンB複合体“ビスラーゼ”添加餌料の効率試験

寺尾俊郎（北海道立水産孵化場）（95-98）

Studies on the fish-culture food (VII). An effect of the cultural food with vitamin B complex “Bisulase” to growth of carp fingerling

(*Cyprinus carpio*).

Toshiro Terao

13, 北海道中部宇津内人工湖の陸水学的条件について
江口 弘（北海道立水産孵化場）・黒萩 尚（北海道さけ・ますふ化場）（99-112）

Limnological conditions of Utsunai Reservoir in central Hokkaido.

Hiroshi Eguchi and Takashi Kurohagi

Utsunai Reservoir is located at Horokanai-mura in central Hokkaido, supplies the water to Uryu Reservoir, and provided with the dam 30m heights and 235m lengths with the area of 1.77 sq. km. at the highest level at 285m above sea level. The observation on general limnological conditions was made in August 1958 and October 1959. The physical, chemical and biological properties of the reservoir were almost those of mesotrophic lakes, but not those of bog lakes. The plankton species were 30, including 16 animal and 14 plant species among which *Bosmina longirostris* and *Asterionell formosa* were dominant in August, 1958, and in October, 1959, too.

14, 最近に於ける雨竜人工湖の湖沼条件について（II）

黒萩 尚（北海道さけ・ますふ化場）（113-124）

Recent observation on limnological conditions of Uryu Reservoir, Hokkaido. (II)

Takashi Kurohagi

Some limnological conditions of Uryu Reservoir were observed. The reservoir has been impounded with fresh water at Horokanai-mura in central Hokkaido since 1942, and has an area of 23.73 sq. km. with about 30m of maximum depth, observed in early August and late October in 1957. The result of observation in August was presented in previous paper (Eguchi H. et al 1958), and the present paper showed the result obtained in October. The temperature of the

water ranged from the surface to the near bottom vertically from 9.97-9.77 to 7.45-7.81°C. The dissolved oxygen changed from 6.64-7.68 (85.8-98.7%) to 1.15-2.23cc/l (14.0-27.4%) and PH value from 6.6-6.7 to 6.5-6.7. The reading of Ule's scale was remarkable high, showing about 19, and the transparency was rather low, the Secchi's disk reading about 2.1m. The plankton species were identified 36 including 15 plant and 21 animal species. *Bosmina longirostris* was dominant. The dry weight of net plankton was remarkable low, showing about 5.61kg/hac, corresponding to that of oligotrophic lake.

15, 北海道東南部糠平湖（人工湖）の1956年6月のプランクトン

黒萩 尚（北海道さけ・ますふ化場）(125-130)

The plankton of Nukabira-ko, a reservoir, in south-eastern Hokkaido observed in June 1956.

Takashi Kurohagi

This paper is a report on the plankton occurred in June 1956 in Nukabira-ko, a reservoir in south eastern Hokkaido, which was filled up with fresh water in September of the preceding year. The species of the plankton collected were identified as 17 including 6 animals and 11 plant species. The occurrence of the plankton was rather rare, as be showed in Table 2.

16, 北海道東南部ペンケ及びパンケ両湖のプランクトンについて

黒萩 尚（北海道さけ・ますふ化場）・長内 稔（北海道立水産孵化場）(131-144)

Notes on plankton from two lakes, Penke-ko and Panke-ko, in southeastern Hokkaido.

Takashi Kurohagi and Minoru Osanai

In this paper, the results of some limnological observations in Penke-ko and Panke-ko, two oligotrophic lakes of the Akan Lake Group in south-eastern Hokkaido, done on late October,

1955 were summarized. The plankton species collected by hauling of silk net and the vertical distribution of the plankton organisms in the daytime are shown in Table 4, 6, 7 and 8.

17, 能取湖の環境調査結果

大東信一（北海道立水産孵化場）・内山正昭（北海道立水産孵化場）(145-167)

Data on the investigation of limnological factor for the aquatics in Notoro Lake

Shinichi Ohigashi and Masateru Uchiyama

第15号（1960）

1, 北海道天北地方の泥炭池沼について（養殖適地調査）

江口 弘（北海道立水産孵化場）(1-8)

Studies on bog lakes at Tenpoku, Hokkaido, with special regard to its suitability for pisciculture.

Hiroshi Eguchi

2, 北海道勇払原野池沼の陸水学的条件について

江口 弘（北海道立水産孵化場）・黒萩 尚（北海道さけ・ますふ化場）・伊藤小四郎（北海道立水産孵化場）(9-16)

Limnological conditions of ponds in Yuhutsu, Hokkaido.

Hiroshi Eguchi, Takashi Kurohagi and Koshiro Ito

3, 常呂川の水質並びに底質の季節的变化について

吉住喜好（北海道立水産孵化場）(17-28)

Seasonal observations on the chemical substances of water and mud in Tokoro River in 1957 to 1959.

Kiyoshi Yoshizumi

4, 石狩古川産ワカサギ魚群の生態研究 1. 忠海漁場附近における産卵期の生態

岡田 雋（北海道大学農学部動物学教室）・伊藤小四郎（北海道立水産孵化場）(29-40)

Ecological studies of the pond smelt, *Hypomesus*

olidus (Pallas) in the Ishikari-Furukawa. 1. Ecological studies in breeding season. Shun Okada and Koshiro Ito

5, 石狩古川産ワカサギ魚群の生態研究 2. 成長並びに系統について
伊藤小四郎 (北海道立水産孵化場) ・岡田 雋 (北海道大学農学部) (41-50)

Ecological studies of the pond smelt, *Hypomesus olidus* (Pallas) in the Ishikari-Furukawa. 2. Growth and stocks of the pond smelt. Koshiro Ito and Shun Okada

6, 石狩古川産ワカサギ魚群の生態研究 3. 生殖巣並びに卵数について
伊藤小四郎 (北海道立水産孵化場) ・岡田 雋 (北海道大学農学部) (51-56)

Ecological studies of the pond smelt, *Hypomesus olidus* (Pallas) in the Ishikari-Furukawa. 3. On the gonads and the number of mature ovarian eggs. Koshiro Ito and Shun Okada

7, 雨竜人工湖に於けるワカサギの食性について (予報) 長内 稔 (57-62)

The feeding habits of the pond smelt, *Hypomesus olidus* (Pallas), in Uryu reservoir. (Preliminary report). Minoru Osanai

8, 桂沢人工湖のワカサギ生態調査 (第2報) 寺尾俊郎 (北海道立水産孵化場) ・今井 輝 (三笠市役所) (63-70)

Ecological survey of pond smelt, *Hypomesus olidus* (Pallas), in Katsurazawa Reservoir (2). Toshiro Terao and Akira Imai

9, 千歳川産カハシシユガイの形態と移殖試験 江口 弘 (北海道立水産孵化場) ・外崎 久 (北海道立水産孵化場) (71-78)

A planting experiment and morphology of the fresh-water pearl mussel, *Margaritifera margaritifera*

(L.), from Chitose River.

Hiroshi Eguchi and Hisashi Tonosaki

10, 孵化器の改良試験 (II) 田中式鮭卵簡易孵化器の改良による虹鱒, 姫鱒卵の孵化並に稚魚飼育試験
江口 弘 (北海道立水産孵化場) ・寺尾俊郎 (北海道立水産孵化場) ・林中信男 (北海道立水産孵化場千歳支場) ・倉橋澄雄 (北海道立水産孵化場千歳支場) (79-84)

Test on the improvement of hatching Box. II. On incubation of eggs and rearing of alevin of rainbow trout and kokanee salmon by use Tanaka simple reformed hatching box.

Hiroshi Eguchi, Toshiro Terao, Nobuo Hayashinaka and Sumio Kurahashi

11, 養魚餌料の研究 (VIII) (クロレラ藻体乾燥粉末添加による養鯉餌料の効率試験) 寺尾俊郎 (北海道立水産孵化場) (85-88)

Studies on the fish-culture food (VIII) On the effect of the dry powder of freshwater green algae, *Chlorella ellipsoidea*, added to diets of carp fingerlings.

Toshiro Terao

12, 養魚餌料の研究 (IX) (S P 飼料と Fish Soluble 添加餌料との比較試験)

江口 弘 (北海道立水産孵化場) ・寺尾俊郎 (北海道立水産孵化場) (89-92)

Studies on the fish-culture food (IX) On the effect of SP food compared with fish soluble added with upon to growth of yearling carp, *Cyprinus carpio*.

Hiroshi Eguchi and Toshiro Terao

第16号 (1961)

1, ホロカヤン沼調査報告 (養殖適地調査)

江口 弘 (北海道立水産孵化場) (1-6)

Limnological studies of Lake Horokayan, with special regard to its suitability for pisciculture.

Hiroshi Eguchi

2, 十勝川水系 (帯広-幕別) の水質並びに底質の季節的变化について

吉住喜好 (北海道立水産孵化場) ・尾崎豊志 (北海道さけ・ますふ化場) (7-28)

Seasonal observation on the chemical substances of water and mud in Tokachi River (Obihiro-Makubetsu) in 1959 to 1961.

Kiyoshi Yoshizumi and Yasuji Ozaki

3, 回転円板による澱粉廃水浄化試験報告 (第1報)

高安三次 (北海道立水産孵化場) (29-36)

An experiment on catalytic oxidation of starch wastes with rotating discs.

Mitsugu Takayasu

4, 石狩古川産ワカサギの生態研究 4. 地域集団の存在について

岡田 雋 (北海道大学農学部応用動物学教室) ・伊藤哲司 (北海道大学農学部応用動物学教室) ・伊藤小四郎 (北海道立水産孵化場) (37-44)

Ecological studies of the pond smelt in the Ishikari-Furukawa. 4. On the occurrence of local populations.

Shun Okada, Tetsushi Ito and Koshiro Ito

5, 雨竜人工湖におけるワカサギの食性について (II) 長内 稔 (45-50)

The feeding habits of the pond smelt, *Hypomesus olidus* (Pallas), in Uryu reservoir (II)

Minoru Osanai

6, サケ・マス属魚類の交雑試験について I.

寺尾俊郎 (北海道立水産孵化場) ・林中信男 (北海道立水産孵化場) (51-62)

On the artificial hybridization among the salmonid fishes. I.

Toshiro Terao and Nobuo Hayshinaka

7, 鱒類に及ぼす除草剤PCPの影響

江口弘 (北海道立水産孵化場) ・寺尾俊郎 (北海道立水産孵化場) (63-66)

On the toxic effect of herbicide, PCP, on the fry of kokanee salmon and rainbow trout.

Hiroshi Eguchi and Toshiro Terao

8, サケ稚魚に対するPCP除草剤の毒性について

石川嘉郎 (北海道さけ・ますふ化場) (67-72)

On the toxic effect of the herbicide, Pentachloro Phenol, in the chum salmon fry (*O.keta*)

Yoshio Ishikawa

9, 養魚餌料の研究 (X)

ビール酵母添加による稚鯉餌料の効率試験

寺尾俊郎 (北海道立水産孵化場) (73-78)

Studies on the fish-culture food. (X) On the effect of the dry brewer's yeast, *Saccharomyces cerevisiae*, added to diet of carp fingerlings.

Toshiro Terao

10, 養魚餌料の研究 (XI) フィッシュ・ソリブル, 甲ミール配合による養鯉餌料の効率試験

江口 弘 (北海道立水産孵化場) ・寺尾俊郎 (北海道立水産孵化場) (79-84)

Studies on the fish-culture food. (XI) On the effect of culture food used of fish-soluble and "K O" meal upon to growth of yearling carp (*Cyprinus carpio* PALLAS).

Hiroshi Eguchi and Toshiro Terao

11, 北海道陸水観察資料 (I) 阿寒湖の昭和16年10月のプランクトン相について

黒萩 尚 (北海道さけ・ますふ化場) ・三原健夫 (北海道庁水産部) (85-90)

Some limnological notes on the inland waters of Hokkaido - I. On the plankton of Lake Akan in south-eastern Hokkaido collected in middle

October, 1941.

Takashi Kurohagi and Tateo Mihara

12, モツゴの新しい棲息地について

疋田豊彦 (北海道さけ・ます・ふ化場) (91-92)

On a new habitat of a cyprinid fish, *Pseudorasbora parva parva* (Temminck et Schlegel), in Hokkaido.

Toyohiko Hikita

第17号 (1962)

1, 二股人工湖の陸水学的条件について

江口 弘 (北海道立水産孵化場)・長内 稔 (北海道立水産孵化場) (1-8)

Limnological conditions of Futamata Reservoir in Hokkaido.

Hiroshi Eguchi and Minoru Osanai

2, 千歳川の水質について

吉住喜好 (北海道立水産孵化場) (9-20)

Water conditions of Chitose River

Kiyoshi Yoshizumi

3, 陸封型サクラマス生態調査 (I). 雨竜人工湖の湖況の遷移と湖産サクラマスの食性について

長内 稔 (北海道立水産孵化場) (21-30)

Ecological studies on the land-locked masu salmon, *Oncorhynchus masou* (Brevort). 1. Ecological succession on the limnological conditions and feeding habit of the lake-locked form at Uryu Reservoir.

Minoru Osanai

4, 北海道における温泉水利用による養魚試験 1. ウナギの人工種苗の飼育試験

伊藤小四郎 (北海道立水産孵化場) (31-40)

Experiments on the fish-culture with spring water in Hokkaido. I. Rearing of fry of the eel, *Anguilla japonica*.

Koshiro Ito

5, ニジマスの海水に対する抵抗性について (I)

粟倉輝彦 (北海道立水産孵化場) (41-48)

On the tolerance of rainbow trout, *Salmo gairdneri irideus* Gibbons, to salt water. I.

Teruhiko Awakura

6, ニジマスの海水飼育例

粟倉輝彦 (北海道立水産孵化場)・柴田尚志 (北海道立水産孵化場)・本間 馨 (小樽市立水族館) (49-58)

Some observations on the breeding of rainbow trout, *Salmo gairdneri irideus* Gibbons, in salt Water.

Teruhiko Awakura, Hisashi Shibata and Kaotu Honma

7, 北海道東部河川に遡上したオシヨロコマについて

疋田豊彦 (59-65)

On the sea-runs charr *Salvelinus malma* (Walbaum), taken from an eastern stream of Hokkaido island.

Toyohiko Hikita

8, 硝子ファイバー製孵化盆による魚卵の附着試験 (I) シシャモ卵について

大東信一 (北海道立水産孵化場)・柴田尚志 (北海道立水産孵化場) (65-68)

An experiment on the adhesion of fish egg with the tray made of the glass fiber cloth. 1. On the egg of long finned smelt, *Spirinchus lanceolatus* (Hikita).

Shinichi Ohigashi and Hisashi Shibata

9, 養魚餌料の研究 (XII) 粉末肝臓配合による養魚餌料の効率試験

寺尾俊郎 (北海道立水産孵化場) (69-74)

Studies on the fish-culture food. (XII) On the effect of dry liver powder upon the growth of carp yearlings.

Toshiro Terao

10, 養魚餌料の研究 (XIII) 北洋産フィッシュ・ミール配

合による養鯉餌料の効率試験

寺尾俊郎（北海道立水産孵化場）（75-81）

Studies on the fish-culture food. (XIII) On the effect of fish meal, made of marine products from northern pacific ocean, upon the growth of carp.

Toshiro Terao

第18号（1963）

1, 産卵期における魚類の生理生態学的研究（I）遡上サケ親魚の酸素消費量について

粟倉輝彦（北海道立水産孵化場）（1-10）

Physiological and ecological studies on the fishes at spawning stage. I. On oxygen consumption of spawning chum salmon, *Oncorhynchus keta* (Walbaum).

Teruhiko Awakura

This is a report on oxygen consumption of the spawning chum salmon which has entered the river. The measurement of oxygen consumption was made using the open system apparatus designed for mature salmon as shown in Fig. 1. After some preliminary tests with this apparatus, oxygen consumption was measured employing chum salmon which have migrated up the Tokachi and Chitose river in Hokkaido. The results obtained are as follows:

1. The oxygen consumption of spawning chum salmon is found to be between 60.9 and 165.3 cc/kg/hr., after 6 to 8 hours from the beginning of the test under the condition which the water flowed 2 to 4 L/min. through the respiration chamber at the water temperature of 9.0 to 15.3 °C (Table III).

2. The relationship between oxygen consumption (Y) and water temperature (X) is shown in the following formula.

$$Y = 0.03983e^{0.1222X}$$

From this formula, temperature coefficient (Q10) was calculated as 3.39. This value is higher than

that of other kinds of fishes.

3. Regardless of maturity, remarkable difference of oxygen consumption between male and female was not recognized. However, there may exist some relationships between maturity and oxygen consumption especially in female. It was found that there is higher oxygen consumption in immature chum salmon than in mature one.

2, サケの飼育に関する研究

小林哲夫（北海道さけ・ますふ化場）・粟倉輝彦（北海道立水産孵化場）・本間馨（小樽市立水族館）・田村 正（北海道大学水産学部）（11-26）

Study of rearing of the salmon, *Oncorhynchus keta* (Walbaum).

Tetsuo Kobayashi, Teruhiko Awakura, Kaoru Honma and Tadashi Tamura

3, シシャモの生態調査 II 地域性について

伊藤小四郎（北海道立水産孵化場）（27-40）

Ecological studies of the long finned smelt, *Spirinchus lanceolatus* (Hikita). II. On the local forms.

Koshiro Ito

4, 北海道産の俗称“イワメ”について

疋田豊彦（北海道さけ・ますふ化場）（41-44）

On a salmonid fish known as “Iwame” in local name within Hokkaido.

Toyohiko Hikita

5, サケ×ヒメマスの交雑種に関する研究 I 受精卵より当才魚迄の成長及歩留について

寺尾俊郎（北海道立水産孵化場）・内山正昭（北海道立水産孵化場）・倉橋澄雄（北海道立水産孵化場）・松本春義（北海道立水産孵化場）（45-58）

Studies on the interspecific salmonoid hybrids between chum salmon, *Oncorhynchus keta* (WALBAUM) and kokanee salmon, *Oncorhynchus nerka* var. *adonis* (JORDAN et MCGREGOR) - I. Survival and growth from fertilized eggs to fry.

Toshiro Terao, Masaaki Uchiyama, Sumio

Kurahashi and Haruyoshi Matsumoto

6, 十勝川水系(千代田大橋-大津・十勝太)の水質並びに底質の季節的变化について

吉住喜好(北海道立水産孵化場)・伊藤安男(北海道立水産孵化場)・細川澄夫(北海道さけ・ますふ化場)(59-82)

Seasonal observations on the chemical substances of water and mud in Tokachi River (Chiyodaohashi-Otsu・Tokachibuto) in 1961 to 1963. Kiyoshi Yoshizumi, Yasuo Ito and Sumio Hosokawa

7, 澱粉工場廃水の流入する河川の自浄についての測定結果

江口 弘(北海道立水産孵化場)(83-86)

Processes of self-purification of river contaminated by starch waste.

Hiroshi Eguchi

8, 二股人工湖(シューパロ湖)の1963年6月と10月の陸水学的条件

長内 稔(北海道立水産孵化場)(87-92)

On the limnological observations of the Futamata Reservoir, Lake Shuparo, in June and October, 1963.

Minoru Osanai

9, 桂沢人工湖の湖沼学的条件と魚類の増殖

寺尾俊郎(北海道立水産孵化場)・今井 輝(三笠市役所)(93-122)

Limnological conditions and fish culture in Reservoir Katsurasawa, Hokkaido.

Toshiro Terao and Akira Imai

10, 石狩川古川の陸水学的研究 I 石狩川古川の水利条件とプランクトン相の季節変化

黒萩 尚(北海道さけますふ化場)・長内 稔(北海道立水産孵化場)(123-146)

Limnological studies on the old water ways of the Ishikari River. I. The seasonal variation of hydrographic conditions and plankton

communities of the Ishikari-Furukawa

Takashi Kurohagi and Minoru Osanai

11, 亜鉛の魚に対する毒性に関する試験

高安三次(北海道立水産孵化場)・木村義一(北海道さけ・ます孵化場)(147-172)

Studies on the toxicity of Zn-salts to salmonid fishes.

Mitsugu Takayasu and Giichi Kimura

第19号(1964)

1, サケ科魚類に寄生したカワシンジュガイ幼生について

粟倉輝彦(北海道立水産孵化場)(1-16)

On the parasitic glochidium of the fresh-water pearl mussel, *Margaritifera margaritifera* (L.) on salmonid fish.

Teruhiko Awakura

This is a report concerning the parasitic glochidium of the fresh-water Pearl mussel, *Margaritifera margaritifera* (L.) on the gills of salmonid fish in the Chitose river in Hokkaido. During parasitological observations on some fish and benthos to elucidate the microsporidian infection of salmonid fish in the Chitose river, the present writer fortunately found some ecology of the glochidia of the fresh-water pearl mussel and some physiological effects of the parasitic glochidia on fish. The spawning of fresh-water pearl mussels takes place from the middle of June to early August. The glochidia were observed in the marsupium of female mussels from the end of July to the middle of August. The glochidia lived only on the gill lamella of salmonid fish from early August to the end of September. The host fish were fingerings of *Oncorhynchus masou* and *Salmo gairdnerii irideus* in the natural condition as well as in the breeding condition. The glochidia were found

also on the gill lamella of fingerings of *O.keta*, *O.nerka* and 2 years old *O.nerka*. However, they were not observed on the gills of both young and mature fish of *Tribolodon hakonensis hakonensis*, *Cottus nozawae* and *Barbatula toni oreas* in the natural condition nor on the gills of young of *Carassius auratus*, *Cyprinus carpio*, *T.hakonensis hakonensis*, *Pleoglossus altivelis* and 2 years old *S.gairdnerii irideus* in the breeding condition. The glochidia living on the gills were enclosed by the epithelium of gill lamella and showed metamorphosis and growth. The size of the glochidium when first found of the gill lamella of fish was 0.07mm to 0.09mm in length and 0.06mm to 0.08mm in width. However, just before falling off, it was 0.44mm to 0.46mm long, 0.28mm to 0.30mm wide. The relationship between the length (X) and the width (Y) is shown by following for: $Y=0.0084+0.8420X - 0.4171X^2$ The glochidia on the gill lamella of fish which were bred artificially, were more numerous than that of naturally bred fish, the number being 10,931 maximum and 4,801 mean in 2 year-old *O.nerka*, 375 maximum, 264 mean in the fingerings of *O.nerka* and 2,137 maximum, 527 mean in the fingerings of *O.keta* in the breeding condition; whereas in the natural condition, it was 118 maximum, 31 mean in the fingering of *O.masou*, 76 maximum, 12 mean in the fingerings of *S.gairdnerii irideus*. The hematocrit of the fish blood with most glochidia parasites was found to be a little higher than that of normal fish. This fact may indicate that the infected fish is in a suffocating condition and it is highly probable that the parasites bring about some physiological change in the host fish.

2, シンヤモの生態調査 III 天然産卵について
伊藤小四郎 (北海道立水産孵化場) (17-26)

Ecological studies of the long finned smelt, *Sprinchus lanceolatus* (Hikita). III. Observations on the natural spawning.

Koshiro Ito

3, 佐呂間湖産魚類

疋田豊彦 (北海道さけ・ますふ化場)・柴田尚志 (北海道立水産孵化場) (27-34)

Fishes of Lake Saroma, Hokkaido

Toyohiko Hikita and Hisashi Shibata

4, トリカイン・メタサルフォネート (M.S.222) によるサケ科稚魚の麻酔試験

寺尾俊郎 (北海道立水産孵化場) (35-42)

Narcotization of salmonoid fish fry with tricaine methasulfonate (M.S.222)

Toshiro Terao

5, サケ×ヒメマス交雑種に関する研究 II. 交雑種 (F1) の支笏湖及びオコタンベ湖への移殖放流試験 1. 寺尾俊郎 (北海道立水産孵化場)・菊地資郎 (北海道さけ・ますふ化場)・内山正昭 (北海道立水産孵化場)・倉橋澄雄 (北海道立水産孵化場)・松本春義 (北海道立水産孵化場)・阿部春三 (北海道立水産孵化場) (43-64)

Studies on the interspecific salmonoid hybrids between chum salmon *Oncorhynchus keta* (Walbaum) and kokanee salmon *O.nerka* var. *adonis* (Jordan et McGregor)- II. Transplantations of salmonoid hybrids to Lake Shikotsu and Lake Okotampe (1).

Toshiro Terao, Shiro Kikuchi, Masaaki Uchiyama, Sumio Kurahashi, Haruyoshi Matsumoto and Haruzo Abe

Salmonoid hybridization was carried out with milt and ova between anadromous chum salmon (*Oncorhynchus keta*) caught from the Chitose River, a tributary of the Ishikari River and adult kokanee salmon (*O.nerka* var. *adonis*) caught from Lake Shikotsu, Hokkaido. The authors (1963) have reported that body growth of the reciprocal hybrids cultured in the ponds is found at least, in the first year, to be more rapid than of their respective parental species (cf. Terao et

al., 1963). In order to make an ecological study on their growth, feeding habit, mortality and maturity in the field, fry of these reciprocal hybrids were released to two lakes, Lake Shikotsu and Lake Okotampe, in years of 1963 and 1964.

Body size and number of the fry released to the lakes are presented in Table 3. The authors have succeeded to collect five specimens of the second year age of chum salmon (♀) X kokanee salmon (♂) hybrid from Lake Shikotsu and twenty-one specimens of the first year-age of kokanee salmon (♀) X chum salmon (♂) hybrid from Lake Okotampe. Observations made on the body growth and some external and internal characteristics of these specimens are described in this paper.

6, 北海道陸水の水質資料 (V)

吉住喜好 (北海道立水産孵化場) (65-88)

Data on the studies of chemical composition of inland water in Hokkaido (V)

Kiyoshi Yoshizumi

7, 養魚餌料の研究 (XIV) ビタミン E 剤添加餌料がサケ稚魚に及ぼす効果について

寺尾俊郎 (北海道立水産孵化場) · 倉橋澄雄 (北海道立水産孵化場) (89-94)

Studies on the fish-cultured food (XIV). On the effect of the incorporation of the vitamin E complex in the diet with the chum salmon fry.

Toshiro Terao and Sumio Kurahashi

Vitamin E or α -Tocopherol is a fat-soluble vitamin that is essential for the proper of animals. The biological functions of vitamin E have been summarized in these categories: as a fat-soluble physiological antioxidant, as a physiological synergist, and as a functioning portion of specific enzyme systems. α -Tocopherol is the only antioxidant that has been shown to be absorbed through the intestinal wall and deposited in the fat. Vitamin E has the ability to promote the

actively of easily oxidized substances such as the carotenoids and vitamin A. Incorporation of vitamin E in the diet has been reported to increase liver deposition of vitamin A and to improve the growth. In cultured rainbow trout, Samegai Trout Hatchery (1961) reported in the effects of vitamin E. Iizuka and Yamazaki (1963) reported incorporation of vitamin E in the diet was the curatical action of "Watakaburi" disease on the eel. As vitamin E complex "Nisshin-E-Feed" was auditioned in the diet contained unsaturated fat with chum salmon fry, some of results obtained with it are the subject of this relative feeding trial. In result, we obtained that incorporation of vitamin E in the diet contained unsaturated fat in rapidly growing fry of chum salmon recognized the occurrence of decreased mortality.

8, 清水沢人工湖の予報調査 (養殖適地調査)

江口 弘 (北海道立水産孵化場) · 長内 稔 (北海道立水産孵化場) (95-104)

A preliminary observation of the Shimizusawa Reservoir, with special regard to its suitability for pisciculture.

Hiroshi Eguchi and Minoru Osanai

9, 最近に於ける豊似湖の湖沼条件について

長内 稔 (北海道立水産孵化場) · 江口 弘 (北海道立水産孵化場) (105-110)

Recent observation on limnological conditions of Lake Toyoni, Hokkaido.

Minoru Oanai and Hiroshi Eguchi

10, 留萌市郊外の2池沼藤山貯水池及び秋田沼の陸水学的観察資料

大東信一 (北海道立水産孵化場) · 黒萩 尚 (北海道さけ・ますふ化場) (111-118)

Limnological notes of two small lakes in neighbouring of Rumoi City in northern Hokkaido.

Shinichi Ohigashi and Takashi Kurohagi

11, 勇払郡厚真町池沼群の陸水学的条件

大東信一（北海道立水産孵化場）・黒萩 尚（北海道さけ・ますふ化場）・長内稔（北海道立水産孵化場）（119-129）

Limnological conditions of several ponds in Azuma-cho, southern Hokkaido.

Shinichi Ohigashi, Takashi Kurohagi and Minoru Osanai

第20号（1965）

1, サケ科魚類の *Plistophora* 病に関する研究 - I 千歳川における発生状況と病理

粟倉輝彦（北海道立水産孵化場）（1-28）

Studies on the plistophora disease of salmonoid fishes - I. Observation on the state of the occurrence and the cause in Chitose River in Hokkaido.

Teruhiko Awakura

This is a report concerning the state of the occurrence and the cause of the *Plistophora* disease of salmonoid fishes in the Chitose river in Hokkaido. In the line of the Chitose river, *Plistophora* disease occurred only in limited areas. It was not found in Shikotu lake, the source of the Chitose and Naibetsu rivers, confluent to the infected area of the Chitose river. Infected fishes were limited to salmonoid fishes, chum salmon (*Oncorhynchus keta*), kokanee salmon (*Oncorhynchus nerka* var. *adonis*), masu salmon (*Oncorhynchus masou*) and rainbow trout (*Salmo gairdnerii irideus*) of both the breeding fish in the river pond and natural fish in the Chitose river. Takeda (1933) reported that the disease was caused by *Plistophora* sp. parasiting to the epicardium of rainbow trout. Parasites were found only in the heart muscle in chronic cases, but in acute cases, they were found also in the trunk muscle, fin muscle, masticatory muscle, eye muscle, throat muscle and gullet muscle as well as in the heart muscle. The parasite caused

various pathological changes in the muscular tissues. In the heart muscular tissues, the infiltration of inflammatory cells and the multiplication of the connective tissues were observed. These pathological changes in the tissues were induced by the multiplication of the parasites and were observed after the sprogony of *Plistophora* sp. had been completed. Many tubers were formed and the tissues became hypertrophied. The heart was deformed and also hypertrophied. In the chronic case, the parasite died in the multiplied connective tissues and natural recovery was sometimes observed. In the trunk muscular tissues and others, the changes in muscular tissues caused by the parasite were not remarkable. But there were numerous and large spindle-shaped colonies (2 to 3 mm wide, 3 to 6 mm long) formed and the surrounding muscle fibers showed abnormal signs. In the artificially bred salmonoid fishes such as chum salmon, kokanee salmon and rainbow trout in the river pond, the earliest parasitism of *Plistophora* sp. was observed in the heart muscle from the end of July to early August and it was observed in the artificially bred fishes that were translated from the well pond to the river pond by early September. Young fish (fingering or 1 year old) that were bred, such as rainbow trout, showed acute changes caused by the infection of the disease and the parasitism of *Plistophora* sp. Progressed from the heart muscular tissues to the trunk muscular tissues. But more advanced fish (2 years old) showed chronic changes and the parasitism was limited in the heart muscular tissues. In the former case, many fish died at the time. However, in the latter, it was not observed. In masu salmon and rainbow trout of the same age, the condition of the disease in the breeding and the natural condition differed from each other, the former being acute and the latter chronic. In the artificially bred rainbow trout, A/G ratio of the serum protein decreased according to the rise of the

environmental water-temperature in summer and it showed the lowest value at the period of the infection. This tendency was also found in naturally inhabited masu salmon and rainbow trout in the Chitose (18.5°C) and the Naibetsu rivers (11.0°C) in August. The inflammation of the intestine, the parasitism of glochidia, exophthalmus and ichthyophthiriasis were sometimes observed as complications of this disease. The progress of the disease and the appearance of the fish which died are influenced by the age of the fish which were bred, environmental water-temperature, breeding conditions and the development of the complication of this disease.

2, サケ×ヒメマス交雑種に関する研究 III. 交雑種 (F1) の生殖能力と外観について

寺尾俊郎 (北海道立水産孵化場) ・内山正昭 (北海道立水産孵化場千歳支場) ・倉橋澄雄 (北海道立水産孵化場千歳支場) ・松本春義 (北海道立水産孵化場千歳支場) (29-36)

Studies on the interspecific salmonoid hybrids between chum salmon *Oncorhynchus keta* (Walbaum) and kokanee salmon *Oncorhynchus nerka* var. *adonis* (Jordan et McGregor) -III. On some external characteristics and fertility of F1 hybrids.

Toshiro Terao, Masaaki Uchiyama, Sumio Kurahashi and Haruyoshi Matsumoto

F1 hybrids between kokanee salmon (*Oncorhynchus nerka* var. *adonis*) and chum salmon (*O.keta*) have been reared up to the age of sexual maturity in a pond at the Chitose Station, Hokkaido Fish Hatchery. Observations were made of their external characteristics and fertility. Mature individuals observed were as follows: 3 females and 2 males of chum female X kokanee male hybrid, and 2 females and 2 males of kokanee female X chum male hybrid. Even apparently, the individuals of these reciprocal hybrids were easily judged to be sexually mature from the external

secondary sexual characteristics, body colour, and their characteristic development of shape of the head. These mature hybrids were either 3 or 4 years old. The maturation index (percentage of gonad weight for body weight) of F1 hybrids was smaller than those of the parent species in nature. Number of the eggs obtained from these individuals of the F1 hybrids ranged from 580 to 630. The mature reciprocal F1 hybrids were backcrossed to chum salmon and were crossed between female and male of chum female X kokanee salmon male. In these experiments, the former showed a very good result, but latter was inferior to the result obtained between male and female of the parent species.

3, 天塩川水系 (土別-天塩) の水質について

吉住喜好 (北海道立水産孵化場) ・大久保正一 (北海道さけ・ますふ化場天塩支場) ・早坂誠一 (北海道さけ・ますふ化場天塩支場) (37-64)

Water conditions of the Teshio River (Shibetsu-Teshio) in 1963 to 1965.

Kiyoshi Yoshizumi, Shoichi Okubo and Seiichi Hayasaka

4, 農薬のサケ及びヒメマス稚魚に対する毒性試験

寺尾俊郎 (北海道立水産孵化場) (65-86)

Toxicity of agricultural control chemicals to the fry of chum salmon and kokanee salmon.

Toshiro Terao

Agricultural control chemicals have been used extensively by many farmers. On the contrary, however, their damage done to fish have been reported repeatedly. The present experiments were made to reveal the critical concentration of twelve kinds of the agricultural control chemicals to the fry of chum salmon and kokanee salmon as any study has not been made on the influence of such chemicals upon salmonoid fish. Tests were conducted on the procedure of a bioassay which has routinely been made in the case of JIS of

industrial waste. The TLM values for the fry tested in the various concentrations of the solutions of these chemicals are indicated in Table 2.

5, 産業廃水が魚類にあたる影響の一評価法としての肝臓グリコーゲン量に関する二三の知見

粟倉輝彦 (北海道立水産孵化場) (87-94)

Some observation on the glycogen content of fish liver for an estimation of the effects on fish caused by industrial waste.

Teruhiko Awakura

The glycogen content of fish liver as the estimation of the physiological effects caused by industrial waste were observed by the optical measurement of histochemical reaction and the common chemical analysis on carp, *Cyprinus carpio*, chum salmon fry, *Oncorhynchus keta* and mature chum salmon. It is known that the optical measurement on the PAS-reacted preparation of fish liver is the practical method for the estimation of the change of glycogen content. The effects of pulp mill waste on chum salmon fry and carp were shown plainly in the absorbance of PAS-reacted preparation. In the mature chum salmon, the glycogen content of liver changed remarkably by the degree of maturity and movement. Hence it appears that the glycogen content of mature chum salmon cannot be used an estimation of the effects caused by industrial waste.

6, 最近に於ける糠平人工湖の湖沼条件について

江口 弘 (北海道立水産孵化場)・長内 稔 (北海道立水産孵化場)・黒萩 尚 (北海道さけ・ますふ化場)・外崎 久 (北海道立水産孵化場) (95-108)

Recent observation on limnological conditions of Lake Nukabira, a reservoir, in Hokkaido.

Hiroshi Eguchi, Minoru Osanai, Takashi kurohagi and Hisashi Tonosaki

7, オンネトーとタンネトーの陸水学的条件について (養殖適地調査)

長内 稔 (北海道立水産孵化場)・江口 弘 (北海道立水産孵化場) (109-116)

Limnological conditions of Lake Tanneto and Onneto, on bog lakes at Nemuro in Hokkaido, with special regard to its suitability for pisciculture.

Minoru Osanai and Hiroshi Eguchi

8, 塘路湖の水理条件

大東信一 (北海道立水産孵化場)・黒萩 尚 (北海道さけ・ますふ化場) (117-130)

The physical and chemical conditions of Lake Toro.

Shinichi Ohigashi and Takashi Kurohagi

9, 塘路湖のプランクトン (I) 植物性種類について

黒萩 尚 (北海道さけ・ますふ化場)・大東信一 (北海道立水産孵化場) (131-138)

The plankton of Lake Toro (I). The flora.

Takashi Kurohagi and Shinichi Ohigashi

The authors studied planktonic algae collected in Lake Toro, a shallow bog lake 6.53 square kilometers, locating in Shibecha-cho of Kushiro Province of south-eastern Hokkaido, at each season from late October of 1961 to middle June of 1963. 40 species of the algae, including 3 species of Cyanophyceae, 36 species of Bacillariophyceae and 1 species of Dinoflagellatae, were identified (Table 1). *Melosira ambigua* of Bacillariophyceae was rich in early spring, and *Aphanizomenon flos-aquae* of Cyanophyceae was frequent during the period between late spring and late autumn, the later forming dense water-bloom in late summer.

10, カラフトマス矮小形の一例について

疋田豊彦 (北海道さけ・ますふ化場) (139-141)

On a dwarf form of the adult pink salmon, *Oncorhynchus gorbuscha* (Walbaum).

Toyohiko Hikita

第21号 (1966)

1, サケ科魚類の *Plistophora* 病に関する研究 II 新しい発生地について

栗倉輝彦 (北海道立水産孵化場) ・倉橋澄雄 (北海道立水産孵化場) ・松本春義 (北海道立水産孵化場) (1-12)

Studies on the plistophora disease of salmonoid fishes- II . Occurrence of the microsporidian disease in a new district.

Teruhiko Awakura, Sumio Kurahashi and Haruyoshi Matsumoto

The *Plistophora* disease of salmonoid fishes has hitherto been reported the limited area in the Chitose river in Hokkaido. In 1965, we found a new infected area of the disease, in the suburbs of Tomakomai City, southwestern Hokkaido. A number of rainbow trouts, *Salmo gairdnerii irideus* in the Tokito Numa died towards the end of July to early August in 1965. At that time they showed the decided conditions of the *Plistophora* disease, and the microsporidia common to the disease in the case of Chitose river were observed in the heart and body muscle of the rainbow trout. Although the fresh water fishes belonging to five families, seven genera and seven species are known to inhabit in this pond, the microsporidia were observed only on the rainbow trout, the only one species of the salmonoid fish living in this pond. The rainbow trout was acclimatized to the pond at first in 1962, and afterwards this is transplanted successively. The microsporidia found in this pond are not presumed to have been introduced by the transplanted rainbow trout, but by another organism inhabiting in this pond. The occurrence of the disease and unusual death of rainbow trout resulted from it in this pond are thought to be influenced especially by the high water-temperature. Therefore it is concluded that the rainbow trout is not good for the object cultured

in this pond.

2, サケ×ヒメマス交雑種に関する研究 IV. 交雑種 (F1) の体節的特徴変異の親魚種との比較について

寺尾俊郎 (北海道立水産孵化場) ・内山正昭 (北海道立水産孵化場) 倉橋澄雄 (北海道立水産孵化場) ・松本春義 (北海道立水産孵化場) 吉崎 勲 (北海道立水産孵化場) ・阿部春三 (北海道立水産孵化場) 奥野敦 (北海道さけ・ますふ化場) (13-42)

Studies on interspecific salmonoid hybrids between chum salmon, *Oncorhynchus keta* (Walbaum) and kokanee salmon, *Oncorhynchus nerka* var. *adonis* (Jordan et McGregor) - IV. Morphological comparison of variation in some meristics characters of hybrids (F1) and parent species.

Toshiro Terao, Masaaki Uchiyama, Sumio Kurahashi, Haruyoshi Matsumoto, Isao Yoshizaki, Haruzo Abe and Atsushi Okuno.

In order to study a morphological variation in the reciprocal hybrids of chum and kokanee salmon, some meristic characters of them were statistically compared with those of the parent species. The specimens used are composed of the following eight groups; that is, (1) adult chum salmon caught from the Chitose River, (2) adult kokanee salmon caught from the Shikotsu Lake, (3) chum salmon, 1-2 years old, cultured in pond after artificially fertilized, (4) kokanee salmon, 1-4 years old, cultured in pond after fertilized, (5) & (6) reciprocal hybrids, 4 years old, cultured in pond (7) & (8) reciprocal hybrids, transplanted into the Shikotsu Lake at their fingerling stage and recaptured after 4 years. Among these, the specimens of (3)-(6) are those which were reared in the same experimental pond. Both the hybrids and their parent fishes showed a high similarity in each of the numbers of the branchiostegal bones, the dorsal, pectoral, ventral and anal fin rays, and of the vertebral bones, though a considerable difference was found in each of the

numbers of the gill raker and pyloric caeca between them. In the gill raker, both of the reciprocal hybrids displayed a wider variation in number ranging from 20 to 35 and from 22 to 33, respectively, when compared with those of the parent species which showed to be 20 to 25 in chum and 29 to 35 in kokanee. Respecting the number of the pyloric caeca, each of the reciprocal hybrids showed an intermediate range of the variations found in both of the parent fishes. Generally speaking, however, the variation of the number of the pyloric caeca in the hybrids was found to show a stronger resemblance to chum than to kokanee. It was found from the present study that each of the reciprocal hybrids displays to have the respective proper meristic characters irrespective of both age and environment. Consequently, it may be said that these characters of the hybrids are formed being controlled more strongly by some hereditary factors rather than by the secondary ones.

3, 日本におけるニジマス (*Salmo gairdnerii irideus* GIBBONS) の Ichthyosporidium disease に関する病理学的研究

小野 威 (帯広畜産大学 家畜病理学教室) ・兼子樹広 (帯広畜産大学 家畜病理学教室) ・粟倉輝彦 (北海道立水産孵化場) ・青海昭紀 (大日本製薬) (43-54)

Pathological studies on Ichthyosporidium disease in rainbow trout (*Salmo gairdnerii irideus* GIBBONS).

Takeshi Ono, Mikihiro Kaneko, Teruhiko Awakura and Akinori Aomi

Authors have made histopathological investigation on five cases of an epizootic occurred on the rainbow trout in a private fish farm in Hokkaido. The results obtained are summarized as follows:
1) The epizootic showed the identical lesion with Ichthyosporidium disease in the marine and fresh water fishes.

2) The disease is considered to have been introduced to this fish farm through the feeding of the infected marine fishes.

4, 西別川および標津川の水質について

吉住喜好 (北海道立水産孵化場) ・小林明弘 (北海道さけ・ますふ化場根室支場) ・柳瀬雅子 (北海道立水産孵化場) (55-70)

Water conditions of the Nishibetsu and Shibetsu Rivers.

Kiyoshi Yoshizumi, Akihiro Kobayashi and Masako Yanase

5, 糠平人工湖のヒメマスについて

長内 稔 (北海道立水産孵化場) ・外崎 久 (北海道立水産孵化場) ・大塚三津男 (北海道立水産孵化場) (71-80)

Studies on the kokanee salmon (*O. nerka* var. *adonis*) of Lake Nukabira, a reservoir, in Hokkaido.

Minoru Osanai, Hisashi Tonosaki and Mitsuo Otsuka.

6, 石狩沼のワカサギの食性とプランクトンとの関係 故 富田光政・羽田良禾 (広島県鈴峯女子短期大学) (81-90)

The relation between the food of *Hypomesus olidus* (PALLAS) and the plankton in Lake Ishikari.

Late Mitsumasa Tomita and Yoshine Hada

7, 最近における洞爺湖の様相について

江口 弘 (北海道立水産孵化場) ・黒萩 尚 (北海道さけ・ますふ化場) (91-98)

Recent observation on limnological condition of Lake Toya, in Hokkaido.

Hiroshi Eguchi and Takashi Kurohagi

8, カワシンジュガイ *Margaritifera laevis* (HAAS) を母貝とする真珠養殖事業の成果について

岡田 雋 (北海道大学水産学部) ・田村 正 (北海道大学水産学部) ・五十嵐孝夫 (北海道大学水産学部)

(99-117)

Failure of a pearl culture industry using freshwater pearl mussel, *Margaritifera laevis* (HAAS), as mother shell in Hokkaido, Japan.

Shun Okada, Tadashi Tamura, and Takao Igarashi

第22号 (1967)

1, 泥土水による水産被害について

江口 弘 (北海道立水産孵化場)・櫻庭弘文 (北海道さけ・ますふ化場) (1-4)

On the effects of muddy water upon fisheries.

Hiroshi Eguchi and Hirobumi Sakuraba

2, 遊楽部川の水質について

吉住喜好 (北海道立水産孵化場)・柳瀬雅子 (北海道立水産孵化場)・尾崎岨志 (北海道さけ・ますふ化場渡島支場) (5-16)

Water conditions of the Yurappu River.

Kiyoshi Yoshizumi, Masako Yanase and Yasuji Ozaki

3, サクラマスと産卵生態に関する研究 I 溯河サクラマスの形態と産卵生態について

長内 稔 (北海道立水産孵化場)・大塚三津男 (北海道立水産孵化場) (17-32)

Ecological studies on the masu salmon, *Oncorhynchus masou* (Brevoort), of Hokkaido.

1. Morphology and spawning habit of the masu salmon which ascends the river.

Minoru Osanai and Mitsuo Otsuka

4, サケ×ヒメマス交雑種に関する研究 V. 試験池で養成したサケ, ヒメマスとその相互交雑種(F1)との生態的特徴の比較について

寺尾俊郎 (北海道立水産孵化場)・内山正昭 (北海道立水産孵化場)・倉橋澄雄 (北海道立水産孵化場)・松本春義 (北海道立水産孵化場) (33-50)

Studies on interspecific salmonoid hybrids between chum salmon, *Oncorhynchus keta* (Walbaum)

and kokanee salmon, *Oncorhynchus nerka* var. *adonis* (Jordan et McGregor)- V. Comparison of variations of some ecological characters in hybrids (F1) and parent fishes cultured in rearing pond.

Toshiro Terao, Masaaki Uchiyama, Sumio Kurahashi and Haruyoshi Matsumoto

1. In order to study variation of some ecological characters in the reciprocal hybrids F1 of chum salmon and kokanee salmon, growth rate, sexual maturity, body colour, and behavior were compared with those of the parent species. The specimens used are those which were cultured for 5 years from October, 1962 to December, 1967, in the neighboring four ponds of each 2.7m X2.7m X0.9m, and those are composed of the following two parent species and two hybrids: (1) chum, (2) kokanee, (3) hybrid F1 of chum X kokanee, and (4) hybrid F1 of kokanee X Chum.

2. Although it has been known that growth rate is higher in chum than in kokanee, that of both hybrids was found to be intermediate between those of the parent species. In young's of the hybrids up to 2 years old, however, a considerable number of the specimens showed in their growth rate to resemble more closely the chum than the kokanee.

3. Survival rate of both hybrids was lower than that of the kokanee but higher than in the chum, which showed to be extremely low, especially in the specimens older than 2 years.

4. In contrast to that most of the kokanee males attained their maturity in 3 years after hatching; the majority of both hybrid males became adult in 3 or 4 years. Further, the kokanee females attained their maturity in 3 or 4 years after hatching, while the females of both hybrids were found to become adult in 4 or 5 years.

5. Although body colour of all the specimens used in the present experiment changed as they grew, the body colour of both hybrids was found

to resemble more closely that of the chum than in the kokanee. In most specimens of both hybrids, the parr mark showed a complicated pattern which appears to be overlapped each other two kinds of them characteristic to the respective parent species.

6. Behaviors such as schooling, swimming ability and feeding manner of both hybrids were observed to resemble more closely those of the chum than in the kokanee.

7. Largest number of the eggs was as follows: 528 in kokanee, 870 in kokanee X chum, and 872 in chum X kokanee. When calculated the ratio of number of eggs per body weight, however, it was found that the values of both hybrids are conversely smaller than that of the kokanee.

8. It was clarified from the present study that the ecological characters of both hybrids are found to be intermediate between those of the parent species similarly as in the case of the meristic characters of the hybrids reported previously.

5, サケ科魚類の *Plistophora* 病に関する研究—III 治療予防法について

栗倉輝彦 (北海道立水産孵化場) · 倉橋澄雄 (北海道立水産孵化場) (51—68)

Studies on the *plistophora* disease of salmonoid fishes—III. On prevention and control of the disease.

Teruhiko Awakura and Sumio Kurahashi

To establish the treatment for the *Plistophora* disease of salmonoid fishes, the authors examined the acquired immunity, temperature treatment and chemotherapy. The results obtained are as follows.

1) Infected fishes acquired the remarkable immunity. Resistance to reinfection may last as long as one year.

2) Shyzo-gony of the microsporidia was stopped by transferring to the low temperature, 8.0—8.4 °C.

3) Multiplications of microsporidia was controlled by the breeding under the temperature, 8.2—16.8 °C, but the infection was extended in complication with bacterial disease.

4) Preventive effects not recognized in the six experimented drugs. But the rising effects of the survival rate of infected fishes or the obstruction of the multiplication of microsporidia were observed in the fishes treated with Sulfaisomidine, Sulfamonomethoxine, Sulfadimethoxine, Nitrofrason and Amprolium.

6, 北海道十勝地方の一泥炭地沼, 幌岡大沼の予察調査
大東信一 (北海道立水産孵化場) · 黒萩 尚 (北海道さけ・ますふ化場) · 疋田豊彦 (北海道さけ・ますふ化場) · 田中寿雄 (北海道立水産孵化場) (69—82)

Limnological reconnaissance of Horo-oka-onuma, a bog lake of Tokachi district, Hokkaido.

Shinichi Ohigashi, Takashi Kurohagi, Toyohiko Hikita and Hisao Tanaka

7, 塘路湖のプランクトン (II) 動物性種類について
黒萩 尚 (北海道さけ・ますふ化場) · 大東信一 (北海道立水産孵化場) (83—94)

The plankton of Lake Toro—(II) The fauna.

Takashi Kurohagi and Shinichi Ohigashi

Observations of planktonic fauna of Lake Toro, a bog lake having an area of 2.65 sp. km. with the maximum depth of 6.5m., locating in Schbecha-cho of Kushiro Province in south-eastern Hokkaido of north Japan, were made six times during the season from Oct., 1961 to June, 1963. The study of the morphological seasonal variation of Genus *Daphnia* according to the season in the lake was also carried out during the season from Oct. 1966 to June 1967. 21 species and 2 varieties were identified namely 9 species of Crustacea, 1 species of Mysidacea—*Neomysis intermedia*, 3 species of Cyclopoida—*Cyclops vicinus*, *Mesocyclops (Th.) crassus* and *Acanthocyclops bicuspidatus*, 5 species of Cladocera—*Diaphanozoma*

brachyurum, *Holopedium gibberum*, *Daphnia galeata*, *Bosmina coregoni* and *Leptodora kindtii*, 11 species and 2 varieties of Rotatoria; *Conochilus unicornis*, *Euclanis dilatata*, *Keratella cochlearis*, ditto var. *hispida*, ditto var. *tecta*, *Asplanchna priodonta*, *Polyarthra euryptera*, *P.longiremis*, *Synchaeta* sp., *Filinia longiseta*, *F.limnetica*, *Trichocerca capucina* and *T.similis*, and 1 species of Rizopoda; *diffugia* sp.. The dominant species were *Mesocyclops (Th.) crassus*, *Asplanchna priodonta*, *Keratella cochlearis* var. *hispida* and *Polyarthra longiremis* in middle spring, *Keratella cochlearis* var. *hispida* in late summer, and moreover *Cyclops vicinus* and *Bosmina coregoni* in late autumn, though they were not so rich in number. In summer, *Daphnia galeata* of the lake has a large pointed helmet and no ocellus, but a low rounded helmet and definite ocellus in winter.

第23号 (1968)

1, カワシンジュガイ有鉤子幼生の寄生生態について
栗倉輝彦 (北海道立水産孵化場) (1-22)

The ecology of parasitic glochidia of the fresh-water pearl mussel, *Margaritifera laevis* (Haas).
Teruhiko Awakura

The present author has observed the breeding habits of the fresh-water pearl mussel, *Margaritifera laevis* (Haas), and the relationship between the parasitic glochidia of the mussel and the host fishes from April 1964 to October 1966 in the Chitose River in Hokkaido. The results thus obtained are as follows;

- 1) The spawning of the mussels in the Chitose River takes place from middle of June to early August, and gravid and discharging of glochidia occur from middle of June to middle of August and from the end of July to middle of August respectively.
- 2) The number of gravid eggs ranged between

440,000 and 3,660,000 in the marsupia of female mussel. The shell length of the smallest gravitated female mussel was 54 mm.

3) The glochidia are observed to be only attached to the gill filaments of the host fishes. The parasitical stage of the glochidia lasted for 30 to 45 days.

4) The length of the glochidia ranged between 0.07 and 0.09 mm at the time of attachment and 0.42 to 0.44 mm at the time of its detachment from the gill filament of the host fishes.

5) Both, in the natural and experimental conditions, the parasitic glochidia of the mussels were only found in the gill filaments of salmonid fishes. However, different species of salmonid fish exhibited different susceptibility to the parasitism of glochidia depending on their age groups. In Chitose River, the fingerling of masu salmon, *Oncorhynchus masou* were observed to be most susceptible to the parasitism of glochidia.

6) The susceptibility of the fishes to parasitism of glochidia is influenced by the structure and nature of the gill lamellae, such as the presence of epithelial encystment and the intensity of the immune cyst formation.

7) Most of the fishes died due to the acute depression of gills caused by the presence of large number of parasitic glochidia. The fishes bearing a small number of glochidia did not show any abnormality, although occasionally they showed some bacterial infection. The bacterial infection was probably caused due to the lesions produced after the detachment of parasitic glochidia from the host fish.

2, サケ×ヒメマス交雑種に関する研究 VI. 支笏湖に放流したサケ♀×ヒメマス♂交雑種の分布と成長について

寺尾俊郎 (北海道立水産孵化場) ・内山正昭 (北海道立水産孵化場) ・倉橋澄雄 (北海道立水産孵化場) ・松本春義 (北海道立水産孵化場) (23-34)

Studies on interspecific salmonoid hybrids between chum salmon, *Oncorhynchus keta* (Walbaum) and kokanee salmon, *Oncorhynchus nerka* var. *adonis* (Jordan et McGregor) - VI. Growth and distribution of chum ♀ × kokanee salmon ♂ hybrids planted at Shikotsu lake.

Toshiro Terao, Masaaki Uchiyama, Sumio Kurahashi and Haruyoshi Matsumoto

1. In order to learn the life history and ecological patterns of the hybrid fish interbred between chum salmon ♀ and kokanee salmon ♂, the young specimens marked by cutting their adipose fins were transplanted in Lake Shikotsu, Hokkaido, Japan, during the period of 1963 to 1967, every year, successively. The present report deals with the result of the studies made on the specimens recaptured in the period of 1964 to 1967 year.

2. The specimens recaptured in the lake were composed of those of 0-4 years of age. However, a considerable number of the specimens of 0-year of age were recaptured in Chitose River (Fig. 1) during the season of summer to autumn. Such a downstream behavior of these young's may be due to their physiological changes resembling that of chum salmon young's. However, the behavior of the former appeared to be not so distinct as in the case of the latter.

3. Growth of the hybrid fish was much greater than that of kokanee salmon. For instance, body length of the hybrid fish of 1-year of age recaptured by angling in the lake was approximately as long as that of 3-year of age of kokanee salmon. Growth of the hybrid fish of 0-year of age resembles that of chum salmon. However, the hybrid fish showed a unique body form becoming fat gradually as they aged.

4. The depth of water at which the transplanted specimens were recaptured, was found to be closely related with the thermal stratification of 6 to 19 °C in the lake. This range, which corresponds to their habitable temperature, is wider than those of both parent fishes, that is 7 to 13

°C in kokanee salmon and 8 to 18 °C in chum salmon. Although the hybrid fish were recaptured even in the surface water and coastal areas of the lake, such a wide distribution of them was considered to be subsequent upon their inherent nature habitable in the wider range of water temperature as compared with the parent fishes.

3, 北海道陸水の水質資料 (VI)

吉住喜好 (北海道立水産孵化場) ・源 雅子 (十勝支庁・前調査課員) (35-62)

Data on the studies of chemical composition of inland water in Hokkaido (VI)

Kiyoshi Yoshizumi and Masako Minamoto

4, 人工湖金山湖の予察調査

長内 稔 (北海道立水産孵化場) ・田中寿雄 (北海道立水産孵化場) ・阿刀田光紹 (北海道立水産孵化場) (63-72)

A preliminary reconnaissance of Lake Kanayama, a reservoir in Hokkaido.

Minoru Osanai, Hisao Tanaka and Mitsuaki Atoda

第24号 (1969)

1, 澱粉工場排水の断続放流法が水産生物に及ぼす影響について

栗倉輝彦 (北海道立水産孵化場) ・阿刀田光紹 (北海道立水産孵化場) ・井上勝弘 (北海道立衛生研究所) ・千葉善昭 (北海道立衛生研究所) (1-12)

On the effect of the intermittently discharging of the waste water from the starch factory on aquatic animals.

Teruhiko Awakura, Mitsuaki Atoda, Katsuhiko Inoue and Yoshiaki Chiba

Experiments of the effect of the intermittent discharge of the starch factory waste on aquatic animals were carried out during the period from August 1967 to January 1968 in the Makkari river

in Hokkaido. From the results of the bioassay on rainbow trout by breeding in the fish preserve, it is highly probable that the physiological effect of intermittent discharge of the waste on rainbow trout is slight. In the areas effected by the intermittent discharge of the waste, aquatic animals decreased in number and were rarely observed. However, they showed the tendency of recovery in the latter period of the intermittent discharge. This tendency showed some correlation with the growth of slimy fungi in the Makkari river.

2, 生簀飼育による生物試験法の検討

粟倉輝彦（北海道立水産孵化場）・吉住喜好（北海道立水産孵化場）・伊藤富子（北海道立水産孵化場）・浅野俊威（北海道立水産孵化場）（13-26）

On the examination of the method to keep fishes in the fish preserve for the bioassay of the effects on fish caused by industrial waste.

Teruhiko Awakura, Kiyoshi Yoshizumi, Tomiko Ito and Toshitake Asano

Examination of the method to keep fishes in the fish preserve for the bioassay of the effects on fish caused by industrial waste was carried out four times using rainbow trout and masu salmon in the Ishikari and the Satsunai rivers in Hokkaido. The results demonstrated that the attention to the hygienic condition of the test fish and water temperature of the river are most important in keeping the fish in the fish preserve. The best result was obtained through the experiment, when the hygienic condition of the test fishes was normal and the water temperature of the river was relatively low.

3, カロチノイド含有脂質の投与効果試験 I. ヒメマス の成長, 成熟に及ぼす効果と体内脂質含有量及びカロチノイド含有量の変動

寺尾俊郎（北海道立水産孵化場）・太田 亨（北海道大学水産学部）・内山正昭（北海道立水産孵化場）・岡田鳳二（北海道立水産孵化場）（27-44）

Effects of dietary lipid containing carotenoid on fish culture. I. Effect on growth and maturation, and changes of carotenoid and lipid content in flesh of kokanee salmon.

Toshiro Terao, Toru Ota, Masaaki Uchiyama and Hoji Okada

It is well known that lipid added on the fish culture dry food are producing many nutritional functions with growth, maturities and thermal resistance, and that carotenoid substance is a necessity in Salmonoid fishes flesh. In order to test the effects of dietary lipid containing carotenoid on Salmonoid fish flesh, comparative breeding experiment of kokanee salmon of 2 ages was carried out by two groups divided into the test and the control for four months from spring to autumn in 1968. The oil used in experiment was Alaska pollack oil containing carotenoid. The test group was fed with dry food added 10 per cent of the oil and the control group was fed with pellet food only. The growth rate, the dietary coefficient, the maturities, and the changes of lipid and carotenoid content in the flesh of kokanee salmon were investigated. In growth rate, dietary coefficient and survival rate of eggs in the developmental period from fertilization to hatching, very good results were obtained in the test group compared with the control group as shown in Fig. 1 to 5. The changes of lipid content of female in comparison with male of each group became larger with the progress of the growth and maturity. The lipid content of the test group came near to these of kokanee salmon of the test group 3 ages propagated in the natural lake. In the test group, the variation of lipid content almost paralleled to the curve of mean growth rate through the experiment. It was shown that the carotenoid content in the flesh increased with the growth and decreased with maturities of the gonads. The effects for addition of 10 per cent of oil containing carotenoid to dry food were well

recognized on the growth, the dietary coefficient, and the survival of eggs in kokanee salmon culture from the results of this experiment.

4, サクラマス¹の生態に関する研究 2. 生殖巣の発達に伴う溯河と産卵行為について

長内 稔 (北海道立水産孵化場)・大塚三津男 (前北海道立水産孵化場 現宗谷支庁水産課) (45-54)

Ecological studies on the masu salmon, *Oncorhynchus masou* (Brevoort), of Hokkaido. 2. On the effect of the ascends river and spawning behavior at the sex maturity of masu salmon.

Minoru Osanai and Mitsuo Otsuka

5, カワシンジュガイの年令組成とサケ科魚類の資源変動との相関性について

粟倉輝彦 (北海道立水産孵化場) (55-88)

On the correlation between the age composition of the freshwater pearl mussel, *Margaritifera laevis* (HAAS) and the population size of salmonoid fishes.

Teruhiko Awakura

The author has carried out the determination of age of the freshwater pearl mussels, *Margaritifera laevis* (HAAS) sampled from four different places: the Chitose river; the Akan river and the Ibeshibetsu river by the HENDELBERG method and studied on the correlation between the age composition of the freshwater mussels and the population size of salmonoid fishes. The results obtained are as follow:

1. In the neighborhood of the Chitose Dais an Electric Power Plant in the Chitose river, the age composition of the mussels showed the influence of kokanee salmon which descended from the reservoir.
2. In the spa of Oakan in the Akan river, the age composition of the mussels showed the influence of four electric power plants constructed on downstream checked upstream migration of salmonoid fishes.

3. In the 500 meters up from the mouth of the Ibeshibetsu river, the age composition of the mussels showed the correlation with the haul of white-spotted char in the Lake Akan.

4. The above results suggest the possibility that population size of salmonoid fishes may be presumed from the age composition of the fresh water pearl mussels.

6, ワカサギの生態学的研究 1. 石狩湾における2魚群の成因に関する考察

田中寿雄 (北海道立水産孵化場) (89-96)

Ecological studies of pond smelt, *Hypomesus transpacificus nipponensis* McAllister. 1. On the existence of two populations in Ishikari Bay, and their probable origin.

Hisao Tanaka

In this paper the writer deals with the relationships between vertebral number and populations of the pond smelt which live in Ishikari Bay. The average number of vertebrae in fish recaptured from Ishikari region (river and coast) had been more than 56 until 1967, but has been less than 56 since 1968 (Table 1). The average number of vertebrae in fish recaptured from Yoichi is more than 56 (Table 1). As far as vertebral number is concerned, the populations of both regions must have been divided into two groups, Ishikari and Yoichi (Table 2). The presence of these two populations may be due to the fact that pond smelt was transplanted from Lake Abashiri to Lake Ishikari Furukawa, an oxbow lake (Fig. 1 and Table 3), because the average number of vertebrae in fish recaptured from Lake Abashiri is less than 56 (Table 1). Furthermore, the existence of two populations suggests that migration of the pond smelt is limited to narrow spaces and that two populations have not yet mingled.

7, 天塩川水系の底棲生物相について

阿刀田光紹 (北海道立水産孵化場)・吉住喜好 (北海

道立水産孵化場)・粟倉輝彦(北海道立水産孵化場)・浅野俊威(北海道立水産孵化場)・伊藤富子(北海道立水産孵化場)(97-114)

Preliminary report on the benthic fauna of the river Teshio.

Mitsuaki Atoda, Kiyoshi Yoshizumi, Teruhiko Awakura, Toshitake Asano and Tomiko Ito

1. The benthic fauna of the Teshio River system was investigated six times from July 1968 to November 1969. Eleven stations were located on the main stream of the Teshio River and 14 stations on 12 tributaries.

2. The benthic fauna collected from the Teshio River were composed of larvae of insects which were may flies, caddis flies, stone flies, midges and others, and adults of leeches, earthworms, lugworms and gammarus.

3. The benthic animals of the upper stream of the Teshio River were comparatively abundant in kinds and numbers, which were mainly composed of intolerant species. In the benthic animals near Nayoro city, the tolerant species began to appear, and as the stream went down, kinds and numbers of the benthic animals began to poor and they were almost composed of tolerant species.

4. In 6 tributaries (Nayoro River, Penke River, Niupu River, Oterekoppe River, Pankesakkuru River and Monomannai River) the bottom conditions were good, so kinds and numbers of the benthic animals were abundant and many of them were intolerant species. But in another 6 tributaries (Kenbuchi River, Inuushibetsu River, Hurebetsu River, Onobunai River, Abishinai River and Toikanbetsu River) kinds and numbers of benthic animals were poor and they were almost tolerant species.

5. One of the important cause of scantness of the benthic fauna of the Teshio River was considered to be the physical condition of the river as the bottom elements of downstream were gravels and sands.

第25号 (1970)

1, サケ属魚類, 特にサケおよびヒメマス的人工交雑と育種に関する研究

寺尾俊郎(北海道立水産孵化場)(1-102)

Studies on the breeding and artificial crosses of chum, *Oncorhynchus keta* (WALBAUM), and kokanee salmon, *Oncorhynchus nerka* var. *adonis* (JORDAN et MCGREGOR) in salmonoid fishes. Toshiro Terao

Many studies have been done since Fujita (1926) and Foerster (1935) presented the papers on the artificial crosses in Salmonoid fishes. From the consistent standpoint, however, of the life stages of the eggs developments, and growth maturity of hybrids F1 and of hybrids F2 through intergeneric crosses and species crosses, any study in which to examine, by comparison with the parental fishes, biological characters and traits in the phenotypes of the hybrids F1 have not been published to date. The characteristics of our studies are that: we have carried this consistent pursuit investigation of the life stages and the biological traits of these hybrids, and moreover, we have not only reared them in the experimental ponds but also transplanted the fingerling and recaptured the adults in the natural lakes' waters, and as a results of examining the above adults, we have found it clear that hybrids F1 in Salmonoid fishes could contribute to aquacultures. We found that growth and survival rates through the life stages of the reciprocal hybrids F1 of Chum and Kokanee salmon indicated the excellent results, after examining the artificial hybridization and the breeding among Chum salmon, *Oncorhynchus keta*, Masu salmon, *Oncorhynchus masou* var. *masou*, Yamame salmon, *Oncorhynchus masou* var. *ishikawae*, and Kokanee Salmon, *Oncorhynchus nerka* var. *adonis*. Accordingly, the reciprocal hybrids F1 of Chum and Kokanee salmon have been cultured on each waters in the

experimental ponds and in the natural lakes. The results of the investigations on the biological characteristics of those reciprocal hybrids F1 indicated on the features of the embryological, physiological, ecological, morphological and cytological traits is that: the improved variety of hybrids F1 in Salmonoid fishes holds widely possession of ecological traits of Chum salmon (sea-run forms) and Kokanee salmon (land-locked forms), and is right fit for freshwater aquacultures. But as for the hybrids F2 there are many problems awaiting solutions, especially from the breeding viewpoints because survival rates were low. Therefore, it is necessary the methods of breeding and selection further, improving variety or species of hybrids of Chum and Kokanee salmon. The synopsis of the results of our studies on the features and the traits of hybrids F1 of Chum and Kokanee salmon is as follows.

1. Embryological Study:

We observed the changes of the days and individual sizes in the developmental stages of eggs and alevins, comparing the reciprocal hybrids F1 with the parental species. We examined the days required during the period of the fertilizations and hatching on the conditions of a fixed water temperature (8°C), with a view to knowing the traits of each eggs as a species. Thus, we found that the required days of each shoal of fish meant one of the most important traits in the hybrids F1 as well as in the parental species, and that in the developmental speed, the reciprocal hybrids F1 were slower and required more days than Chum salmon but they were faster and required fewer days than Kokanee salmon, while the days required for hatching (or developmental speed) of the reciprocal hybrids F1 showed a tendency to being nearer to the paternal than to maternal species in the parental species which were used for crossing. Namely, in the developmental speed, Kokanee ♀ X Chum ♂ F1 was

nearly similar to Kokanee salmon, Chum ♀ X Kokanee ♂ F1 was similar to Chum salmon respectively and the F1 fishes were similar to the paternal species in the parental species. The individual sizes of eggs and alevins of the hybrids F1 in the same developments and the same developmental process are as follows: in each stage of unfertilized eggs, fertilized eggs, eyed eggs and alevins, Chum ♀ X Kokanee ♂ was similar to Chum salmon and Kokanee ♀ X Chum ♂ was similar to Kokanee salmon and their sizes were nearer to the maternal than to the paternal species. They underwent changes in developmental stages and especially the weight of each egg in the eyed eggs stage and the body weight of each alevin in the hatching stage were similar to the maternal in the parental species. As for the developmental speed and the sizes of alevin, the reciprocal hybrids of Chum and Kokanee salmon grew nearly in the same size and their sizes were the intermediate between the parental species. Survival rates of eggs and alevins of the reciprocal hybrids F1 were inferior to that of the parental species.

2. Physiological Study:

We measured the oxygen consumption of the reciprocal hybrids F1 and parental species of Chum and Kokanee salmon in the developmental stages. Those values of the oxygen consumption are considered a physiological indicator, that is, are very useful for indicating the developmental speed and metabolic value in the growth of the reciprocal hybrids F1 and parental species. Those values in the reciprocal F1 and parental species were found to be largely independent of each species in the developmental stages. Namely, the oxygen consumption values of the reciprocal hybrids F1 varied with each sizes and each developmental stages under each the condition. The oxygen consumption values of the reciprocal hybrids F1 is smaller than Chum salmon and bigger than Kokanee salmon. This outcome

is in accord with the results in our embryological study.

3. Ecological Study:

The reciprocal hybrids F1 of Chum and Kokanee salmon grew remarkably larger and more satisfactory than the parental species in the case of rearing both in the experimental ponds and the natural lakes. Especially, the maximum individual body size of the hybrids F1 of Chum ♀ X Kokanee ♂ was the largest among the Salmonoid (Genus *Oncorhynchus*) fishes of land-locked form. But the sizes of the reciprocal hybrids F1 of Chum and Kokanee salmon were the intermediate between Chum salmon, sea-run form and Kokanee salmon, land-locked form. Survival rates of the reciprocal hybrids F1 during the developmental period was inferior to Kokanee salmon and very superior to Chum salmon, being the intermediate value between the parental species. Both females and the males of the reciprocal hybrids F1 of Chum and Kokanee salmon had their fertility, but the eggs of each individual female varied in size, and the gonad weight index (gonad weight in relation to body weight) in maturated female adult was inferior to the parental species. Maturity age of the reciprocal hybrids was delayed one or two years by comparison with the Kokanee salmon female which grew earlier and matured within three or four years.

4. Adaptability and Resistibility of the Hybrids F1 to the Changes of Habitat Factor:

Within the limits of the parental species adaptability and resistibility, the reciprocal hybrids F1 had wide viability for the habitat factors under the physical and chemical conditions, that is, water temperature, concentration of hydrogen ions, and salinity etc. Namely, those hybrids F1 showed that they could live in and migrate in the waters of the range of 6.0°C to 19.8°C in the water temperature, and of 5.0 to 8.0 value in concentration of hydrogen ions, and of below 18.6

‰ in the salinity. In the food habits, those reciprocal hybrids F1 covered a wide range of feeding, — wider than the parental species in all life stages.

5. Morphological Study:

The morphological differences between the reciprocal hybrids F1 and the parental species were that on the metameric traits we could see gill raker number in first arches and pyloric appendages number, and that on the morphological traits when thinking of each body part in relation to scaled body length, that is, of each growth ratio, we could see head height, body height, caudal height (caudal peduncle), maximum length of pectoral fin and base length of anal fin. The morphological features of the reciprocal hybrids F1, in general, were the intermediate with wide variety between the parental species.

6. Cytological Inheritance Study:

Chromosome number (2n) of somatic cell was 74 in Chum salmon and 58 in Kokanee salmon, and 66 in the reciprocal hybrids F1 of Chum and Kokanee salmon. Chromosome numbers of the reciprocal hybrids F1 was the intermediate between the parental species. In view of the results above mentioned on the biological features of the reciprocal hybrids and the parental species of Chum and Kokanee salmon, the following three remarkable points should be emphasized when breeding in freshwater aquiculture.

(1) In freshwater area the reciprocal hybrids F1 grew considerably better than the parental species.

(2) The reciprocal hybrids F1 were remarkably superior to the parental species in adaptability and resistibility to the changes of habitat factors, such as water temperatures, concentration of hydrogen ions, salinity and food habits.

(3) The maximum individual body size of the hybrids F1 of Chum ♀ X Kokanee ♂ was the largest among the Salmonoid fishes of land-locked

form.

On the contrary, the sizes and developmental speeds of eggs and alevins of the hybrids F2 of Chum and Kokanee salmon covered a strikingly wide range of variation and the survival rates were low—wider and lower than the hybrids F1 and the parental fishes. Therefore, it is necessary to study deeply into the way of selecting superior variety from among the hybrids F2. The ways how to select superior variety are as follows.

Selection by means of:

- (1) The days required and the differences during the period of the fertilization and hatching stages, with a view to knowing the size and the developmental speed of eggs and alevins.
- (2) The changes and the differences in oxygen consumption of eggs and alevins in the developmental stages.
- (3) The growth rates measured by the size and the difference of the length and weight of the body in the life stages.
- (4) The differences of the morphological traits on the specific growth of body height in the individual body length over 10 centimeters.
- (5) The differences of adaptability and resistibility to the changes of physiological conditions of habitat factors, such as water temperature, concentration of hydrogen ions, salinity etc.
- (6) The variation of chromosome number in view of cytological inheritance.

2, キュウリウオの形態と生殖巣について

伊藤小四郎（北海道立水産孵化場）（103-112）

Morphometrical studies and the gonad of *Osmerus eperlanus mordax* (MITCHILL).

Koshiro Ito

3, 北海道におけるイシカリワカサギ *Hypomesus olidus* の生息地とその環境条件

田中寿雄（113-117）

Habitats and environmental conditions of pond smelt, *Hypomesus olidus*, in Hokkaido

Hisao Tanaka

The present report is summarized as follows:

- 1) In Japan *Hypomesus transpacificus nipponensis* is widely distributed from Hokkaido to Kyushu, but *Hypomesus olidus* only in Hokkaido. The recent habitats of *H.olidus* reported by several investigators are shown in Fig.1, including a new habitat of the old-waterway of Yoichi River.
- 2) The morphological characteristics of both species *H.olidus* and *H.transpacificus nipponensis*, collected from the old-waterway of Yoichi River are shown in Table 1 and Fig. 2.
- 3) Of these environmental conditions, water color is in general brownish, transparency small and water depth shallow. The habitats of *H.olidus* reported by some authors until now are mainly limited to the lower parts of the river system and to the area of the stagnant water like a pond and a lake.

第26号（1971）

1, 最近の常呂川の水質汚濁状況について

吉住喜好（北海道立水産孵化場）・阿刀田光紹（北海道立水産孵化場）・伊藤富子（北海道立水産孵化場）・今田和史（北海道立水産孵化場）（1-18）

The recent states of the water pollution in the Tokoro River

Kiyoshi Yoshizumi, Mitsuaki Atoda, Tomiko Ito and Kazushi Imada

2, 岩尾内人工湖の水産利用に関する研究 I. 湛水初期の陸水学的調査

外崎久（北海道立水産孵化場）・柴田尚志（北海道立水産孵化場）・倉橋澄雄（北海道立水産孵化場）・伊藤富子（北海道立水産孵化場）（19-32）

Studies on the fishery utilization of the Iwao-nai Reservoir in Hokkaido. I. Limnological survey in early water storage of the reservoir.

Hisashi Tonosaki, Hisashi Shibata, Sumio

Kurahashi and Tomiko Ito

3, 摩周湖に移殖したヒメマスについて

長内 稔 (北海道立水産孵化場) ・田中寿雄 (北海道立水産孵化場) (33-46)

Studies on the transplanted kokanee salmon (*Oncorhynchus nerka var. adonis*) to the Lake Mashu, Hokkaido.

Minoru Osanai and Hisao Tanaka

4, カラフトマスの海水飼育試験 (1) 淡水・海水両飼育による成長と減耗について

寺尾俊郎 (北海道立水産孵化場) ・岡田鳳二 (北海道立水産孵化場) (47-62)

On the experiments of salt waters rearing of pink salmon *Oncorhynchus gorbuscha* WALBAUM - (1). Growth and mortality of salmon in freshwater and salt waters.

Toshiro Terao and Hoji Okada

In order to confirm experimentally the practicality of salmon mariculture in the salt waters, pink salmon were reared in salt-water medium, water simple circular system at the Warm Water Fish Experimental Station, Shikabe and the nets enclosures, Oshoro Bay, Hokkaido and in the freshwater ponds at the Mori Station of Hokkaido Fish Hatchery. Young pink salmon which they are ready to migrate downstream to the seawater could rear to maturity over the entire life cycle of these fish in the medium both of the freshwaters and salt waters. The scopes of nets enclosures in salt water of this experiments at Oshoro Bay were one hundred cubic meters. For the environmental conditions, water temperatures ranges from 2.2 to 22.0 °C and specific gravity of salt waters from 1.020 to 1.027. In this salt waters, during the colder months of winter and the warmer months of summer, the growth rate of the pink salmon dropped both of body weight and body length. We concluded from the experiments described above that acceptable

temperature limits of pink salmon were 5 to 18 °C both of salt water and freshwater, the optimum temperature differed with from 8 to 13 °C in the salt waters and from 10 to 15 °C in the freshwaters. Those pink salmon reared in salt water have been showed better growth, better survival rate and the high efficiency of food conversion with negligible losses than in the freshwaters. For maximum growth of salmon, they grew the limits of 400 g in body weights and 29.8 cm in body length, 60 to 70 per cent in mortality of the salmon in the freshwater pond, and 700 g in body weights, 35 cm in body length in the salts waters in the period of two years respectively. In spite of results of the experiments, those growth were more slow than those of pink salmon propagated in natural waters. Therefore, the salt waters rearing by net enclosures will be indicates possibility of profitable method of the aquacultures.

5, 飼育カラフトマスの結節様病変を伴なう疾病について

栗倉輝彦 (北海道立水産孵化場森支場) ・木村喬久 (北海道大学水産学部微生物学教室) (63-75)

On a disease associated with the presence of tubercul-like lesions in pink salmon, *Oncorhynchus gorbuscha*, reared in fresh water pond.

Teruhiko Awakura and Takahisa Kimura

A disease associated with the presence of tubercul-like lesions occurred in the one year old pink salmon, *Oncorhynchus gorbuscha*, reared in the fresh water pond at the Mori Branch of the Hokkaido Fish Hatchery from 1970 to 1971. Tubercular nodules were observed in the liver and kidney, and less frequently in the spleen, intestine and gill. Most of the ill female fish lacked secondary sexual development, and were stunted and silvery colored. The lesions seem to be made up of a central group of round cells and composed of concentric bundles of a connective

tissue. The acid-fast bacteria were isolated from lesions of the liver, but could not be found in the smears prepared from them. However, a parasite-like body which was stained by haematoxyline or azocarmine and which indicated PAS-positive was observed in the round cells around the lesions. The young pink salmon which was artificially infected by the juice of the tubercular nodules showed hyperemia and swelling of the intestine and of the injected part. Those fish died three to four days after the inoculated period. Several antibiotics have been tried to prevent this disease, but no effect was detected. This disease has resemblance to the tuberculosis of the migratory salmonides reported in the pacific coast of the United States of America from the viewpoint of clinical signs or the isolable acid-fast bacteria, but its similarity in the histopathological observations and other evidences is not proved.

第27号 (1972)

1, *Acanthocephalus minor* YAMAGUTI, 1935の寄生によるサケ科魚類の鉤頭虫症について

粟倉輝彦 (北海道立水産孵化場) (1-12)

Studies on acanthocephaliasis of the salmonid fishes infected by *Acanthocephalus minor* YAMAGUTI, 1935.

Teruhiko Awakura

The author has observed the Acanthocephaliasis of salmonid fishes in the Mori branch of Hokkaido Fish Hatchery locating in southern Hokkaido. *Acanthocephalus minor* YAMAGUTI, 1935 was studied frequently in rainbow trout *Salmo gairdneri irideus*, Yamabe *Oncorhynchus masou*, dolly varden *Salvelinus malma* left in an unused fishpond and the waterways from other fishponds, naturally breeding three-spined stickleback *Gasterosteus aculeatus aculeatus* and steelhead trout *Salmo gairdneri gairdneri* reared in

fishpond located in down stream. From the same unused ponds, a large numbers of intermediate host *Asellus hilgendorfi* were also collected, and larval acanthocephalans were found to infect the body cavity of 6.5 percent of them. Many *Asellus hilgendorfi* were obtained from the gastric contents of host fishes. The parasite bores into the wall of intestine, particularly near the anus with its proboscis. The infiltration of inflammatory cells, multiplication and damage of submucosa in the intestine were observed around the proboscis at the point of its penetration. It is first time that *A. minor* is recorded in Hokkaido and the present study is the first report of *A. minor* infection in *Salmo gairdneri irideus*, *S. gairdneri gairdneri*, *Salvelinus malma*, *Oncorhynchus masou* and *Gasterosteus aculeatus aculeatus* in Japan.

2, 池中養殖ヒメマスの肝腫瘍について

石井清士 (北海道大学水産学部) ・粟倉輝彦 (北海道立水産孵化場) ・高野和則 (北海道大学水産学部) (13-34)

Hepatic tumor in pond-cultured kokanee.

Kiyoshi Ishii, Teruhiko Awakura and Kazunori Takano

Hepatic tumor in pond-cultured kokanee (*Oncorhynchus nerka*) reared at the Mori Branch of Hokkaido Fish Hatchery from 1969 to 1972 was studied from the viewpoint of gross anatomy and histopathology.

1) Neoplastic liver lesions accompanied with hepatic hypertrophy occurred with high incidence in the dead fish collected in 1969 and 1970. On the contrary, no hepatic tumor could be detected in the dead fish in 1971.

2) In the liver cells of unaffected kokanee, sexual differences were detected during the course of gonadal maturation, and some degenerative aspects were observed in the breeding season.

3) The tumor was recognized at first as minute, white or greyish white nodules of 1-2 mm in

diameter, and raised above the surface of the liver. These nodules consisted of markedly vacuolated cells. Ultrastructurally, these vacuoles contain fat droplets which are surrounded with glycogen.

4) Besides the vacuolated cells, many pleomorphic cells with the nuclei of varied shapes and abundant connective tissues were observed in the advanced nodules of the liver obtained in 1970. On the contrary, neither occurrence of the pleomorphic cells nor striking increase of the connective tissues were detected in the nodules examined in 1971 except the only one case.

5) A brief discussion was conducted on the relation between the diet which had been given during the course of sexual maturation and the tumor formation.

3, ワカサギの生態学的研究 2. 石狩川河口附近に出現する成長の異なる2魚群について

田中寿雄 (北海道立水産孵化場) (35-42)

Ecological studies of pond smelt, *Hypomesus transpacificus nipponensis* McAllister 2.

On the appearance of "large" and "small" populations in size in the mouth of River Ishikari
Hisao Tanaka

In this paper the writer observed the growth, age and maturity of gonad of the pond smelt collected from River Ishikari and its coast during 1969 to 1970. The feature of appearance and growth of the pond smelt in the mouth of the Ishikari river is different from pre-spawning period in February and March to spawning period in May. "Small" in size, 0-year-age immaturd fish, is dominant, while "large" one, 0-year-age matured, is very poor at pre-pawning period. On the other hand, "large" matured fish of 1-year-age is prominent in number, but small immaturred fish of same age have hardly collected by seine or small set nets at spawning period. Considering the seasonal emergences of the two populations, these life histories are shown in

Fig. 4. It is suggested that these variations in size might be caused by the differences in habitats, abundant food organisms and vast space in "off-shore", but scanty diet and narrow space in "in-shore and estuarine".

4, 最近の大沼湖群 (大沼, 小沼, 蕁菜沼) の水質について

吉住喜好 (北海道立水産孵化場) ・阿刀田光紹 (北海道立水産孵化場) ・伊藤富子 (北海道立水産孵化場) ・米川年三 (北海道立水産孵化場) (43-58)

The recent states of the water quality on Lakes Onuma, Konuma and Junsainuma.

Kiyoshi Yoshizumi, Mitsuaki Atoda, Tomiko Ito and Toshizo Yonekawa

5, 千走川の水生昆虫相ならびに環境条件

阿刀田光紹 (北海道立水産孵化場) ・今田和史 (北海道立水産孵化場) (59-96)

Studies on the aquatic insect fauna and environmental conditions of the Chihase River, Hokkaido.

Mitsuaki Atoda and Kazushi Imada

6, 積丹川・見市川・落部川の水生昆虫相ならびに環境条件

阿刀田光紹 (北海道立水産孵化場) ・今田和史 (北海道立水産孵化場) (97-149)

Studies on the aquatic insect fauna and the environmental conditions of the Shakotan River, the Kenichi River and the Otoshibe River, Hokkaido.

Mitsuaki Atoda and Kazushi Imada

第28号 (1973)

1, メチルテストステロンによるヤマベの銀毛防止と皮膚抵抗について

山崎文雄 (北海道大学水産学部) ・ 粟倉輝彦 (北海道立水産孵化場) ・ 阿刀田光紹 (北海道立水産孵化場) ・ 柵田昭二 (北海道立水産孵化場) (1-10)

On the inhibition of silvering and protective effect induced by methyltestosterone in the skin of masu salmon (*Oncorhynchus masou*).

Fumio Yamazaki, Teruhiko Awakura, Mitsuki Atoda and Shoji Tanada

This study was carried out to elucidate the inhibitory effect of methyltestosterone on the silvering a masu salmon (*O.masou*). The protective effect of the methyltestosterone on the skin was also examined.

1) It was found that oral treatment of methyltestosterone in the concentration of 10ug or 30ug per g diet for 15 days had strong effect on the silvering and caused the fish to the state of stream residual parr.

2) Descaling caused during handling of silver masu salmon was also inhibited by the methyltestosterone. This inhibitory effect to descaling was almost the same when both groups of 10ug and 31ug were fed for two weeks.

3) The skin of the methyltestosterone treated fish increased much in thickness, especially in epidermis and upper layer of the dermis which includes scales. No remarkable changes were found in stratum compactum.

4) Mucous cells in epidermis moved toward the surface of the body and were more active in mucous secretion.

5) In the ovary of the fish of both experimental groups, there was no increase in weight during the hormone treatment, but after stopping the treatment the ovarian weight increased parallel to the control fish. No histological changes such as atrophy of ovarian eggs were found in both 10ug

and 30ug groups during the hormone treatment.

6) It is suggested that oral treatment of methyltestosterone under the concentration of 10ug per gram diet is useful for the prevention of skin diseases in salmonidae.

2, サケ科魚類の性分化に関する研究-I ニジマスの性分化に及ぼす Estrone の影響

岡田鳳二 (北海道立水産孵化場) (11-22)

Studies on sex differentiation of salmonidae-I. Effects of estrone on sex differentiation of the rainbow trout (*Salmo gairdnerii irideus* GIBBONS). Houji Okada

The present study carried out to elucidate the normal development of the gonad and sex differentiation in the rainbow trout. The effect of estrone on the sex differentiation was also examined. The results obtained here were summarized as follows.

1) At the time of hatching, the primordial germ cells were found in the gonadal rudiment. The females were identified when 26mm in body length (48 days after swimming) by the appearance of oocytes, and the males were identified 55mm or more in body length (124 days after swimming) by the development of seminiferous tubules.

2) After the oral treatment of the estrone at the concentration of 10ug., 50ug., 100ug. per gram diet to newly hatched fry for 58-124 days, some of them retained undifferentiated gonads having only gonial and gonadal stroma, whereas some others undeveloped ovaries. But most of the gonads developed to ovaries through the normal development. Female ratio was about 80% to 90% in all estrone treated groups, though high mortality was recorded.

3) The effect of estrone were observed in other organs such as liver, kidney or swim bladder. Liver and kidney were enlarged, and renal tubule was degenerated. Outer connective tissue of swim bladder were hypertrophied. These abnormalities

increased with the concentration of estrone, and normal condition returned after stopping estrone treatment.

4) Relation between concentration of the estrone and duration of treatment in inducing sex differentiation was discussed.

3, マスノスケの淡水及び海水飼育試験

寺尾俊郎（北海道立水産孵化場）・松本春義（北海道立水産孵化場）・岡田鳳二（北海道立水産孵化場）・斎藤清造（北海道立水産孵化場）（23-44）

Studies on the cultures of chinook salmon, *Oncorhynchus tshawytscha* (WALBAUM) reared in freshwaters and saltwaters (1).

Toshiro Terao, Haruyoshi Matsumoto, Houji Okada and Seizo Saito

In order to confirm experimentally the practicality cultures in freshwater and saltwaters, chinook salmon, *Oncorhynchus tshawytscha* were reared in saltwater medium, net enclosures, Oshoro bay and in the freshwater ponds at the Chitose Station of Hokkaido Fish Hatchery. The rearing tests of salmon had carried out during five years from 1968 to 1972 in freshwater ponds and two years from 1970 to 1972 in saltwaters. For the freshwater culture of salmon, water temperatures were showed the ranges from 6 to 11 °C. For the environmental conditions of saltwaters, water temperatures were showed the ranges from 2.2 to 24°C and specific gravity of saltwaters from 1.020 to 1.027. In this saltwaters, during the colder months of winter and warmer months of summer, the growth rate of the chinook salmon dropped both of body weigh and body length. We concluded from the experiments described above that acceptable temperature limits of chinook salmon were 5 to 22°C both of saltwater and freshwater the optimum temperature with from 8 to 20°C in saltwaters and from 8 to 15°C in the freshwaters. The results of both cultures of freshwaters ponds and saltwater floating pens

are shown in Figure 1 to 8 and Table 1 to 8. Those chinook salmon reared in saltwaters have been showed better growth, better survival rate and the high efficiency of food conversions with negligible losses than in the freshwater ponds. In point of growth, chinook salmon reared in saltwater fish pen had not inferior to chinook salmon propagated in natural saltwaters. For the largest growth of salmon, they grew the limits of 1,800g in body weights in freshwater pond and 5.42kg in body weight, 64.6cm in body length in the saltwater pens in the period of two years respectively. Therefore, the saltwaters rearing by net enclosures will be indicates possibility of profitable method of the aquacultures. For the result of culture of the freshwater ponds, ovarium of chinook salmon matured in five years. We were able to obtain many of healthy eyed out eggs and alevins at first time. Further investigations are to shorten matured four year age in freshwater rearing and to be able to rear more larger specimens of three and four year ages of chinook salmon.

4, 魚類の脊椎骨異常 I. 道内で発見された奇形魚について

今田和史（北海道立水産孵化場）・吉住喜好（北海道立水産孵化場）（45-56）

Studies on the vertebral malformation of fishes I. On the abnormal fishes found in Hokkaido. Kazushi Imada and Kiyoshi Yoshizumi

This paper deals with the morphological study of twenty abnormal fishes; six daces, nine crucians, a flatfish, a pond smelt and others, caught in Hokkaido. Five daces and eight loaches showing normal bodies collected from the Osarappe river, a branch of the Ishikari river, are also observed. These thirteen fishes have slight abnormal vertebrae. By radiographic observations, thirty three specimens are grouped into following four types according to vertebral

structure. Type-①; Scoliosis is ten specimens. Type-②; Lordosis and kyphosis are only two specimens. Type-③; Combination of scoliosis, lordosis and kyphosis are eight specimens. Type-④; Fusion or shortening of vertebral centrum are thirteen fishes showing normal bodies. Malformed vertebral centrum, *i. e.* fracture or curvature, mostly appeared to the part of caudal vertebrae, and total vertebral counts of these abnormal fishes are equal to that of normal ones.

5, 札幌市精進川の汚濁と底棲生物相について
伊藤富子 (北海道立水産孵化場) (57-68)

On the pollution and benthic fauna of Shojin-gawa, a small stream, in Sapporo.

Tomiko Ito

1. In Shojin-gawa, a small stream in Sapporo, Japan, polluted by organic matter and suspended solids, the chemical condition and benthic fauna were studied in June and in October 1973.

2. In the middle part of the stream (Stations number 2-3) where the waste of pig farms drained into the stream and the B.O.D. value of the water was 1-2 ppm, the number of bottom animals decreased and *Tubifex tubifex* and *Spaniotoma* sp. A formed over 90 per cent of the benthos.

3. The number of benthic animals decreased strikingly in the lower part of the stream (Stations number 6-7), where it was heavily polluted by human organic waste from nearby houses. However, in the lowest part of the stream (Stations number 8-9), the pollution decreased and Hirunidea, *Asellus*, Tubificidae and Chironomidae formed a typical benthic fauna in a polluted stream.

4. A heavy rainfall made the stream turbid, except for the upper stream (Stations number 1), because of the quarry of volcanic ash and the unpaved road along the stream in October.

5. Three species of Tubificidae (*Tubifex tubifex*,

Limnodrilus hoffmeisteri and *L.claparedeianus*) were found in the stream. Many newly hatched worms of *Tubifex tubifex* occurred in mildly polluted sites. In heavily polluted localities, *L.hoffmeisteri*, *L.claparedeianus* and a few *Tubifex tubifex* were found. The percent occurrence of genus *Limnodrilus* was related to the B.O.D. value and the saturation percentage of dissolved oxygen.

6, ホロカヤン沼の湖沼学的予察調査

長内 稔 (北海道立水産孵化場) · 田中寿雄 (北海道立水産孵化場) (69-76)

Limnological reconnaissance of Horokayan-to, a bog lake of Tokachi district, Hokkaido.

Minoru Osanai and Hisao Tanaka

7, 支笏湖で採取されたサケ科魚類の大型魚について
寺尾俊郎 (北海道立水産孵化場) · 疋田豊彦 (北海道さけ・ますふ化場) (77-89)

On the large specimens of salmonoid fishes obtained from Shikotsu Lake, Hokkaido

Toshiro Terao and Toyohiko Hikita

This paper will be help to know the large specimens records and growing capacities of some different species of Salmonoid fishes landlocked in lakes and rivers. We reported on the largest samples of Salmonoid fishes obtained in the Shikotsu lake. In this paper, we described the morphological and meristic characters with reciprocal hybrids F1 of Chum salmon, *Oncorhynchus keta* × Kokanee salmon, *Oncorhynchus nerka* var. *kennerlyi* male and female, Cherry salmon, *Oncorhynchus masou* male and female and Char, *Salvelinus leucomaenis*.

第29号 (1974)

1, サケ科魚類の微孢子虫病に関する研究

粟倉輝彦 (北海道立水産孵化場) (1-96)

Studies on the microsporidian infection in salmonid fishes.

Teruhiko Awakura

Microsporidian infection is a problem in the propagation and culture of salmonid fishes in Hokkaido Island, Japan. As the microsporidia which infection in the fresh water fishes in Japan, *Plistophora anguillarum* Hoshina in cultured eel and *Glugea* sp. in cultured ayu have been reported. The studies, however, on this disease are restricted mainly in taxonomy of the parasitic microsporidia. Studies on transmission, host-parasite relationship, prevention and the control of this disease are few and many problems are still to be solved. In this study, the author relates a microsporidian infection which occurred endemically in Chitose river in Hokkaido. This study has been made to investigate the macroscopic, patho-histological and hematological aspect of this endemic disease. Taxonomy of parasitic microsporidia, biological characteristics of the spores, natural transmission, histological reaction of host fish, the prevention and the control were also studied. The results obtained from the present study are summarized as follows:

1. The disease occurred in all kinds of salmonid fishes bred in the upstream waters of the Chitose river in Chitose City, a tributary of the Ishikari river, and in the Tokito Numa in the suburbs of Tomakomai City. Parasites were found only in the heart muscle in chronic cases. But in acute cases, they were found also in the trunk muscle, fin muscle, masticatory muscle, eye muscle, throat muscle and gullet muscle as well as in the heart muscle. Mortality was high in the acute case, but low in the chronic case.

2. The parasite caused various pathological changes in the muscular tissues. In the heart muscular tissue, the infiltration of inflammatory cells, phagocytosis of host cells, hyperplasia of the connective tissues, inflammatory hydrops and granulomatus lesions were observed. Many tuber were formed and the tissues became hypertrophied. The heart was deformed and also hypertrophied. The changes in the trunk muscular tissue and others caused by the parasites were not remarkable. But numerous and large spindle-shaped cyst-like bodies (2 to 3 mm wide, 3 to 6 mm long) were found there and the surrounding muscle fibers showed abnormal signs.

3. In both chronic and acute cases, the increase in serum protein and the decrease in A/G ratio were recognized. Other haematological changes were not remarkable. This tendency was also found in naturally inhabited masu salmon and rainbow trout in the Chitose and the Naibetsu river in August. This fact may indicate that the infected fish produce the antibody to parasitic microsporidia.

4. In 1933, Dr. Takeda reported the microsporidia of this disease as *Plistophora* sp.. But the author identified this to genus *Glugea* from morphological characteristics of the vegetative stage of this microsporidia. At present, eight species have been reported as the species of *Glugea* from fresh water and euryhaline fishes. Compared with the eight species, the present species is distinctly different from them in the size of spore, length of polar filament, vegetative form and host specificity. As a result, the present species appears to be new to science and will be called *Glugea takedai* n. sp. after the name of the late Dr. Takeda, who first discovered it. Comparisons with the life cycles of *Glugea takedai* n. sp. to *G.anomala* and *G.weissenbergi* may indicate that the host-parasite relationship of this microsporidian and salmonid fishes is slight and occurred relatively late in the evolutionary process of the host-

parasite relationship. An illustrated synopsis of the known microsporidea of freshwater and euryhaline fishes in Japan is given and taxonomic keys of them are described. Three microsporidian spores found in fresh water fishes in Japan were studied with the scanning electron microscope. The details of the surface structures of the spores might well prove to be of great help in recognizing differences in the individual microsporidian species.

5. Studies on the biological characteristics of this species, especially on the activity of spores were carried out. As a result, the determination of activity of spores by the method of evaginating polar filament was possible in this species and the spores which were treated with 0.5% trypsin solution evaginated the polar filament. Effect of temperature, dryness and three germicidal agents upon the extrusion of filaments in the spores of this microsporidia were examined by the above mentioned method. The possibility of culture of this microsporidia in MEM-RTG-2 medium was examined. As a result, the appearance of parasite-like bodies in cultured cells was observed in the trypsin treated spores inoculated in RTG-2 cells. But the cells detached themselves from the culture tubes about 10 days later and it was difficult to observe their complete life history.

6. From the epidemiological studies on the natural and experimental transmission, investigations of organisms both in the reservoir in the upstream of the Chitose River and the Chitose River, and experiments on the mechanism of transmission, the intermediate of natural transmission presumed rotifers, *Euchlanis dilatata* which flowed from the reservoir. The author suggested the possibility that the transmission is trans-epidermis and the parasitic glochidia of freshwater pearl mussel, *Margaritifera laevis* were connected indirectly with this transmission, Host-parasite relationships with this microsporidia and salmonid fishes are presumed to occur after

the construction of electric power reservoir.

7. The host reaction to the infection of this microsporidia were summarized as the infiltration of inflammatory cells, phagocytosis of host cells and hyperplasia of the connective tissue. These host reactions were different in the species and age of host fishes and were more remarkable in more aged fish in the same species. It was clear that the host reaction was influenced by environmental water temperature.

8. In order to establish the treatment for this disease, the author examined the acquired immunity, temperature treatment and chemotherapy. The microsporidia ceased to increase in number at the schizogonic stage after transferring to the well water (about 8.0°C) and the microsporidia was located only in the heart muscle. In cold water (mean 11.4°C) made by mixing well water and river water, (18.3°C), the multiplication of the microsporidia was lower and the microsporidia were found one month later than in the control group which was bred in the river water. Six drugs which were recognized to be effective for the treatment of coccidiosis and toxoplasmosis were tried out on this microsporidian infection. But fishes treated with sulfa drugs, amporolium showed remarkably less multiplication of microsporidia and there was an increase in the survival rate of infected fishes. Infected fishes acquired the remarkable immunity. This immunity was very strong and lasted as long as one year.

9. The author has been able to demonstrate that microsporidian disease of salmonid fishes is due to *Glugea takedai* n. sp. which is mediated by planktonic organisms found in the reservoir used for electric power. The present results suggest that the construction of electric power stations and reservoirs influence composition of organisms in the down-stream waters and a new host-parasite relation arises.

2, 池中養殖サクラマス¹の生態に関する知見 I.
種苗の初期生残率, 性比, 0年魚の分化及び親魚の孕
卵数について

阿刀田光紹 (北海道立水産孵化場) (97-114)

Ecological notes of pond-cultured masu salmon
(*Oncorhynchus masou*) I.

Notes on the survival rate from egg to fry, sex
ratio, differentiation of the 0 year old fish and
embraced egg number of adult females.

Mitsuaki Atoda

3, 札幌市北の沢および穴沢の汚濁と底棲生物相につ
いて

伊藤富子 (北海道立水産孵化場) (115-124)

On the pollution and benthic fauna of the stream
Kitanosawa and the stream Anazawa in Sapporo.
Tomiko Ito

1. In the stream Kitanosawa and the stream
Anazawa, Sapporo, Japan, polluted by organic
matter, the chemical conditions and benthic
fauna were studied in May and in November,
1974.

2. In the upper part of both stream (K1, A1, A2)
where no waste drained into the stream, the
benthic fauna had a relative diversity. On the
other hand, in the lower part of both stream (K4-
7, A3) where it was polluted by human organic
waste from nearby houses, B.O.D. value reached
3-9 ppm and the number of benthic animals de-
creased. But the oxygen content of the water was
high and substratum was not covered with sand
or mud in the lower part of both stream, because
the gradient of both stream was large and cur-
rent speed was fast. Therefore, the typical
benthic community in a gross polluted waters,
which will be usually formed by *Asellus*,
Chironomus or Tubificidae, did not appear in
both stream.

3. Number of *Spaniotoma* sp., Chironomidae,
Antocha sp., Tipulidae, and *Nais* sp., Naididae,
increased strikingly in the station where the

oxygen of the water were nearly saturated and
nutrient salts were abundant.

4, 北海道の湖沼, 人工湖の環境調査 1.

頓別沼, 湧洞沼, 風蓮湖

長内 稔 (北海道立水産孵化場) · 田中寿雄 (北海道
立水産孵化場) · 今田和史 (北海道立水産孵化場)
(125-146)

The research of the environmental conditions in
the lakes and reservoirs of Hokkaido. 1.

The Lake Tonbetsu, Yudo and Furen

Minoru Osanai, Toshio Tanaka and Kazushi
Imada

第30号 (1975)

1, 知床五湖群のプランクトン相について

田中寿雄 (北海道立水産孵化場増毛支場) (1-14)

Report on the plankton-fauna and-flora of the
Shiretoko-goko Lake group, northeastern Hokkaido
Hisao Tanaka

In this paper the author deals with the plank-
ton-fauna and-flora of the Shiretoko-goko Lake
group in the Shiretoko Peninsula, northeastern
Hokkaido. As in Table 1-3, 19 species of
planktonic animals and 110 species of planktonic
plants were identified. Many of them are cosmo-
politan species, but some of them are grassy
pond-or moor-like-habitants which are zooplanktonic
Macrocyclus fuscus, *Daphnia rosea*, *Alona affinis*,
Alonella excisa and *Chydorus*, and phytoplanktonic
Frustulia, *Eunotia*, *Pinnularia* and many desmids.
Considering from the plankton-fauna and-flora of
the Shiretoko-goko Lake group, it is regarded
that this lake group belongs under disharmonic
lake type and dystrophic lake.

2, 有機汚染水域におけるユリスカ3種幼虫 (*Chironomus*
yoshimatsui, *Syncricotopus rufiventris*, *Anatopynia*
vaia) の微細分布

伊藤富子（北海道立水産孵化場）（15-22）

Microdistribution of three chironomids larvae (*Chironomus yoshimatsui*, *Syncricotopus rufiventris*, *Anatopynia vaia*) in organically polluted waters.

Tomiko Ito

1. The microdistribution of the larvae of *Chironomus yoshimatsui*, *Syncricotopus rufiventris*, *Anatopynia varia* (Chironomidae, Diptera) was studied in the organically polluted waters of Shojin Stream, and a nearby pond in Sapporo, in August and October of 1974. The pond's water came from Shojin Stream.

2. The microdistribution of three chironomid larvae was influenced by the substratum and water current.

3. The younger larvae of *C.yoshimatsui* built their cases on the stones in the stream. In the pond, they built their cases on floating substances, such as leaves, dead insects and grass. The grown larvae of this species built their tubes in mud bottom of the stream and the pond. The larvae of *C.yoshimatsui* as well as some species of the genus *Chironomus* do "age migration."

4. The larvae of *S.rufiventris* built their cases on the stones of the stream and on floating substances in the pond. They never lived in the mud bottom.

5. The larvae of *A.varia* lived in the mud bottom of the pond, and rarely lived in the stream. The pupae of this species floated in the pond water.

3, サケ科魚類の臨床生化学検査による血液性状 (1). からふとますの成熟期の天然生育魚と人工飼育魚の比較

寺尾俊郎（北海道立水産孵化場）・岡田鳳二（北海道立水産孵化場）・松本春義（北海道立水産孵化場）（23-30）

Studies on blood properties of Salmonoid fishes by clinic biochemical analysis (1). Comparison on blood and serum analysis parameters between natural return fish and the cultured fish of Pink

salmon, *Oncorhynchus gorbusha* (WALBAUM) in the spawning season.

Toshiro Terao, Hoji Okada and Haruyoshi Matsumoto

In order to assess their physiological states of salmonoid fishes at each growth stage, we analysed primarily sixteen articles on blood and serum properties natural and artificial cultured adult pink salmon in spawning season. Analysis methods used the spectrophotometric clinical procedures (RaBA-3010) and clinical biochemical Kit reagents. This is the first report of blood parameters for the pink salmon in the spawning season. In this results, those blood analysis parameters of natural returns of pink salmon were able to show more exactly those physiological conditions in the spawning season. When comparing the results of analysis of blood parameters in natural return adult fish with those in cultured fish, we feel strongly that the former showed more normal analysis values of blood clinical conditions than the latter of pink salmon in the spawning season. The normal values of blood clinical biochemical parameters for human are very different from that of the salmonoid fish ones. Further investigations are to research ones blood clinical biochemical parameters in stages of each growth of many salmonoid fishes.

4, シシヤモ *Sprinchus lanceolatus* (HIKITA), の産卵生態-I 水槽内での産卵行動について
岡田鳳二（北海道立水産孵化場）・工藤 智（北海道立水産孵化場）・林 和明（北海道立水産孵化場）（31-38）

Studies on the spawning habit of the long finned smelt, *Sprinchus lanceolatus* (HIKITA) - I. On the spawning behavior in the aquarium.

Hoji Okada, Satoshi Kudo and Kazuaki Hayashi

We investigated the spawning habit of Long finned smelt, *sprinchus lanceolatus* (HIKITA),

collected in the Saru river in Hokkaido Prefecture, in the autumn of 1974 and 1975. The present studies carried out to clear the spawning behavior of Long finned smelt in the circulated angular glass tank. Observations on the spawning behavior were made by means of the naked eyes, 35mm photographs and 8 mm movies. Oviposition rate of females, percentage of fertilized eggs and rate of survival were also investigated. The results obtained here were summarized as follows.

(1). If suitable conditions of lights and water temperatures were settled, the Long finned smelts would spawn easily even in the aquarium.

(2). The spawning behavior was held by mated male and female. Each female oviposited in several times in a night and their coelom became empty. The mated pair was changed freely in each spawning. Digging movements for redd and territories were not observed in the present experiments of the spawning behaviors.

(3). Spawning acts started with male's feeling postures. The paired male and female swim quickly against water current standing side by side on the gravel of the aquarium.

The oviposited eggs were whirled up in the water. Soon after, the eggs sank to bottom and stuck to gravels.

(4). Fertilized rate of eggs was above 95% and it was close to fertilized rate of natural spawning. Survival rate of eggs was also very high.

5, ウグイ属3種の産卵習性

伊藤和雄 (北海道立水産孵化場) (39-42)

Notes on the spawning habits of three species of Genus *Tribolodon*, in Hokkaido.

Yoshio Ito

6, 森支場における養魚用水の水質について

坂本博幸 (北海道立水産孵化場) (43-56)

Chemical composition of fish-pond water in Mori Branch.

Hiroyuki Sakamoto

7, 北海道太平洋沿岸の様似湾で捕獲されたサケ×ヒメマス交雑魚F1について

寺尾俊郎 (北海道立水産孵化場)・松本春義 (北海道立水産孵化場)・岡田鳳二 (北海道立水産孵化場) (57-63)

On the chum × kokanee salmon hybrid F1 caught from Samani bay, Hokkaido.

Toshiro Terao, Haruyoshi Matsumoto and Hoji Okada

A female salmon specimens caught by salmon trapnet in Samani bay, Hokkaido on June 19, 1975 year. It was identified that this species was a salmon of Chum × kokanee hybrid F1 estimated from meristic characters of gill raker number, pyloric caeca number and scale features. In this paper, we described the morphological, meristic characters and some ecological habits of hybrid F1 fish. Many of morphological and ecological characters compared between a specimens of Chum × kokanee salmon hybrid F1 fish and Chum, Sockeye salmon obtained North Pacific Ocean. As a result of this investigation, we estimated that female fish of hybrid F1 grew remarkably large specimens in natural saltwater environment of North Pacific Ocean. The values for practical usage are well recognized that fish cultures of Chum × kokanee salmon hybrid F1 are closely related to the production works of sockeye salmon in Hokkaido.

第31号 (1976)

1, サクラマス蓄養中の体筋肉, 肝臓及び血清中の生化学組成変化について

寺尾俊郎 (北海道立水産孵化場)・岡田鳳二 (北海道立水産孵化場)・伊藤小四郎 (北海道立水産孵化場)・米川年三 (北海道立水産孵化場)・田中寿雄 (北海道立水産孵化場) (1-22)

Changes of biochemical components in serum,

liver and muscle of adult masu salmon retaining pond for sexual maturity.

Toshiro Terao , Hoji Okada, Koshiro Ito, Toshizo Yonekawa and Hisao Tanaka

Adult Masu salmon *Oncorhynchus masou* migrate into rivers and streams in Hokkaido from spring to autumn season. During the spawning season, it is necessary to support these fish on the healthy conditions retained at the culture pond. Recently, useful methods of diagnosis of nutritional and pathological conditions have been employed these analysis of biochemical components in fish blood serum. The changes of physiological conditions were carried out with investigations by biochemical analysis in serum, liver and muscles in three times of stages of sexual maturity obtained from the Nobuscha hatchery pond Hokkaido. With the progress of sexual maturity, the moisture content increase and the fat content decrease in the fish flesh and liver. Considerable individual variability's of biochemical characters in blood serum were obtained within the retained fish population of each three stage of sexual maturities. From the above mentioned results, it seems to be quite all right consider adult masu salmon retained in the culture ponds were matured more proper under their environmental conditions to the spawning season.

2, 魚類の脊椎骨異常 II 池中養殖サクラマス短尾症(寸づまり)

今田和史(北海道立水産孵化場)・阿刀田光紹(北海道立水産孵化場)(23-42)

Studies on the vertebral malformation of fishes II. Ecological and histological researches of pond-cultured short-tail masu salmon (*Oncorhynchus masou*).

Kazushi Imada and Mitsuaki Atoda

3, 魚類の脊椎骨異常 III カーバメート系農薬によるキンギョ, ヒメダカの脊椎骨異常

今田和史(北海道立水産孵化場)(43-66)

Studies on the vertebral malformation of fishes III. Vertebral deformation of goldfish (*Carassius auratus*) and medakafish (*Olyzias latipes*) exposed to carbamate insecticides.

Kazushi Imada

This author examined that the vertebral deformation of fishes were realized by carbamate insecticides, for example, NAC, PHC, XMC and MIPC. Goldfish (*Carassius auratus*) and medakafish (*Olyzias latipes*) were exposed to carbamate insecticide solutions (1-10ppm) for a week, and after this treatment the fishes were bred in well water for a month and fed on the commercial dry fish feed. Five, eight or ten fishes were put in each tank but given no feed for exposed period of insecticide solutions. Water temperature was maintained at 23°C and aerated with compressed air. Several days after exposure, the spinal body curvature appeared in some fishes and they did not return to the original form during the bred period for a month. X-radiographic observation of curved fishes proved that vertebral fracture and luxation occurred in the centroms of caudal vertebrae which were nearly seventeenth centrom from the first centrom of abdominal vertebrae of goldfish, and fifteenth to twentieth of medakafish. Histological observation of fractured goldfish showed that the osteoid appeared at periphery of fractured centrom and transformed into neoplastic bone. Neoplastic bone grew at both ends of fractured centrom. This histological figure indicated the, spontaneous repairing of fracture. In the insecticide solutions, all fishes showed the abnormal swimming forms, it might be one of the cause of vertebral deformation and body curvature.

4, 北海道におけるコイ科魚類のリグラ条虫症について
粟倉輝彦(北海道立水産孵化場)・外崎久(北海道立水産孵化場)・伊藤富子(北海道立水産孵化場)

(67-82)

Ligulosis of cyprinid in the lakes of Hokkaido, Japan.

Teruhiko Awakura, Hisashi Tonosaki and Tomiko Ito

The present authors studied the parasitism, taxonomy and ecology of tapeworms infecting cyprinid fishes from May, 1975 to November, 1976 in Lake Onuma, Lake Toro and Lake Akan of Hokkaido. The results obtained from the present study are summarized as follows:

1. The tapeworms obtained from cyprinid fishes in Lake Onuma, Toro and Akan were all found to be the same species identified as *Digramma alternans* (Rud., 1810).

2. Parasitism of *D.alternans* was observed in the SG-type and H-type of crucian carp in Lake Onuma. They were also observed in the SG-type of crucian carp and Japanese dace in Lake Toro.

3. Infection rate of *D.alternans* in the SG-type of crucian carp was low in the spring and high in the autumn. The maximum percentage of infection recorded in Lake Onuma was 69.2%.

4. Young worms, less than one gram in body weight were observed in crucian carp in middle of July and late November in Lake Onuma. It suggests that the parasitism of *D.alternans* occurs in early summer to late autumn.

5. The infection rate was different in different age groups in the SG-type of crucian carp. The fish 2-4 age group were found to have 15.5-29.2% in Lake Onuma, which in Lake Toro the percentage ranged from 6.7-66.7% in fish 5-6 years old and no parasite was observed in 2-4 years old fish.

6. The condition factor of infected fish was high. If the parasite was removed from the fish, the condition factor was the same between the infected and uninfected fish. Castration like condition caused by the parasite was observed in the SG-typed crucian carp in the relationships

between gonad and parasite weight index.

7. The first intermediate host of *D.alternans* in Hokkaido was not confirmed.

8. *D.alternans* lived over 30 days at 4 and 7°C, 12 days at 15 and 20°C and 4 days at 37°C. No change in gonads was observed at 4, 7, 15 and 20°C and spermatogenesis in testis was recognized at 37°C.

5. 雨竜沼高層湿原の水質とプランクトン相について
田中寿雄 (北海道立水産孵化場増毛支場) (83-96)

On the water qualities and plankton-fauna and flora of the Uryu high moors, Hokkaido.

Hisao Tanaka

The writer investigated the water qualities and plankton communities of the Uryu high moors in Hokkaido. As the water qualities are shown in Table 1, pH values are low and dissolved substances are very poor. Zooplankton identified are shown in Table 2. Of these species, *Heterocope appendiculata* was the dominant species, and *Daphnia rosea* was the subdominant species. *Heterocope appendiculata* was found by this survey for the first time in Japan. This species is a northern habitant, and the others, *Eurycerus glacialis*, *Drepanothrix dentata*, *Ophryoxus gracilis*, are also northern habitants. Phytoplankton identified are shown in Table 3. Of these species, *Dinobryon sertularia* was the dominant species in 1975, and *Netrium digitus* was the dominant species in 1976. Other noticeable species (high moors habitants) are as follows: *Chroococcus turgidus*, *Tabellaria flocculosa*, *Frustulia rhomboides* var. *saxonica*, *Pinnularia*, *Eunotia*, *Cosmarium cucurbita*, *Gymnozyga moniliformis*.

6. 1973年~1976年の大沼湖群 (大沼・小沼・蕁菜沼) の水質について

伊藤富子 (北海道立水産孵化場) ・吉住喜好 (北海道立水産孵化場) ・今田和史 (北海道立水産孵化場) ・栗倉輝彦 (北海道立水産孵化場) ・岡本真美 (元北海

道立水産孵化場研究職員) (97-112)

Chemical composition of lake water of lake group Onuma (Onuma, Konuma and Junsainuma) in 1973-1976.

Tomiko Ito, Kiyoshi Yoshizumi, Kazushi Imada, Teruhiko Awakura and Mami Okamoto

1. Chemical composition of water of Lake Onuma group (Onuma, Konuma and Junsainuma) was studied in 1973-1976. And the secular change of the chemical composition of water was discussed.

2. Transparency, COD value, the concentration of nitrogen ammonia and phosphate of Lake Onuma and Lake Konuma in 1973-1976 were little different from the status before 1971.

3. The concentration of the sulfate and calcium of Lake Konuma had been as same as those of Lake Onuma in 1976.

4. Chemical composition of water of Lake Junsainuma in 1975 was little different from that in 1971.

7, 1972年～1976年の阿寒湖および流入河川の水質について

附表：湖水および流入河川水に関する1971年以前の分析値一覧

吉住喜好 (北海道立水産孵化場)・伊藤富子 (北海道立水産孵化場)・今田和史 (北海道立水産孵化場)・栗倉輝彦 (北海道立水産孵化場)・岡本眞美 (元北海道立水産孵化場研究職員) (113-154)

Chemical composition of water of Lake Akan and its affluents in 1972-1976.

Appendix: all published data on the chemical composition of water of Lake Akan and its affluents before 1971.

Kiyoshi Yoshizumi, Tomiko Ito, Kazushi Imada, Teruhiko Awakura and Mami Okamoto

1. Chemical composition of water of Lake Akan and its affluents was studied in 1972-1976 (Table 2). And the secular change of the chemical composition of the lake water in 1927-1976 was discussed (Table 1, Fig. 5).

2. There was little difference on the chemical composition of the surface water at different sampling stations. But the concentration of nitrogen ammonia and phosphate of bottom water was a little higher than those of surface water in many sampling times.

3. Transparency, COD, chloride and sulfate largely fluctuated every sampling times even in same year (Fig. 4). In the sampling times with large transparency, COD value was low and chloride was high. The seasonal changes of the transparency, COD and chloride were not clear in Fig. 4.

4. COD, nitrogen ammonia and phosphate have increased and transparency has lowered since 1960 (Fig. 5). Eutrophication of the lake water has progressed. Chloride, sulfate and residue of soluble substances have decreased since 1927.

8, (短報)シシャモ, *Sprinchus lanceolatus* (HIKITA) の産卵における鰭の働きについて

岡田鳳二 (北海道立水産孵化場)・工藤 智 (北海道立水産孵化場)・林 和明 (北海道立水産孵化場) (155-162)

(Note) On the action of male's anal fin of long finned smelt, *Sprinchus lanceolatus* (HIKITA), in spawning behavior.

Hoji Okada, Satoshi Kudo and Kazuaki Hayashi

第32号 (1977)

1, 微孢子虫, *Glugea takedai* の微細構造

三木伸一 (北海道大学水産学部)・栗倉輝彦 (北海道立水産孵化場) (1-20)

The fine structure of *Glugea takedai* AWAKURA, 1974. (Microsporida, Nosematidae)

Shinichi Miki and Teruhiko Awakura

Life cycle of *Glugea takedai* occurring in the trunk muscle of an experimentally infected rainbow trout, *Salmo gairdneri irideus* and steelhead

trout, *Salmo gairdneri gairdneri*, were observed by means of electron microscopy. Early to late schizonts and sporogony from sporoblasts to spores were observed in the infected part of muscles. These parasites were found extracellular and surrounded by lysed muscle. The fine structure was basically similar to that of other Microsporidia particularly to that of *Nosema* species. In *Glugea* species, each sporont produces two spores. We observed some cytoplasmic connection existing between sporoblast and mature spores. These cytoplasmic connection was, however, supposed to be artifact or malformation because of their asymmetrical shapes. *Glugea takedai* was first reported as new species by AWAKURA (1974) through the light microscopical observations of cytoplasmic connection in sporoblast. The present study, however, clearly showed that the spores originated directly from sporont without any division. This indicates that the present species should be placed in the genus *Nosema*.

2, 細菌性腎臓病に対するエリスロマイシンの治療効果並びにサケ科魚類4種の感受性について

河村 博 (北海道立水産孵化場) ・粟倉輝彦 (北海道立水産孵化場) ・渡辺克彦 (北海道立水産孵化場) ・松本春義 (北海道立水産孵化場) (21-36)

Therapeutic effects of erythromycin and the sensitivity of four salmonid fishes to bacterial kidney disease.

Hiroshi Kawamura, Teruhiko Awakura, Katsuhiko Watanabe and Haruyoshi Matsumoto

It was confirmed that bacterial kidney disease (BKD) occurred in a period from the winter, 1976 to early spring 1977 in juvenile chinook salmon, *Oncorhynchus tshaw ytscha* held at the Erimo and the Chitose Branches of the Hokkaido Fish Hatchery. Erythromycin was given to them at the rate of 100 milligrams per kilogram of fish per day during periods of 21 and 23 days in order to examine effects of the therapy. As a result the mortality

at the Chitose Branch was almost repressed. While three salmonid fishes, chum salmon (*Oncorhynchus keta*), masu salmon (*O.masou*), and steelhead trout (*Salmo gairdneri gairdneri*), were kept together with infected chinook salmon for 33 days, the incidence of kidney disease lesion was 42.9% in chum salmon, 13.3% in chinook salmon, 9.1% in steelhead trout and 0% in masu salmon at the end of the rearing. Histopathological observations revealed that marked hypertrophies of urethra epithelium and the connective tissue, and granulomous lesions occurred in the kidney were also found in pyloric caeca and gut. Hypertrophies of stratum compactum and muscularis. Spleen was occupied with a large number of blood cells at the most part but liver did not show any lesions to be seen.

3, 大沼のゲンゴロウブナの体筋肉中の栄養成分と血液性状の変化について

寺尾俊郎 (北海道立水産孵化場) ・粟倉輝彦 (北海道立水産孵化場) ・外崎 久 (北海道立水産孵化場) ・岡田鳳二 (北海道立水産孵化場) (37-60)

Changes of blood conditions by clinical test in serum and nutritional compositions in fish muscles of the deep bodied crucian carp *Carassius auratus* caught in Lake Onuma in Hokkaido.

Toshiro Terao, Teruhiko Awakura, Hisashi Tonosaki and Hoji Okada

Through spring to summer season of 1975 year, a lot of the dead adult deepbodied crucian carp were generally recognized in the waters of Lake Onuma. In order to investigate reasons of these died fish, we examined both of infection rate of ulcer diseases and nutritional and healthy conditions of the fish by clinical biochemical analysis method in the blood and muscle on the period of 1975 to 1976 year. Inflectional rate of ulcer disease on the deepbodied crucian carp showed the maximum value among the cyprinid fishes at July 15, 1976 year. This is identical to the investigational results of Takahashi et. al., (1977)

in Tamagawa river. We recognized that the physiological conditions of the fish showed the best conditions at growing season and worst condition from the seasonal changes of biochemical compositions in muscle and blood of the fish inhabited Lake Onuma. From the results described above, we may conclude that the reason upon high mortality of the fish in Lake Onuma are affected remarkably by the physiological conditions.

4, サケ科魚類セッソウ病における *Aeromonas salmonicida* の起病因子—菌体外プロテアーゼ
坂井勝信 (北海道立水産孵化場) (61-89)

Causative factor of aeromonas salmonicida in salmonid furunculosis: extracellular protease.

Daiku K. Sakai

Sixty-seven strains of *Aeromonas salmonicida*, which has been well-known pathogenic microorganisms of furunculosis in salmonids, isolated from furunculosis-contracting amago salmon (*Oncorhynchus rhodurus*), masu salmon (*Oncorhynchus masou*), rainbow trout (*Salmo gairdneri*), brook trout (*Salvelinus fontinalis*), kokanee salmon (*Oncorhynchus nerka*), Japanese char (*Salvelinus leucomaenis f. pluvius*), chum salmon (*Oncorhynchus keta*) and pink salmon (*Oncorhynchus gorbuscha*) in 1967-1976 were collected from the laboratories in the various districts of Japan. All of them greatly produced caseinolytic enzyme with plate culture at 20°C. Since it was thought that protease should be a primary causative factor of *A. salmonicida* in the furuncle-developing process from tissue necrosis to tissue collapse of salmonid furunculosis, the interrelationship between extracellular protease of *A. salmonicida* and salmonid furunculosis was studied in this paper. In order to clarify the pathogenicity of extracellular protease, protease production-deficient mutant designated as NTG-1 was obtained from *Aeromonas salmonicida* A-7301 by ethylenediaminetetraacetic acid

(EDTA, 1 mM)–N-methyl-N'-nitro-N-nitrosoguanidine (NTG, 100 mcg per ml) treatment. In the comparison of important characters and serological aspect, the features of NTG-1 coincided with those of A-7301 except protease production. Therefore, NTG-1 was confirmed to be a protease production-deficient mutant from A-7301. NTG-1 had markedly stable mutational character without back mutation after transferring and passing through live kokanee. *A. salmonicida* A-7301 produced protease with plate culture, static liquid culture and shaking culture at 20°C and initiated the protease secretion in the mid-logarithmic growth phase, however NTG-1 did not produce it with those cultures. The protease of A-7301 indicated the optimal activity in pH 9.6 and retained approximate 70% in pH 7.4 in comparison with that activity. The protease secretion was repressed by adding 5-10 mM glucose though glucose of the concentrations extremely accelerated the growth of A-7301 and NTG-1. Higher response on the protease production and growth was observed in casamino acids (2g/L)-peptone (2g/L) medium rather than in the either casamino acids or peptone. A-7301 was able to grow in the presence of the low concentrations (0.1-0.5g/L) of casamino acids as a sole carbon and nitrogen sources, while it could not produced protease without regard to the supplement of casein as a additional nutrient to those amino acid media. It suggested that A-7301 indispensably needs a definite amount of amino acid (>0.5g/L) for protease biosynthesis. When A-7301 bacterial cells buried with nutrient agar were placed on the confluent monolayer cell culture of RTG-2 which had been established as a cell line, the cell sheet was completely collapsed and dissolved by protease in the minimum essential medium for tissue culture (MEM) containing 10% fetal bovine serum without antibiotics at 20°C. NTG-1, however, did not exhibit this function because of lacking the protease secretion. In the pathogenicity on

one-year kokanee, A-7301 revealed extremely strong pathogenicity but not NTG-1 with the intraperitoneal (i. p.) injection, and then the inoculum was reisolated from dead fish kidney in the case of A-7301 but NTG-1 could not be done from live fish. The i. p. inoculations of A-7301 cells collapsed with the French Press and the collapsed cells suspended with cell-free culture fluid as a protease solution did not demonstrate pathogenicity. In the intramuscular (i. m.) injection, the protease solution, however, caused furuncle formation in the skin of the injection site without death. The furuncle changed into the hollow of the skin after successive breeding during three weeks, and after six weeks this symptom restored to normalcy. It seems to be the patho-histological process of cicatrization. Based on the findings, the author insists that the attack of furunculosis needs the growth and the protease production of *A.salmonicida* in vivo, and that the secreted extracellular protease should be the primary causative agent of furunculosis in salmonids.

第33号 (1978)

1, 大沼湖群 (大沼, 小沼, 蕁菜沼) の底生動物と底質
伊藤富子 (北海道立水産孵化場) (1-20)

Benthic macroinvertebrates and bottom sediments in Lake Onuma group (Onuma, Konuma and Junsainuma), Hokkaido, Japan

Tomiko Ito

1. Benthic fauna in Lake Onuma group (Onuma, Konuma and Junsainuma) was investigated in 1974-1975. The fauna was mainly consisted from Tubificidae and Chironomidae.

2. Monthly survey on the number and biomass of benthos was carried out in central portion and littoral portion of Lake Onuma in 1976-1977.

3. *Branchiura sowerbyi* inhabited only in littoral sampling station. *Tubifex hattai* and *Procladius*

sp. F were more abundant in the littoral sampling station than in the central sampling station. Numbers of *Limnodrilus* spp. and *Chironomus plumosus* in littoral sampling station were little different from those in central station.

4. Two generation in a year were detected in *C.plumosus* based on the seasonal change of larval density and biomass and monthly distribution of body lengths of larvae.

5. It was also presumed that *Procladius* sp. F had bivoltine life cycle based on the seasonal change of larval density and biomass.

6. Survival rates of *C.plumosus* and *Procladius* sp. F in winter were very high.

7. Organic substances of bottom sediments of Lake Onuma group were analyzed.

2, 越冬中のコイの魚体筋肉成分と血液性状について
寺尾俊郎 (北海道立水産孵化場) (21-26)

Nutritional constituents in muscle and biochemical components in blood of carp, *Cyprinus carpio*, in the winter season.

Toshiro Terao

During the winter season, it is necessary to support these carp on the healthy condition retained at the culture pond. My aim is to judge the healthy condition of the carp throughout its winter season. Hence, useful methods of diagnosis of the physiological conditions of these carp employed those analysis of biochemical and nutritional in muscle and blood composition of carp in winter season of 1976 year at Kamikawa district, Hokkaido. The results of analysis of the muscle and blood of adult carp were shown in Table 2 and 3. Also, as a healthy physiological conditions the fat factor and nutritional components in muscle of fry fish was exhibited by POLIAKOV (1957) and the inorganic and organic constituents analysis of adult carp blood was reported by FIELD, ELVEHJEM and JUDAY (1943). When comparing the results by POLIAKOV and

FIELD, ELVEHJEM and JUDAY with those in the author, the latter also be similar to the former. From the facts described above, the author may confirm that adult carp in the environment of the winter season have retained the healthy physiological condition in the long period. As a next research, we must investigate the physiological conditions of adult carp at the end of winter for reason of death of carp in the winter.

3, 歌別川におけるサケ稚魚放流時期の餌生物相と稚魚の食性および降海移動について

河村 博 (北海道立水産孵化場えりも支場) (27-44)

Bait organisms, habit and seaward migration of chum salmon fry during the liberated period in the Utabetzu River.

Hiroshi Kawamura

In order to carry out an adequate liberation of chum salmon fry in the eastern river system of Hidaka coast, Hokkaido, bait organisms, habit and seaward migration of the fry were investigated in the Utabetzu River. Thawing flood in spring in this river grew in early (early phase), late April (excellent phase) and middle May (late phase). Benthic animals in bottom area of 50×50 cm (0.25m²) with rubbles and gravels, and drifting organisms from two Surber nets of 25×25cm wide set for an hour, respectively, in main and side stream were collected in the Station 2, about 1.5km upstream from the estuary and about 2.5km downstream from the liberated point of fry, from March 19 to May 24 in 1978. Benthic fauna had closely relation to the thawing flood in spring, especially in the early and excellent phases of that. Plecoptera increased in number in the early phase. Ephemeroptera and Trichoptera appeared abundantly in the early and late phases. Diptera were found plentifully in the early and excellent phases. In Ephemeroptera, *Baetis* sp. as swimming form, *Epeorus latifolium* and *Rhithrogena japonica* as gliding form, and

Ephemerella trispina as creeping form were recognized in the early and late phases. Drifting organisms also fluctuated in number along with growing of the thawing flood. They became decreased in number just during the thawing flood, while increased before or after that. Almost all the drifting organisms were occupied by adults of Diptera and aquatic insects. *Baetis* sp., *Ephemerella trispina*, Chironomidae and its pupae were found throughout the examined period. Diptera and Collembola of terrestrial insect, and Limnophilidae and *Brachycentrus* sp. of aquatic insect appeared abundantly in the early and late phases of thawing flood. From the rearing pond in the Erimo Branch of Hokkaido Fish Hatchery located in about 4km from the estuary, 2.2 million chum salmon fry were released at a time on May 23. Downstream moving of the released fry was observed day after day by means of a water glass from the liberated point to the estuary. Growth and stomach contents of the fry as well as drifting organisms collected at Station 1 near by the liberated point, Station 2 and Station 3 near by the estuary were determined first and 5th day after release. Stomach contents of the fry captured by cast nets in each of the stations were almost similar to each of the constituents of drifting organisms. The fry fed mainly emerging larvae of aquatic insects, *Ephemerella trispina*, *Baetis* sp., Limnophilidae and Chironomidae. From the behavioral observations by means of a water glass, it was concluded that main run of 2.2 million fry released at a time migrated into the sea within 5 days and almost all the rest left from the river by 9th day after liberation according to a rainy flood. By 4th day after liberation, the fry were found here and there in stream current of about 30cm per a second. The smaller fry tended to remain into the river longer than the larger ones.

4, タンニン酸のミズカビ防除効果

小島 博 (北海道立水産孵化場) (45-54)

Effects of tannic acid on aquatic fungi associated with diseases of fish eggs.

Hiroshi Kojima

Malachite green has frequently used as a prophylactic for fish eggs. However, this pigment has become unbearable for environments, because colored drainage makes a change for the worse of water quality as a pollutant. Though some substitute for this pigment is desired, a suitable substance has not been found as yet. Some experiments, therefore, were attempted to estimate the effect of tannic acid as a prophylactic medicine on aquatic fungi, *Saprolegnia diclina* HUMPHREY, isolated from diseased cherry salmon (*Oncorhynchus masou*) fry. Mycelium of *S.diclina* treated at 1 ppm tannic acid (pH 6.3) for one hour at 15°C grew well as great as in the non-treated condition (pH 6.6) on agar plate, however, tannic acid completely inhibited the mycelial growth at 1,000 ppm (pH 4.1). This inhibitory effect seemed to be caused with unionized tannic acid but not with low pH, because mycelial growth was also inhibited with 1,000 ppm tannic acid solution adjusted to pH 7.0 with 50mM tris (hydroxymethyl) aminomethane-malic acid. On the other hand, the median tolerance limit (TLm) for tannic acid on the eyed eggs of steelhead trout (*Salmo gairdnerii*) was approximately 170 g/l (170,000 ppm) and the water hardened eggs of chum salmon (*Oncorhynchus keta*) could sufficiently survive during repeated bathes twice per week in 10 g/l (10,000 ppm) tannic acid solution for one hour. From these results, it was suggested that tannic acid as a prophylactic medicine for fish eggs has evident utility value.

5, *Aeromonas salmonicida* subsp. *salmonicida* における部分精製プロテアーゼの筋肉組織融解活性
坂井勝信 (北海道立水産孵化場) (55-74)

Colliquative activity of purified protease for

muscular tissue in *Aeromonas salmonicida* subsp. *salmonicida*

Daiku K. Sakai

The ability of extracellular protease from *Aeromonas salmonicida* subsp. *salmonicida* to destroy the muscular tissue was studied. In the previous paper, the extracellular protease of the culture fluid revealed the formation of swelling lesions in kokanee salmon (*Oncorhynchus nerka*). However, intracellular substances did not show the ability. Protease-deficient mutant NTG-1 which was derived from a virulent strain A-7301 by chemical mutagen converted virulency into an avirulent strain. The protease of the virulent strain showed the degrading effects on monolayer cell culture. In the present paper, the further investigation on the pathogenicity of the extracellular protease was performed, using the strains of A-7301 and NTG-1. When the viable cells of A-7301 were injected to kokanee salmon, the external swelling of the injected site in the epidermis was observed. High count (10^6 - $10^7/g$) of the injected bacterial cells and high protease activity (60-70units/g) were also observed in the liquefactive materials of the swelling lesion after breeding for 5-6 days at 15°C. The degree of the external swelling correlated with the size of the cell count and the activity of protease. A-7301 grew well with shaking at 15°C, 20°C and 25°C and the optimal growth was observed at 20°C. Protease was produced at 15°C and 20°C, however, at 25°C the enzyme was not secreted by A-7301. To investigate the effects of the culture fluid owning protease on kokanee salmon, the culture fluids of A-7301 at 20°C and at 25°C were injected. The former fluid had the ability to swell but not did the latter. Inactivated culture fluid at 20°C which was heated at 60°C for 1 hour did not form the swelling lesion. The culture fluid of NTG-1 also indicated the same negative effect. Based on the facts, the purification of protease

was performed with DEAE-cellulose column chromatography (1.6 × 25cm). Acetone-precipitates from the culture fluid of A-7301 were eluted with phosphate buffer solution. Three peaks of protein (F-I, F-II and F-III) were fractionated and protease activity appeared in F-II. After injecting the eluted F-I, F-II and F-III into the muscle of live kokanee salmon, the half number of F-II (2.7-7.0 protease units/g fish weight)-injected fish was mortal, of which the fish showed violent swelling, softening and hemorrhage in the injection site and also demonstrated hemorrhage in the anal fin within 2 days at 15°C. From the results the lethal effect of the protease fraction was pointed out. F-I and F-III, however, had no functions. Using protease (F-II)-inoculated kokanee salmon which was raised at 15°C for 1 day after injecting, the patho-histological changes of muscular tissue in the swelling lesion were investigated with paraffin sections stained by hematoxylin-eosin. The disappearance of myofibrils, the fragmentation of muscle fibers and the hemorrhage of whole muscular tissue were observed in the sections of swelling lesion. The colliquative necrosis of musculature occurred in the serious lesion. The changes suggested the function of the injected protease. To determine the proteolytic activity of F-II for kidney, liver and spleen, homogenized organs were employed. F-II markedly demonstrated lytic functions not only homogenized muscle but kidney, liver and spleen, respectively. From the findings, a virulence factor of *A.salmonicida* subsp. *salmonicida* in salmonid furunculosis is considered to be an extracellular protease produced by this organisms.

6, 魚類の脊椎骨異常 IV NAC 暴露によるキンギョの骨折部の組織変化

今田和史 (北海道立水産孵化場) (75-88)

Studies on the vertebral malformation of fishes IV. Histological observation on the repair of fractured goldfish (*Carassius auratus*) exposed to

NAC.

Kazushi Imada

The repair process of fractured centrum was observed histologically. Goldfish (*Carassius auratus*) were exposed to NAC (1-Naphthyl N-methylcarbamate) 10 ppm four hours to obtain the fractured specimens, and then these treated fish were kept in the well water. At 1, 2, 7, 14, 21 and 28 days, the fish were killed for the histological observation. At 1 and 2 days, the fracture and the luxation of centrams occurred in the caudal vertebrae, and the histological features of these injuries showed hemorrhage, degeneration of muscle and fluxion of notochord. At 7 days, hyperplasia of fibroblasts structured the granulation tissue. Neoplastic capillary, and osteoblasts surrounded with poor collagen fibers were observed in this tissue. At 14 days, the cartilage cells which were large regularly round were distinguished in this granulation tissue. These cartilage cells were located adjacent to the fractured centrum. At 21 and 28 days, it was observed that the fibroblasts were surrounded with rich collagen fibers and the cartilage cells were dominant in the granulation tissue. The fibrous cartilage bone which was situated adjoining to the fractured centrum was also observed in this tissue. Quantity of the fibrous cartilage bone may gradually increase with rearing time. However, completely repaired feature of, the fractured centrum could not been observed about four weeks rearing after the treatment.

7, ワカサギの生殖行動刺激物質

岡田鳳二 (北海道立水産孵化場) ・坂井勝信 (北海道立水産孵化場) ・杉若圭一 (北海道立水産孵化場) (89-100)

Chemical stimulus on the reproductive behavior of the pond smelt.

Houji Okada, Daiku K. Sakai and Kei-ichi Sugiwaka

This study was carried out to examine the chemical stimuli to induce the reproductive behavior of the pond smelt, *Hypomesus olidus*. The reproductive behavior of the pond smelt in an aquarium was summarized as shown in Fig. 5. The response of male's courtship behavior to the chemical stimuli was used as a bioassay of the substances obtained from mature fish. Chemical nature of the effective substance was also examined. The results obtained were summarized as follows.

1 The substances obtained from mature fish as chemical stimuli were; a) squeezed genital cavity fluid (Fe I), b) supernatant of homogenized egg (Fe II), c) incised genital cavity fluid (Fe III), d) supernatant of homogenized kidney (Kidney), and e) supernatant of squeezed testis (Ma I). The male's courtship behavior could be elicited only by genital cavity fluid and supernatant of squeezed testis among these substances. Males did not respond to homogenized kidneys and eggs.

2 The mixture of genital cavity fluid and the supernatant of testis was chromatographed on DEAE-cellulose column (1.6×25cm) with a linear gradient concentration of KCl solution. The ultra-violet absorption at 280nm was observed with the eluted fraction. Only the first peak (FP₁) elicited the male's courtship behavior and the other fractions were not effective.

3 FP₁ was reduced the activity after the treatment of heat (80°C, 5 min) or trypsin (trypsin 2 mg/ml-FP₁, 30°C, 60 min).

4 It was suggested that the chemical substance to stimulate the reproductive behavior detected in the genital cavity fluid, was protein or substance including protein in it's structure. It was also suggested that the genital cavity fluid acts as chemical information in the reproductive behavior of the pondsmelt.

8, ハゼ類に寄生する *Henneguya* spp. について

粟倉輝彦 (北海道立水産孵化場) ・外崎 久 (北海道立水産孵化場) (101-115)

Studies on *Henneguya* spp. (Protozoa: Myxosporidia) parasitic in gobiid fishes.

Teruhiko Awakura and Hisashi Tonosaki

The present authors studied the host-parasite relationship between the myxosporidia and gobiid fishes from April of 1977 to November of 1978 in Lake Barato of Hokkaido. The results obtained from this study are summarized as follows:

1. Two species of myxosporidia belonging to genus *Henneguya* were found from the four species of gobiid fishes, *Rhodonichthys laevis*, *Chaenogobius castanea*, *C.annularis* and *Aboma lactipes* sampled from Lake Barato.

2. The cyst of *Henneguya* sp. A was observed in the dermis of *R.laevis* and *A.lactipes*. The cyst of *Henneguya* sp. B was observed in the ovary of *R.laevis*, *C.castanea* and *A.lactipes* and in the kidney of *R.laevis*, *C.annularis* and *A.lactipes*.

3. Infestation rate of *Henneguya* sp. A in the dermis of *R.laevis* was high in spring seasons, but increased during the spawning season of the host fish. The cysts were mostly destroyed and the spores discharged from the host at the end of the spawning season.

4. The cysts of *Henneguya* sp. A were found to contain numerous *Henneguya* spores after 13 days when host fish were reared at 20 to 23°C and they were mostly destroyed and discharged after 20 days, but not changed after 20 days when host fish were reared at 6.0 to 10.3°C.

5. It seems that *Henneguya* sp. B infected in the ovary of *R.laevis* are discharged through the genital pore of host fish with mature eggs at spawning season. However, it was not observed that the spores of *Henneguya* sp. B infected in the kidney of *R.laevis* were discharged from host fish. The infestation rate of *Henneguya* sp. B in the kidney of *C.annularis* showed that the

parasitism of this species in the kidney was very harmful to the host fish.

第34号 (1979)

1, *Aeromonas salmonicida* subsp. *Salmonicida*
の侵入経路

坂井勝信 (北海道立水産試験場) (1-6)

Invasive routes of *Aeromonas salmonicida* subsp.
Salmonicida.

Daiku K. Sakai

Invasive routes of *Aeromonas salmonicida* subsp. *salmonicida*, the pathogen of salmon furunculosis, were discussed by several inoculation tests, using the yearling of masu salmon (*Oncorhynchus masou*). The mortalities of the fish through intraperitoneal and intramuscular injections (10^8 viable cells/fish) were 100%— When the fish were bathed with the bacterial cell-suspension (10^8 /ml) for 30 min, the normal (unhurt) fish completely survived. However, the mortalities of fish injured by cutting the caudal fin and the dorsal fin were 80% and 60%, respectively. To investigate an invasion via the stomach or *via* the intestine, the cell-suspension (10^8 /fish) was inoculated into the stomach or the intestine through fine polyethylene tubes inserted from the mouth or the anus. The mortalities through the inoculations *via* the stomach and *via* the intestine were 50% and 10%, respectively. These results suggest the following points: first, *A. salmonicida* subsp. *salmonicida* does not cause an invasion through the unhurt gills or the unhurt epidermis, but this pathogen invades into the fish through the injury of the fin; second, there is an apparent infection *via* the stomach, but an infection *via* the intestine demonstrates only a low mortality. Hence, there are two invasive routes in *A. salmonicida* subsp. *salmonicida*: a percutaneous infection through the epidermal

injury and an infection through the digestive canal.

2, 厚田川におけるサクラマス幼魚の成長と生息密度および現存量の季節変化

小島 博 (北海道立水産試験場)・杉若圭一 (北海道立水産試験場) (7-16)

The growth, individual density and standing crop of juvenile masu salmon in the Atsuta River, Hokkaido.

Hiroshi Kojima and Kei-ichi Sugiawaka

The growth, individual density and standing crop of juvenile masu salmon (*Oncorhynchus masou*) caught with casting nets, in order to promote the propagation of fish resources, were examined at three stations (pools) in the Atsuta River, Hokkaido, from July to October, 1978. The juveniles grew almost straightly from 6.5 to 10.1 cm in fork length during three months from July to October. The greater part of the fish population was occupied by fish of 6-7 cm in fork length in July, 8-9 cm in September, and two groups of 9-10 and 11-12 cm in October. It was considered that phase differentiation of the juveniles appeared in October. The individual density of juveniles, determined by marking method and removal method, changed scarcely ($0.46-0.53/m^2$). The standing crop of juveniles increased almost straightly and reached the maximum of $5.80 \text{ g (w.w.)}/m^2$ in October, showing the rise of $3.87 \text{ g (w.w.)}/m^2$ during 85 days. From these results, it is considered that the Atsuta River has the capability to produce enough feed to maintain greater amounts of juvenile masu salmon than those in now.

3, サケ・マスの生産河川におけるハナカジカ (*Cottus pollux* GUNTHER) の生態

河村 博 (北海道立水産試験場えりも支場) (17-24)

Distribution, movement and age constitution of the common freshwater sculpin (*Cottus pollux*

GUNTHER) in the salmon propagation river.
Hiroshi Kawamura

The author had already described, in the preceding paper (KAWAMURA, 1978), on the bait organisms, the habit and seaward migration of chum salmon (*Oncorhynchus keta*) fry in the Utabetu River where was a small river in the eastern Hidaka coast, Hokkaido. In downstream area of the river, common freshwater sculpin (*Cottus pollux*) has been watched out as a fry eater. Therefore, in order to estimate a predation of the chum salmon fry by the fish, distribution, movement and age constitution of the sculpin were studied ecologically in the Utabetu River from late April to late May, 1979. The sculpins, 369 fish in total, were captured with cast nets, marked and released at five riffles and a shallow pool in downstream area of the river. Among the marked sculpins, 50 fish in total were recaptured from 12 to 25 days after liberation, remaining 78.3% of them in the releasing points, moving 15.2% upstream and 6.5% downstream. The mature fish have a tendency to remain in the same place, or to move downstream from that. On the other hand, there is a tendency for the spent fish to move upstream and for the immature ones to run up- and downstream. These movements seemed to depend on a bed condition of river, a process of thawing flood, a bait organisms and an aggressive behavior for protecting spawned eggs by the mature male fish. Distribution density of the sculpins (number of fish/m²) indicated almost constant values, 0.23 near by the estuary and 0.1 about 1.5 km upstream from it. The freshwater sculpin in downstream area of the Utabetu River was estimated at 1,430 fish in total. By means of frequency distribution of the body length (CASSIE, 1945), the sculpins were divided into five year classes. The male sculpin was larger than the female in every year class. The sculpins in downstream area of the Utabetu

River are ecologically of a small-egg type, which live into the sea at early stage of the life cycle.

4, 厚田川における降海型サクラマス幼魚に関する研究
1978年降海群の年齢と生態

杉若圭一 (北海道立水産孵化場) · 小島 博 (北海道立水産孵化場) (25-40)

Studies on the smolt of juvenile masu salmon (*Oncorhynchus masou*) in the Atsuta River. Age and ecology of smolts in 1978.

Kei-ichi Sugiwaka and Hiroshi Kojima

The ecological investigations on the sea-run form (smolt) of juvenile Masu salmon were carried out in the Atsuta River in mid-April and mid-May of 1978, and remarkable findings on the age of smolt were procured. The method of age determination in this study was as follows: in number of ridges from central plate on scales, the most outside ridge of annulus ranging between 5 and 9 was regarded as the simulate annulus, while ranges from 10 to 18 and 20 to 27 were regarded as the actual first and second annulus, respectively. According to the literatures, it has been described that the greater part of smolt of juvenile Masu salmon observed in the rivers and the coast of the North Japan were 1-year-old (2.) but 2-year-old (3.) smolt occupied only 2 or 3 per cent in the frequency. But in the Atsuta River, the frequency of 2-year-old smolt was markedly high (41.3 per cent). The numerical difference of the frequency of 2-year-old smolt in this study and in the other reports can not be explained clearly at present. Some reasons for this difference, however, were considered: 1) selectivity to fish of sampling method (angling), 2) difference of the age determination method, 3) difference of locality. Several 1-year-old small parr which commenced neither phase differentiation nor smolt transformation were found, and it is considered that these small parr will differentiate into 2-year-old smolt or stream resident parr

by next spring. The 2-year-old smolt examined exhibited characteristics suggesting a high degree of inferior growth during the period of one year after hatching. Hence, if the emergence of 2-year-old smolt depends on inferiority of growth, it is supposed that its frequency may fluctuate yearly, because it must be influenced by the environment of the river, especially, the amount of feed, the number of anadromous adults, and the individual density of parr in the river.

5, イシカリワカサギ (*Hypomesus olidus*) の脊椎骨異常について

今田和史 (北海道立水産孵化場) (41-56)

Histological observation on the deformed pond smelt, *Hypomesus olidus*, collected in Hokkaido.

Kazushi Imada

Deformed fish, *Hypomesus olidus*, collected from Barato River one of the branches of Ishikari River in Hokkaido, were observed with morphological and histological methods. One of the specimens was lordosis and kyphosis and X-ray photograph of this fish showed the sigmoid vertebrae. Another two specimens, shortened bodies, were heavy coalescence of their vertebrae. Histological features of sigmoid fish showed the normal centrums in abdominal vertebrae, but in caudal part some centrums were deformed and were hypertrophic at the outward of curvature. Coalescented centrums of shortened fish changed their original forms, hourglass-shape, and the fibrous sheath were not regularly. At the conjunctive part of centrums, the fibroblasts and cartilage cells were hyperplastic and cartilage bone appeared surrounding these cartilage cells.

6, 北海道から初めて採集されたアブラハヤ

小島 博 (北海道立水産孵化場) ・疋田豊彦 (北海道さけ・ますふ化場) (57-61)

First occurrence of aburahaya, *Phoxinus lagowski* f. *steindachneri*, in Hokkaido

Hiroshi Kojima and Toyohiko Hikita

On June 30, 1979, a male specimen of Aburahaya, *Phoxinus lagowski* f. *steindachneri*, was collected for the first time from the Atsuta River in the western Hokkaido. It is suggested that the Aburahaya was ten years or more since carried incidentally with Ayu, *Plecoglossus altivelis*, which was transplanted from the Biwa Lake to the Atsuta River. The present paper gives data on the new distribution of this species in Japan.

第35号 (1980)

1, 阿寒湖の夏季停滞期に見られる低酸素現象について
米川年三 (北海道立水産孵化場) ・川村洋司 (北海道立水産孵化場) (1-10)

Dissolved oxygen condition of Lake Akan
Toshizo Yonekawa and Hiroshi Kawamura

Seasonal changes in the vertical distribution of dissolved oxygen (DO) were observed in Lake Akan from June to November, 1979. The good correlation was found between the vertical distribution of DO and that of water temperature in the lake. In June, DO distributed uniformly from the surface to the bottom, but from August, the oxygen concentration at deep layer (under 10-15 m depth) decreased rapidly with time, and became absent under the thermocline from September to October. In November, the stagnation of water temperature disappeared, and DO distributed uniformly again. The results of the detailed literature review, it has been observed since 1959 that DO at deep layer became absent from September to October.

2, 阿寒湖における底生動物相の永年変化および底質の有機物含量

伊藤富子 (北海道立水産孵化場) ・宇野 勉 (北海道

立水産孵化場) (11-19)

Long-term change of benthic macroinvertebrates and high contents of organic matters of bottom sediments in Lake Akan, Hokkaido, Japan

Tomiko Ito and Tsutomu Uno

The benthic fauna of Lake Akan, Hokkaido, Japan, had violently changed in last forty years. Profundal fauna was composed of the chironomids, as *Chironomus plumosus*, tubificids, *Chaoborus*, vivalves and gastropods in nineteen-thirties. And in the present date, it was simply composed of the chironomids, as *C. plumosus*, and tubificids; the benthic animals were abundant in the zone of 10-20 m of water depths and they were very scarce in 20-36 m. It was presumed that the eutrophication of the lake may be the main cause of the change. The contents of organic matters of the bottom sediments in the lake were very high in comparison with other eutrophic lakes in Japan. The mean values on the profundal zone were; COD, 6.9%; ignition loss, 22%; organic carbon, 5.5%; and total nitrogen, 0.69%, respectively.

3, 支笏湖の透明度, COD および数種溶存イオンの変動 (1973年~1979年)

今田和史 (北海道立水産孵化場) · 伊藤富子 (北海道立水産孵化場) · 吉住喜好 (北海道立水産孵化場) · 粟倉輝彦 (北海道立水産孵化場) · 米川年三 (北海道立水産孵化場) (21-34)

Transparency, COD and several dissolved ions of caldera Lake Shikotsu in 1973 to 1979.

Kazushi Imada, Tomiko Ito, Kiyoshi Yoshizumi, Teruhiko Awakura and Toshizo Yonekawa

Transparency, COD, Cl⁻, SO₄²⁻, Hardness, Ca²⁺, Mg²⁺ and SiO₂ of Lake Shikotsu were examined from June 1973 to November 1979. The investigations were four or seven times in a year, we discussed the distribution of the analytical values and the difference of water quality between each station of the lake. The largest reading of Secchi

disc transparency measured with fishing mask was 38.5 m, the lowest was 4 m, and the mean was approximately 20 m. Transparency in spring was higher than in summer. Mean of COD was about 0.57 mg per liter, and the concentration at the central part of the lake were lower than that at the shores (P=0.05), but seasonal changes were unclear. The concentrations of SO₄²⁻, Hardness and Mg²⁺ were widely distributed and the annual changes of these variables were irregularly fluctuated. Ca²⁺, Cl⁻ and SiO₂ showed narrow distributions and the seasonal or annual changes were indistinct. The concentrations of silicate in the surface water were lower than these in 20 m layer during the summer stratification (P=0.05). This phenomenon suggested that the silicate consumption by phytoplankton in surface water was larger than that in deep layer. The concentrations of Cl⁻, SO₄²⁻ and Ca²⁺ at the shore station located near the hot spring were higher than these at the central part of the lake (P=0.05).

4, 厚田川におけるサクラマス幼魚の生産量と資源量
小島 博 (北海道立水産孵化場) · 杉若圭一 (北海道立水産孵化場) (35-43)

Population size and net production of juvenile masu salmon in the Atsuta River, Hokkaido

Hiroshi Kojima and Kei-ichi Sugiwaka

The growth, individual density and standing crop of juvenile masu salmon (*Oncorhynchus masou*) at pools in the Atsuta River, Hokkaido, were revealed in the previous paper. The investigation of 1978 was continued not only in the further study of the growth, individual density and standing crop of the juveniles, but also in the study of production and population size of the juveniles in the same river, from July to October, 1979. The patterns of the growth and change in the standing crop of the juveniles in pools were almost the same as those described in the previous paper. Namely, the juveniles grew almost

straightly from 6.2 to 9.7 cm in fork length, from 2.8 to 10.4 g in body weight (wt. w.) and the standing crop of the juveniles increased almost linearly from 1.35 to 4.74 g/m² during the 87 days from July to October. However, upon investigation of growth rates and relative growth rates in body weight, a slowdown of growth between August and September became obvious. The change in frequency distribution of the fork length of juveniles also was similar to that of last year. Phase differentiation of the juveniles appeared in October. The individual density of juveniles in pools decreased gradually from 0.49 to 0.45/m² during the three month period. In riffles, the individual density of juveniles in August was 0.17/m². Net production calculated from biomass increment of standing crop and loss by death in pools was similar between 1978 (from the data of the previous paper) and 1979, averaging about 3.8g/m²/3 months (July-Oct.). In addition to these, in order to estimate the population size of the juveniles, a few other investigations were performed, i.e. the estimation of the density rate within three reaches and the measurement of the areas of the three reaches. From these results, it was estimated that the population size of the juveniles in August in the Atsuta River was approximately 160,000 fish.

5, 厚田川における降海型サクラマス幼魚に関する研究 II : 1979年降海群の年齢と生態

杉若圭一 (北海道立水産孵化場) · 小島 博 (北海道立水産孵化場) (45-52)

Studies on the smolt of juvenile masu salmon (*Oncorhynchus masou*) in the Atsuta River. II. Age and ecology of smolts in 1979.

Kei-ichi Sugiwaka and Hiroshi Kojima

The present authors reported previously that the frequency of 2-year-old smolt was high (41.3%) in the Atsuta River in 1978. Further investigation was performed in the same river from

mid-April to mid-June of 1979 and the appearance of 2-year-old smolt unexpectedly reduced to only 8.0% in the frequency. The relative growth merits whose items reflect on the density of parr were presumed to be one of the major factors for the annual fluctuations. The distribution of the smolts in mid-April was characteristic, that is, many smolts were ubiquitously observed in the tributary, while a small number of smolts forming a small school were maldistributed in the main stream. Reversely, in May, there was many smolts in the main stream but few in the tributary. This movement of smolts suggested the hibernant migration in the preceding year. The peak of smolt seaward migration was observed in mid-May of the preceding year, however the peak of this year was supposed to be early May. The shift of the peak may depend on the yearly environmental changes of the river, for example, water temperature, water quantity etc. The alternate changes in sex ratio during the course of each smolt run were also observed. The rate of male smolt increased gradually with the passage of the migration period. It suggests that this phenomenon is due to the differential courses of the phase differentiation and smolt transformation *in situ* between female and male in Autumn.

6, サケ・マス生産河川におけるハナカジカによるサケ稚魚の捕食減耗について

河村 博 (北海道立水産孵化場えりも支場) (53-62)

Predation of chum salmon fry by common freshwater sculpins (*Cottus pollux* GUNTHER) in the salmon propagation river.

Hiroshi Kawamura

Predation of chum salmon (*Oncorhynchus keta*) fry liberated from Erimo Branch of the Hokkaido Fish Hatchery by common freshwater sculpins was studied ecologically in downstream area of the Utabetzu River, eastern Hidaka coast of Hokkaido, during the periods of seaward

migration from 1978 to 1980. Breeding season of the sculpins, from late April to early June, corresponded with seaward migration period of the liberated chum salmon fry. The sculpins, 764 fish in total, were captured with cast nets during the periods of one to five days after the chum salmon fry were liberated through 1978 to 1980. Among the collected sculpins, 240 fish in total (31.4%) ate more or less chum salmon fry. Percentages as predator on chum salmon fry in the sculpins became 37.8% in 1978, 30.0% in 1979, and 27.9% in 1980. The percentages differed by both sexes as well as by their age. In female fish, the values increased with advance of age, while in male fish, they became highest in third year class. Chum salmon fry, 529 fish in total, were found from 220 predator on the fry in the sculpins. The fry found into, the stomach were various stage in digestive process. Average number of chum salmon fry eaten per a predator were about 2.4 fish through 1978 to 1980, being 2.3 fish in 1978 and 1979, and 2.5 fish in 1980. The average number in female (2.5 fish) was larger than that in male (1.9 fish). The numbers in female sculpin increased with advance of age from 1.0 fish in first year class to 4.2 fish in fifth year class, while in male became higher in third (2.2 fish), or fifth year class (6.5 fish) than in second and fourth year classes (1.4 fish). Stomach contents of both predator and not-predator on chum salmon fry in the female sculpins tended to decrease with advance of sexual maturation, suggesting a decline in feeding activity of mature fish during the breeding season. Similar tendency of the stomach contents was recognized also in not-predator fish of the male sculpins, but it was not found in the predator fish.

7, *Digamma alternans* (RUD.) YAMAGUTI, 1934 の試験管内培養
栗倉輝彦 (北海道立水産孵化場) (63-71)

Cultivation of *Digamma alternans* (RUD.) YAMAGUTI, 1934 in vitro.

Teruhiko AWAKURA

The plerocercoid of *Digamma alternans* (RUD.) YAMAGUTI, 1934 were taken from infected crucian carp (*Carassius* spp.) and cultured *in vitro* by the method of SMYTH (1958). After 48 hours of cultivation of plerocercoid in horse serum at 40°C, late spermatid morulae and the formation of free spermatozoa were seen in the testis, and the accumulation of large oocytes were observed in the ovary. After 72 hours of cultivation, the spermatozoa were seen in large masses in the seminal ducts, many ova appeared in matured uteri and the fine granulation were observed in most of the vitelline cells. Normal eggs appeared in all culture flasks from 72 to 96 hours of culture. The eggs were taken from the cultured fragments, varying from 0.058 to 0.078 mm in length and from 0.043 to 0.053 mm in width. These sizes closely resembled the eggs of *D.interrupta* (RUD. 1810) and *D.nemachili* DUBININA, 1957.

8, サケ・マス類血清の溶血活性測定による健康状態の数值化

坂井勝信 (北海道立水産孵化場) (73-82)

Evaluation on the health of salmonid fishes by determinating the spontaneous hemolysis activity of sera

Daiku K. SAKAI

Native serum obtained from rainbow trout (*Salmo gairdneri*) always demonstrates a highly hemolytic function against washed goldfish (*Carassius auratus*) red blood cells (GFRBC) but not against rainbow trout red blood cells (RTRBC), while the serum of goldfish indicated a hemolytic activity against RTRBC but not against GFRBC. These hemolytic functions have no relation to immune hemolysis based on the

synergy with immunoglobulin and complement, because both red blood cells scarcely contact one another as an immunogenic in cultured and natural environments. Therefore, if this spontaneous hemolytic serum activity mirrors the resisting power of fish to the invasion of foreign substances and pathogens, it will be an easy tool for evaluation on the situation of health. Based on the MEYER's method for the determination of hemolytic complement activity, this hemolytic serum activity was expressed as 50% hemolysis of GFRBC. The original MEYER's unit, however, could not apply for this study, because GFRBC contained approximately tenfold hemoglobin as much as sheep red blood cells and this activity did not detect at 37°C. Hence, the present author modified the hemolysis unit for this purpose and newly defined a spontaneous hemolytic serum unit (SH₅₀) as follows: 1 SH₅₀ unit is the serum volume which lyses the 50% of 5×10⁷ GFRBC or RTRBC in 7.5 ml of reaction volume at 30°C. The hemolytic serum activity of rainbow trout was 17.4 (mean) SH₅₀ units against GFRBC and <2 SH₅₀ unit against RTRBC. This hemolysis against GFRBC was present not only in the serum of rainbow trout but also in the sera of steelhead trout (*Salmo gairdneri*, 26.2 SH₅₀ units), coho salmon (*Oncorhynchus kisutch*, 16.6 SH₅₀ units), masu salmon (*O.masou*, 19.3 SH₅₀ units), Japanese huchen (*Hucho perryi*) (10.3 SH₅₀ units) and smelt (*Hypomesus transpacificus*, 11.4 SH₅₀ units). The serum of goldfish, however, did not function against GFRBC (<2 SH₅₀ unit) and hemolysed RTRBC (3.2 SH₅₀ units). This activity responded to the delicate changes of physiological conditions: it decreased to 10.3 SH₅₀ units against GFRBC in the stage of smolt masu salmon and lowered to 9.5 SH₅₀ units with starvation for 10 days in coho salmon. Representative pathogens in salmonid fishes were also more effective to decrease the hemolytic activity: *Aeromonas salmonicida*, the causative agent of furunculosis, and *Vibrio*

anguillarum, the causative agent of vibriosis, markedly reduced the activity with *i.p.* injection into juvenile masu salmon and steelhead trout. Especially in steelhead trout, the virulent strain of *A.salmonicida* subsp. *salmonicida* gradually lowered the SH₅₀ unit as furunculosis progressed to the worse and finally shifted to 6.6 SH₅₀ units in the moribund state, whereas the avirulent strain scarcely indicated a function to lower. As such results show, sera of fishes reacted on heterologous red blood cells and hemolysed them, though the sera hardly displayed the hemolytic function against homologous red blood cells. This hemolytic serum activity responded sharp to the changes of physiological conditions and to the progresses of infectious diseases. These findings support the fact that SH₅₀ unit concerning the spontaneous hemolysis activity of serum is regarded as a possible indicator for the state of health in fishes.

第36号 (1981)

1, シンヤマモの性成熟に伴う鰭の形態変化とその生殖行動における役割

岡田鳳二 (北海道立水産孵化場) ・工藤 智 (北海道立水産孵化場) ・杉若圭一 (北海道立水産孵化場) (1-10)

Morphological changes of fin on the sexual maturity and role of the reproductive behavior of the long-finned smelt, *Spirinchus lanceolatus* (HIKITA).

Houji Okada, Satoshi Kudo and Kei-ichi Sugiwaka

The present study was carried out to elucidate the growth of the fin along with the sexual maturity of the long-finned smelt. Growth of body weight, body length and liver weight were also investigated. Area of fin was measured and fin index (F.I.: area of fin/B.L². X 10³) was employed

as an index to observe the morphological changes of fins. The results obtained here were summarized as follows.

1) Gonad of the long-finned smelt grew slowly on August and September, but on October, ovary and testis grew with rapidity and became close to the maturity.

2) The paired fins, pectoral and ventral fin, grew at a high speed on October and November. Their fin index of male became greater than that of female at the maturity. These paired fins were recognized as a secondary sexual character.

3) The unpaired fins except anal fin, the F.I. growth rate were very low. On the dorsal fin and adipose fin, their F.I. of male were similar to that of female. Although there was a few significance between male and female of caudal fin, morphological changes according to sexual maturity were very few in other unpaired fins.

4) Male's anal fin grew greater and greater as well as female's paired fin, and grew into the biggest at the maturity. In females, the anal fin grew slowly in the same way of other unpaired fin. Difference between male and female in anal fins was the most distinguishable and the anal fin was the most definite secondary sexual character in all of the fins.

5) The relation between morphological changes of fins and reproductive behavior was also discussed.

2, 標識放流から見た1⁺池産サクラマスモルトの回遊
杉若圭一（北海道立水産孵化場）・田中寿雄（北海道
立水産孵化場）・笠原 昇（北海道立水産孵化場）・
新谷康二（北海道立水産孵化場）（11-31）

Smolt run in the sea by tagging experiment of pond-reared smolt of masu salmon (*Oncorhynchus masou*).

Kei-ichi Sugiwaka, Hisao Tanaka, Noboru Kasahara and Kouji Araya

Pond-reared smolts of masu salmon (*Oncorhynchus*

masou) 9,319 in the number were tagged on the base of dorsal fin and they were released from two rivers, which discharged into the Japan Sea, located in the southwest area of Hokkaido. Tagging experiment was performed in late-March of 1980 to obtain information's of the migration of sea run smolts. Tagged smolts of 1-year-old were 22.6 cm in mean fork length and they were fairly large-sized rather than that of wild smolts. The tagged group would mature if rearing maintenance was proceeded up to September in 1980. Tagged smolts released from the lower reaches of the river (two places: 0.8 and 1.8 km from the sea) immediately migrated to the seaward, while seaward migration of a group released from upper stream (two places: 3.5 and 7.5 km) delayed about 3 or 4 weeks. Tagged smolts of 136 were recaptured in the coast of Hokkaido and Aomori prefectures and in the offshore areas of the Japan Sea. These recaptured locations suggested their migration ways. Sea run smolts released from the rivers divided the greater number of them into three groups in migratory ways: the first group passed through the Tsugaru Strait and migrated toward east along the Pacific coast of Hokkaido; the second group went up north along the Japan Sea coast of Hokkaido and migrated to the Okhotsk Sea; the third group also showed northward movement but migrated in the offshore of the Japan Sea, approximately 100 km off the coast. These migration ways, on the whole, accorded with the main direction of ocean current and, moreover, depended upon the seasonal changes of sea surface temperature. While, the sea run smolts in earlier stage demonstrated diverse movements with the influence of complicated environmental factors. The growth of released smolts was extremely inferior to the wild smolts in the sea environments. Moreover, some tagged fish on the way of a return from the sea were recaptured in other rivers with the exception of the released rivers. These results suggest that

a great many of tagged fish return from the sea and mature in the rivers within 1-year-old as contrasted with wild sea run group. Therefore, the release of such large-sized smolts is appropriate to understand ecological know ledges of smolt run, but a utilization of large pond-reared smolts is unavailable for the production of masu salmon resources in the sea.

3, 阿寒湖 (1973年~1980年) の透明度, COD および数種溶存イオンの変動

今田和史 (北海道立水産孵化場) ・伊藤富子 (北海道立水産孵化場) ・吉住喜好 (北海道立水産孵化場) ・米川年三 (北海道立水産孵化場) (33-50)

Transparency, COD and several dissolved ions of Lake Akan in 1973 to 1980.

Kazushi Imada, Tomiko Ito, Kiyoshi Yoshizumi and Toshizo Yonekawa

Lake Akan is one of the eutrophic lakes in Hokkaido. We have investigated on water quality for eight years from 1973 at intervals of three to six times in a year. Statistical estimation of the observations were discussed in this paper. Histogram of each variable calculated from the results of surface water, with the exception of Chloride, fitted to the normal distribution. In each variable, the seasonal or annual changes were not observed and the tendency of these changes were unclear. Transparency varied from 1.1 to 7.5m and the mean was 3.47m. The mean of transparency at the central part of the lake was higher than that of the other shore stations ($P=0.05$ paired t -test). COD concentration were almost 2-4mg/l, and the mean was 2.64mg/l. The mean at the shore station near urban area was higher than that of the central part with the difference of 0.21 ± 0.14 mg/l ($P=0.05$). The means of the other variables at the surface water Cl⁻, SO₄²⁻, SiO₂, Hardness, Ca²⁺ and Mg²⁺ were 12.49, 30.19, 29.95, 75.65, 16.90 and 7.80mg/l, respectively. The mean values of each variable at center of the

lake seems to be indicated the typical profiles of the water quality of this lake.

4, ニジマス腹腔抽出細胞の食菌現象に対する抗体および補体の協力作用

坂井勝信 (北海道立水産孵化場) (51-56)

Cooperative opsonic functions of antibody and serum complement in the phagocytosis of peritoneal exudate cells derived from rainbow trout.

Daiku K. Sakai

Peritoneal exudate cells (PEC) were obtained from juvenile rainbow trout stimulated by an intraperitoneal injection of sterilized liquid paraffin. PEC contained three kinds of white blood cells after 3 days of the stimulation; i.e., small lymphocytes of 44-50% and neutrophile-like and macrophage-like cells of 42-50% in the occurring rates, and also the rates of neutrophile-like cells-to-macrophage-like cells were approximately 1: 1 under microscopic observations. When PEC were incubated at 20°C for 2 hours with viable bacterial cells of *Aeromonas salmonicida* subsp. *salmonicida*, the causative microorganism of salmonid furunculosis, PEC including the bacteria could be scarcely discovered on the specimens of rainbow trout unimmunized and immunized with formalin-killed *A.salmonida*. The addition of the heat-inactivated antiserum (heated at 44°C for 20 min: this condition for the heat inactivation of rainbow trout complement had been demonstrated by SAKAI), which contains the intact antibody but lacks a serum complement activity, a little improved the phagocytic functions of PEC to the pathogen. The supplement of rainbow trout complement as fresh normal serum, however, indicated an incapacity of improving the efficiency of the phagocytosis. The coexistence of the antibody and complement markedly enhanced the phagocytic activity of PEC. Almost all the PEC belonging to neutrophile-like and macrophage-like cells included the considerable

numbers of bacterial cells in the presence of the antibody and complement. The presence of Fc and C3b receptors in the phagocytic PEC of rainbow trout were suggested by the cooperative opsonic functions of the antibody and complement as well as in neutrophils and macrophages of marines and humans.

5, サクラマスの寄生虫に関する研究-I 淡水生活期における *Tetraonchus* (単生類) の鰓寄生

粟倉輝彦 (北海道立水産孵化場) · 小島 博 (北海道立水産孵化場) · 杉若圭一 (北海道立水産孵化場) (57-63)

Studies on parasites of masu salmon *Oncorhynchus masou* - I. The parasitism of *Tetraonchus* (Monogenea) on the gills of juveniles in fresh water.

Teruhiko Awakura, Hiroshi Kojima and Kei-ichi Sugiwaka

The authors examined the parasitism of *Tetraonchus* of the gills of juveniles masu salmon in four natural rivers, two hatcheries and a fish farm in Hokkaido, Japan. *Tetraonchus awakurai* OGAWA & EGUSA, 1978 commonly parasited the gills of juvenile masu salmon inhabiting natural rivers. Prevalence and intensity of *T. awakurai* was high in summer in 0⁺ juveniles, in winter and spring in the stream resident parr of 1⁺ or 2⁺ juveniles and May and June in the silvery parr and smolt of 1⁺ or 2⁺ juveniles in the Atsuta River. They parasited fish which escaped from rearing ponds and grew wild in reservoir, but we could not find the parasite on the juveniles reared in the pond located downstream of this reservoir. The parasitism of this parasite was very rare in juveniles reared in hatcheries or fish farms in Hokkaido.

6, サクラマスの寄生虫に関する研究-II 腎臓に寄生する胞子虫について

粟倉輝彦 (北海道立水産孵化場) · 小島 博 (北海道立水産孵化場) · 杉若圭一 (北海道立水産孵化場)

(65-73)

Studies on parasites of masu salmon *Oncorhynchus masou* - II. The sporozoan parasites found in kidney.

Teruhiko Awakura, Hiroshi Kojima and Kei-ichi Sugiwaka

A total of 1327 juvenile, maturing or mature masu salmon (*Oncorhynchus masou*) caught in natural rivers, off shore and reared in fish ponds, and a total of 377 mature chum salmon (*O.keta*), mature pink salmon (*O.gorbusha*), pond-reared coho salmon (*O.kisutch*), pond-reared rainbow trout (*Salmo gairdneri*) and juvenile white spotted char (*Salvelinus leucomaenis*) were examined for the sporozoan parasites found in the kidney. Haplosporidia-like organisms which were reported by KUBOTA and KAMADA, 1972 and *Myxidium* sp. which is new record from salmonid fish in Japan were found in the kidney of juvenile, maturing and mature fish of masu salmon. Haplosporidia-like organisms were observed in the glomerules and the renal tubules from small juvenile to mature masu salmon at all season, but *Myxidium* sp. in the renal tubules only at summer season which water temperature increased over 15°C. These sporozoan parasites were found in white spotted char with high prevalence and in rainbow trout with low prevalence, but not in coho and chum salmon. Another species of Haplosporidia-like organisms and *Myxidium* were found in the renal tubules and ureters of pink salmon.

7, ホルマリン保存したサクラマス幼魚標本に対する水洗の影響

小島 博 (北海道立水産孵化場) (75-81)

Effects of rinse on the weight and length of juvenile masu salmon preserved in 10% formalin solution of fresh water

Hiroshi Kojima

In general, fish samples preserved in 10% formalin solution are mainly used for the measurements of their body weight and fork length, whereas they are rinsed with fresh water for a long time to remove irritating smell of formalin from the samples. The initial weight and length of samples are quite presumed to be changeable in formalin and rinsing treatments. When the samples preserved in 10% formalin were rinsed with fresh water for various periods, the changes of weight and length were measured, using juvenile masu salmon (*Oncorhynchus masou*) ranging from 4.1 to 15.8 cm. When the juveniles were preserved in 10% formalin solution for 137 to 306 hours, the weight of all the samples increased at rates of 7.2 to 12.3% and, on the contrary, the length decreased at rates of 1.2 to 3.4%. The weight of samples rinsed with fresh water temporarily increased to 110.6-114.0% and then it lost weight at a decelerating rate, approaching 107-109% of the initial weight up to 67-139 hours. The length of samples rinsed were unchangeable during the rinsing period. Significant differences which depended on the size of fish could be scarcely obtained throughout various rinsing experiments. Based on the finding, it is concluded that the weight and length of juvenile masu salmon preserved in 10% formalin solution of fresh water should be measured after the weight equilibrated into steady states throughout the rinsing treatment and that the initial values of weight and length must be corrected by using the changing rates determined by rinsed samples.

第37号 (1982)

1, 北海道えりも岬周辺の淡水魚類

河村 博 (北海道立水産孵化場) (1-12)

Freshwater fishes in the eastern Hidaka coast and Cape Erimo in Hokkaido, Japan.

Hiroshi Kawamura

Freshwater fishes lived in twelve rivers and two lakes in the eastern Hidaka coast and Cape Erimo in Hokkaido, Japan were investigated in the period from 1976 to 1981. It was obvious that they involved fourteen genera and eighteen species which were composed of eight fishes of the Siverian element, eight ones of the North Pacific element and two ones of the Indo-China element. Of these eighteen species, only four fishes, siberian stone loach (*Barbatula toni*), sand lamprey (*Lampetra mitsukurii*), rosyface dace (*Tribolodon ezoe*) and the large egg type of wrinklehead sculpin (*Cottus pollux*) were primary freshwater fish distributed in a state of nature. They tended to distribute in the western region except for the wrinklehead sculpin. On the other hand, dolly vardens (*Salvelinus malma*) which seemed to run up the river from the sea were collected in the Nikanbetsu River and the Utabetsu River, being a first report in this region. Two ecological types of wrinklehead sculpin were investigated to clarify their distribution in a river. Generally speaking, the large egg type of them dwells in the upstream area and the small egg type, which is amphidromous fish, lives in the downstream area. However it was known that the former also distributed in the downstream area of the comparatively steep and small river. This manuscript is a part of studies in relation to the prey of salmon fry (Kawamura 1978, 1979, 1980).

2, 海産卵サケ稚魚の標識放流試験 第1報 1977年級群の3および4年魚の回帰

河村 博 (北海道立水産孵化場)・渡辺克彦 (北海道立水産孵化場増毛支場)・宮本真人 (北海道立水産孵化場えりも支場) (13-21)

Tagging liveration of fry from adult chum salmon captured in the eastern Hidaka coastal sea - I. Returns of three- and four-year- old adults in 1977 year class.

Hiroshi Kawamura, Katsuhiko Watanabe and

Mahito Miyamoto

Although the salmon propagation in Japan has been enforcing by means of adult salmon captured into rivers, it has recently begun to make use of silver or colored salmon migrated in the coastal sea, which is called "Kaisan-Ran". An anal-fin-clipped chum salmon fry (*Oncorhynchus keta*) of 105,935 fish in number from "Kaisan-Ran" were released into the Utabetu River in the eastern Hidaka coast in Hokkaido on 23 May in 1978 in order to examine the effect of "Kaisan-Ran" with relation to the salmon propagation. Adults for the "Kaisan-Ran" were captured with set nets in the coastal sea and held in the fresh-water ponds at the Erimo Branch of Hokkaido Fish Hatchery for about 13 days until the full maturation. Return of 241 anal-fin-clipped adults, in total, were found during the period from 26 October in 1980 to 26 December in 1981 in the eastern Hidaka and Meguro coastal sea and rivers. Adults of 3- and 4-year-old were 67 and 174 fish respectively. Timing of return into the coastal sea and full maturation of the adults clipped corresponded nearly with those of the parental fish, but the latter was prolonged till for about 20 days. Adults of 110 fish were recaptured in the sea from middle October to early November. They were with silvery or only fine nuptial coloration. Ratio of their fish showed 51.8% in total. Run of 4-year-old adults upstream the Utabetu River was earlier about two weeks than that of 3-year-old fish. Only an adult entered into another river. As a result of rearing of the fin-clipped fry in the freshwater pond for two years, regeneration of every fin clipped showed 0% in adipose fin, 19.7% in left ventral fin, 24% in anal fin, and 24.5% in left pectoral fin. Accordingly, ratio of the recapture in total was estimated at 0.3%.

3. カラフトマス稚魚の海水適応に関する研究

本間正男 (北海道立水産孵化場) (23-32)

Studies on the sea water adaptation of pink salmon (*Oncorhynchus gorbuscha*) in the early stages.

Masao Honma

It is well known that the fry of pink salmon migrate to sea shortly after hatching. However, there is few information on changes in sea water adaptability of pink salmon in the early stages. This investigation was carried out to study the relationship between sea water adaptability of pink salmon in the early stages and their size or time spent in fresh water. The eyed period eggs, which were about 7 days before hatching, and most of alevins were stenohaline. But, most of fry, which were 60 days from hatching, were able to live in pure sea water when they were transferred abruptly to it from fresh water. It has been recognized that the gill of euryhaline teleost might participate the osmoregulatory adaptation during their seaward migration. In this investigation, a slight increase of $\text{Na}^+\text{-K}^+\text{ATPase}$ activity in the gills was observed in the pink salmon fry adapted to sea water. This enzyme activity increased up to the 7th day of sea water adaptation, the value of 7th day was about 2 times higher than that of fish adapted to fresh water. A similar increase in the intestinal alkaline phosphatase (ALK-Pase) activity was observed in the pink salmon fry during the course of sea water adaptation. This enzyme activity was higher by 4.5 fold in sea water adapted fish for 7 days than in fresh water adapted fish. The degree of activation of gill $\text{Na}^+\text{-K}^+\text{ATPase}$ and intestinal ALK-Pase by sea water adaptation was higher in chum salmon fry than in pink salmon fry. This data suggest that the sea water adaptability of pink salmon fry is stronger than that of chum salmon fry. All of feeding pink salmon fry adapted well to sea water, whereas some of fast-feeding pink salmon fry failed to survive. Therefore,

to keep pink salmon fry in a hatchery healthy is responsible for their smooth adaptation to sea water.

4, ニジマスおよびその突然変異間における溶血抗体応答

坂井勝信 (北海道立水産孵化場) (33-36)

Haemolytic antibody response in mutants of rainbow trout.

Daiku K. Sakai

The comparison of haemolytic complement activity (CH_{50}) and haemolytic antibody response to goldfish red blood cells (GFRBC) was investigated using yearling rainbow trout *Salmo gairdneri* of different genetic types, including steelhead trout, a sea-run variety, albino rainbow trout, obtained as a mutant from normally-pigmented rainbow trout, and unspotted rainbow trout (called "Horai masu"), a mutant lacking black-pigmented spots in the skin. The CH_{50} activity of serum complement against GFRBC sensitized with rainbow trout antiGFRBC antibody (inactivated by heating at 44°C for 20 min) was assessed and consequently decreased in the arithmetic mean \pm standard deviation ($n=5$) in order of steelhead trout (43.4 ± 1.8 units/ml), unspotted rainbow trout (42.6 ± 1.5), rainbow trout (33.3 ± 1.6) and albino rainbow trout (28.5 ± 1.4). AntiGFRBC haemolysin was titrated 1 week after intraperitoneal injection with GFRBC (10^8 cells). No significant difference in the antibody productivity could be traced to each other in the trouts (rainbow trout, 485 ± 185 ; steelhead trout, 516 ± 234 ; albino rainbow trout, 404 ± 181 ; unspotted rainbow trout, 394 ± 228), even though the dissimilarity in CH_{50} activity was clearly detected in such different genetic types of rainbow trout.

5, サクラマスの寄生虫に関する研究-III 脊椎に寄生する粘液胞子虫 *Myxobolus* について

栗倉輝彦 (北海道立水産孵化場) ・ 小島 博 (北海道

立水産孵化場) ・ 杉若圭一 (北海道立水産孵化場) ・ 小川俊文 (北海道立水産孵化場) (37-47)

Studies on parasites of masu salmon, *Oncorhynchus masou* - III. *Myxobolus* (Protozoa: *Myxosporea*) found in spinal cord.

Teruhiko Awakura, Hiroshi Kojima, Kei-ichi Sugiwaka and Toshifumi Ogawa

During the years 1981 to 1982, a total of 1716 juvenile, immature and mature masu salmon, *Oncorhynchus masou* caught in the Japan Sea and Okhotsk Sea, rivers, hatcheries and fish farms in Hokkaido and Honshu were examined for spinal cord parasites. Two kinds of *Myxobolus* were found in the spinal cord of the natural and reared juvenile, immature and mature masu salmon in sea, rivers, hatcheries and fish farms. Provisionally, there were described and designated as *Myxobolus* sp. A and B. The immature masu salmon caught in Okhotsk Sea and Japan Sea had spores of *Myxobolus* sp. A and B, but returning adults in the rivers of Hokkaido and Honshu had one of the species which has been found in juveniles in each river. One of the well-recognized aspects of the life history of salmon is the tendency to return to spawn in their natal stream, but this tendency did not prove true for masu salmon in Japan. As a result, it can be said that masu salmon has a marked homing phenomenon.

6, サクラマスの寄生虫に関する研究-IV 鰓に寄生する微胞子虫 *Loma* について

栗倉輝彦 (北海道立水産孵化場) ・ 田中 真 (北海道大学水産学部) ・ 吉水 守 (北海道大学水産学部) (49-55)

Studies on parasites of masu salmon, *Oncorhynchus masou* - IV. *Loma* sp. (Protozoa: Microsporea) found in the Gills.

Teruhiko Awakura, Makoto Tanaka and Mamoru Yoshimizu

A microsporidian parasites was found in the gills of the masu salmon, *Oncorhynchus masou*, which was similar to *Loma* sp. MORRISON and SPRAGUE 1981 and *Loma salmonae* (PUTZ, HOFFMAN and DUNBER 1965) MORRISON and SPRAGUE 1981 by the light and electron microscopically observations. *Loma* sp. was found only in the gills of the masu salmon which were reared in hatchery pond, escaped from rearing pond and grew wild in the reservoir of this hatchery from early June to October. We could not find the parasite on the juvenile in four natural rivers in Hokkaido.

第38号 (1983)

1, カラフトマス稚仔魚の消化管の構造と機能に関する研究

本間正男 (北海道立水産孵化場) (1-11)

Studies on the structure and function of the alimentary tract of pink salmon (*Oncorhynchus gorbuscha*) in the early stages.

Masao Honma

The characteristic features of the alimentary tract of pink salmon from larval to juvenile stages were examined histological and morphologically to obtain information on the absorption and digestion. The differentiation of the alimentary tract can be categorized into four stages by the appearance of the esophagus, stomach and intestine. It is estimated that the tract is not functional at the 1st stage (A type). The function of absorption and digestion begins first at the 2nd stage (B type). This function is rapidly promoted in the 3rd stage (C type) characterized by the differentiation of the gastric glands and pyloric caeca. At the period when pyloric caeca differentiate, fishes are at the transitional stage from larva to juvenile. At this time body forms are regulated to approach basic forms of their

adults (D type).

2, 産卵回遊後期のサケの血球および血漿イオンの変化, 特に捕獲・採血前処理の違いが及ぼす影響について 河村 博 (北海道立水産孵化場)・帰山雅秀 (宮城県気仙沼水産試験場) (13-32)

Changes of plasma ions and blood cells of chum salmon (*Oncorhynchus keta*) in the course of spawning migration particularly in relation to the capture and hypoxic stresses

Hiroshi Kawamura and Masahide Kaeriyama

Plasma ions and hematocrit of chum salmon (*O.keta*) returning for the spawn in the coastal sea and rivers, Miyagi prefecture, Japan were investigated in the middle of December in 1982. Hematocrit and carcium levels from the lots of the Shizugawa Bay and the Okawa River were significantly higher than those of the Mizushiri River ($P<0.05$, $P<0.01$). Magnecium level from the Shizugawa showed significantly far higher concentration than that of the Mizushiri ($P<0.01$) however in the Okawa it was maintained at the medium level between them ($P<0.01$). The concentration of magnecium in the Shizugawa was not so low as those in the Okawa and the Mizushiri ($P<0.05$). It was known that ion levels of plasma (carcium, magnecium and chloride) from the sea group increased more and more following the order sacrificed. On the other hand magnecium levels decreased more and more according to the advance of the sampling order in two river groups. However carcium and chlorid levels did not change due to the sampling order fish in them. The high concentration of plasma ions from the sea group were brought about probably by the diuresis caused from the stresses of struggle and hypoxia at the catch and the pre-sampling treatment. Struggle and hypoxia caused the swelling of erythrocytes. The Okawa reached the largest size ($P<0.01$) but although being affected by the stresses, the Shizugawa changed

into the smallest one. Because it seemed to be caused by that blood sample had been held in the polyethylene tube for about an hour until smeared. In such a group it was often observed that the neutrophils had shrunk and that the erythrocytes involved some small vacuoles (0.5~2.3 μ) in the cytoplasm, which were seen in the river groups too. The following corpuscles were morphologically classified into six groups from the smear preparation (May-Giemsa's stain); erythrocyte, neutrophil, monocyte, lymphocyte, thrombocyte and hemocyteblast.

3, サクラマスの寄生虫に関する研究-V 幽門垂に寄生する球孢子虫 *Eimeria truttae* について

栗倉輝彦(北海道立水産孵化場)・小島 博(北海道立水産孵化場)・杉若圭一(北海道立水産孵化場)・野村哲一(北海道さけ・ますふ化場)(33-38)

Studies on parasites of masu salmon *Oncorhynchus masou*. - V. *Eimeria truttae* (Protozoa: Coccidia) found in pyloric caeca.

Teruhiko Awakura, Hiroshi Kojima, Kei-ichi Sugiwaka and Tetsuichi Nomura

A total of 861 juvenile, maturing or mature masu salmon (*Oncorhynchus masou*) caught in natural rivers, off shores and reared in fish ponds were examined for the coccidian parasites found in the pyloric caeca. *Eimeria truttae* LEGER & HESSE, 1919 commonly parasitized in the epithelium of pyloric caeca of juvenile masu salmon inhabiting natural rivers in Hokkaido, Japan. The present discovery is a new host record and extends its known distribution to Japan. The oocysts of *E.truttae* appeared in epithelium and lumen of pyloric caeca of 0⁺ juvenile masu salmon and they were observed in 1⁺ juvenile also, but not observed in the maturing captured in off shores, the mature returned to rivers and in the juvenile reared in hatchery ponds. It can be said that *E.truttae* is considered non-pathogenic or well adapted to masu salmon by

the observation of host tissue reaction in the pathological sections.

4, サクラマスの寄生虫に関する研究-VI 消化管に寄生するヘミウルス類について

栗倉輝彦(北海道立水産孵化場)・野村哲一(北海道さけ・ますふ化場)(39-46)

Studies on parasites of masu salmon, *Oncorhynchus masou* - VI. Hemiurid trematodes found in alimentary tract.

Teruhiko Awakura and Tetsuichi Nomura

During the year 1980 to 1983, total of 612 immature and mature masu salmon, *Oncorhynchus masou* caught in the off shores of Japan Sea and Okhotsk Sea, and the rivers in Hokkaido and Honshu were examined for hemiurid trematodes of alimentary tract. Four species of hemiurid, *Brachyphallus crenatus*, *Lecithaster gibbosus*, *Parahemiurus merus* and *Tubulovesicula lindbergi* were found in the alimentary tract of masu salmon caught in the sea and the rivers. In the immature masu salmon caught in the off shores of Hokkaido, *B.crenatus* was most abundant and *P.merus* was not found, but in off Miomate River, *P.merus* was most abundant and *B.crenatus* was found also. As a result, it is clear that *P.merus* not distributed in the off shores of Hokkaido. In the masu salmon caught in off Miomote River, *P.merus* was very height incidence and *B.crenatus* was low incidence in the small size group (body length 25-35cm), but in the large size group (body length over 40cm), the incidence of *P.merus* was low and the incidence of *B.crenatus* was height. As a results, it can be said that in the masu salmon caught in off Miomote River, the large size group has long distance migration to northern area, and the small size group migrated only in the costal area of Honshu. In the mature masu salmon caught in the rivers, hemiurids almost disappeared from alimentary tract at spawning season after about three months of rearing for maturation.

5, 道東の汽水湖・厚岸湖で漁獲されるイトウ *Hucho perryi* (BREVOORT)

川村洋司 (北海道立水産孵化場)・馬淵正裕 (釧路東部地区水産技術普及指導所浜中支所)・米川年三 (北海道立水産孵化場) (47-55)

The Japanese huchen, *Hucho perryi* (BREVOORT), collected in blackish water Lake Akkeshi, eastern Hokkaido, Japan.

Hiloshi Kawamura, Masahiro Mabuchi and Toshizo Yonekawa

The period of fishing by fishermen, age and growth and foods of the Japanese huchen, *Hucho perryi* (BREVOORT), were investigated in blackish water Lake Akkeshi, eastern Hokkaido, Japan during 1979-1981. The specimens were caught from late in May to late in June every year in the lake by fishermen, but no specimen was caught in Akkeshi Bay. They were mainly 5⁺ age. All of female specimens were immature while all of male were spent. It seems that these specimens fed in the lake because the stomach contents of them were almost fishes and crustaceans lived in sea water or blackish water. Applying the Bertalanffy's equation for length increase, the length L_t (mm) and the age t relationship for the Japanese huchen was represented by the following equation without 1-yr: $L_t = 870 (1 - e^{-0.1668t - 0.8819})$ Based on the situation of the fishing and the growth pattern, the seaward migration of the Japanese huchen in this lake and its tributaries was discussed.

6, 大沼湖 (大沼・小沼) の透明度, COD および数種溶存イオンの変動 (1974年~1980年)

今田和史 (北海道立水産孵化場)・伊藤富子 (北海道立水産孵化場)・吉住喜好 (北海道立水産孵化場)・栗倉輝彦 (北海道立水産孵化場) (57-74)

Transparency, COD and several dissolved ions of Lake Onuma in 1974 to 1980.

Kazushi Imada, Tomiko Ito, Kiyoshi Yoshizumi

and Teruhiko Awakura

Lake Onuma is one of the eutrophicated lakes in Hokkaido. We have investigated on water quality (Transparency, COD, Cl, SiO₂, Hardness, Ca, Mg, SO₄) for seven years from 1974 at intervals of four to six times in a year. We analyzed the seasonal and annual changes of these properties statistically. All of them except Chloride ion of surface water presented the normal distribution. COD and Ca showed the seasonal change, but on the other variable, the seasonal or annual changes were not observed and also tendency of these changes not clear. The mean of Transparency was 2.29m with the range from 1.0 to 3.6m. The mean value at the central part of the lake was higher than that of other shore area (P=0.05 paired *t*-test). COD concentrations were almost 2-4mg/l and mean was 2.67mg/l. The mean values of other variables at surface water, Cl, SiO₂, Hardness, Ca, Mg, and SO₄ Were 11.56, 24.13, 65.56, 18.61, 4.42, 39.9mg/l, respectively. The shore area showed lower concentration affected by the influents. The mean values of each variables at center of the lake seems to be indicated the typical profiles of the water quality of this lake.

7, 河川の天然サクラマス幼魚血清ナトリウム濃度の変動

小島 博 (北海道立水産孵化場) (75-84)

Changes in the serum sodium concentration of wild juvenile masu salmon.

Hiroshi Kojima

Although the serum sodium concentration of salmonids is used as a parameter for seawater adaptability, a problem-what causes the changes in this concentration-remains unsolved. In this study, changes in serum sodium concentration were investigated using wild juvenile masu salmon *Oncorhynchus masou* captured from a

stream. Fish blood, which was drawn from caudal vessel, was placed in plastic tube and was immediately separated with serum-plasma separator by a centrifuge (1,600×g, 4°C, 20min). The serum sodium concentration was determined with an atomic absorption spectrophotometer. The concentration of masu salmon was unchangeable within a day. There was no significant difference in the serum sodium concentrations between starved fish (25 days) and normal fish. However, the concentration of fish which were acclimated to the static water for a day showed a small significant increase (5.2%). From August to November, the serum sodium concentrations of both 0-year-old and 1-year-old fish increased with the fall of temperature. The fish in a middle stage of smolt-transformation represented a transitory increase of the sodium concentration, whereas the decreasing reduction was observed by the fish of later stage. The serum sodium concentration of post-smolts was lower than that of stream resident parr (7.7% for 1-year-old and 5.4% 2-year-old). In late autumn, the serum sodium concentration of 0-year-old fish (largely silvery parr) inhabiting lower stream where they moved in schools was found to be lower than that of 0-year-old fish (yellowish parr and dark parr) inhabiting upper stream. The concentration of 1-year-old silvery parr was also lower than that of stream resident parr. These findings indicate that phase differentiation, season and age are closely associated with the changes in the serum sodium concentration of juvenile masu salmon.

8, 種々のステロイドホルモンおよび生殖腺刺激ホルモンによる池産サクラマス *Oncorhynchus masou* 卵母細胞の生体外成熟誘起
山内皓平 (北海道大学水産学部) ・伴 真俊 (北海道大学水産学部) ・津田 要 (北海道大学水産学部) ・笠原 昇 (北海道立水産孵化場) ・泉 孝行 (北海道立水産孵化場) (85-91)

The *in vitro* effects of various steroid hormones and gonadotropin on oocyte maturation in masu salmon, *Oncorhynchus masou*.

Kohei Yamauchi, Masatoshi Ban, Kaname Tsuda, Noboru Kasahara and Takayuki Izumi

We have investigated the effects of various steroid hormones and salmon gonadotropin on germinal vesicle breakdown (GVBD) in oocytes of the masu salmon, *Oncorhynchus masou*, during *in vitro* incubation. Progestogens were the most effective compounds in inducing GVBD. Of the progestogens, $17\alpha, 20\beta$ -dihydroxy-4-pregnen-3-one ($17\alpha, 20\beta$ -diOHprog) was clearly the most active. Of the other steroid hormones tested, deoxycorticosterone, to a lesser degree, cortisol also showed some activity, but testosterone and estradiol- 17β were without effect. We have also found that partially purified chum salmon gonadotropin (SGA) possesses considerable GVBD activity, secondary only to $17\alpha, 20\beta$ -diOHprog. This indicates that ovarian follicle layers are major site of gonadotropin action.

9, 北海道紋別川に産卵沂上したキウリウオの血液性状について

寺尾俊郎 (北海道立水産孵化場) (93-99)

On the biochemical components in blood of the matured rainbow smelt, *Osmerus dentex* migrated at Monbetsu River, Hokkaido.

Toshiro Terao

Adult rainbow smelt, *Osmerus dentex* migrate into river from pacific ocean in spring season, Hokkaido. I recaptured this fish samples in Monbetsu river at two times of period the spawning season. I investigated the morphological and physiological characters of this species each sexual fish on the this fish samples. The exact distinctions of the morphological characters were showed body weights, body length/body height rate, head length/eye diameter rate, fat

factor and gonad weight/body weight rate in the period of the spawning season. The distinction of meristic character were showed body weight, ages, body length/head length rate and gonad weight/body weight rate between female and male, and another measured character of fish were indistinguishable from measurements of external body parts. The physiological characters investigated by results of clinical analysis of blood components for each sexual fish in spawning season. Those female and male fish showed conservation of healthy conditions by clinical blood analysis in the period of the spawning season. The comparison of clinical blood components between natural rainbow smelt and natural salmon, cultured rainbow trout were carried out on the many analysis articles. The strong relation were observed the similarity of many blood component between rainbow smelt and masu salmon. Those results of clinical analysis of blood component will be guess that these show the strong relation of life cycle and nutritional condition in rainbow smelt fish.

第39号 (1984)

1, 河川に放流した池産サクラマス幼魚 *Oncorhynchus masou* (BREVOORT)の個体群動態
 永田光博 (北海道立水産孵化場)・宮本真人 (北海道立水産孵化場)・外崎 久 (北海道立水産孵化場) (1-17)
 Population dynamics of the pond-cultured juvenile masu salmon, *Oncorhynchus masou* (BREVOORT), released into the stream.
 Mitsuhiro Nagata, Mahito Miyamoto and Hisashi Tonosaki

The estimations of population dynamics and production of 0-year-old pond-cultured juvenile masu salmon, 85,000 fish in number, released into the Utabetsu river of eastern Hidaka in Hokkaido were carried out from May to October,

1983. From an analysis by making use of a probability graph paper method, 0⁺ juveniles were divided into three size group from June. In the pools, the juveniles of small size group was superior in the frequency distribution, while in the riffles, that of middle size group did so. molt transformation of 0⁺ juvenile masu salmon was observed in large size group from June to July. In July, smolts occupied 10% of the juveniles collected by nets. Applying the von Bertalanffy's growth model, curves of three size groups were represented by the following equations.

$$\text{Small size: } L_t = 10.72 (1 - e^{-0.6294 - 0.2969t})$$

$$\text{Middle size: } L_t = 12.43 (1 - e^{-0.6950 - 0.3294t})$$

$$\text{Large size: } L_t = 14.55 (1 - e^{-0.7289 - 0.3313t})$$

where,

L_t = fork length at time
(month)

The relationships between the dry or wet body weight (Y) and the fork length (X) in the undifferentiated parr, stream resident parr and smolt were represented as exponential equations, $Y = aX^b$, respectively. The result of covariance analysis on regression constants (a=intercept, b=slop) showed that the water content in body of 0⁺ juvenile without smolt type decreased from September. In both pools and riffles, the density of fish decreased exponentially after released. The survivorship using estimation of the density were represented as follows: Pool: $N_t = 1.191e^{-0.572t}$, Riffle: $N_t = 0.984e^{-0.601t}$

The bio-economics of the bond-cultured juvenile masu salmon released into the Utabetsu river was made using estimates of average body weight and average density in each size group. In pools, the amounts of entering matters in the 0⁺ juvenile expressed as body growth, gonad growth and immigration, were estimated at 1,426, 5 and 17 mg dry weight/m²/167 days, respectively. On the other hand, the amounts of lost matters in the juveniles were seaward migration, gametes ejected and the sum of predation, emigration and

fishing were 147, 4 and 1,721 mg dry weight/m²/167 days, respectively. Consequently, the amounts of 424 mg dry weight/m² of the juvenile in pools was deducted from that of released fish during the period of 167 days from May to October, 1983. Similarly, in riffles, the deducted value was 338 mg dry weight/m²/167 days.

2, 厚田川におけるサクラマス幼魚のスマルト化に及ぼす生息密度の影響

杉若圭一（北海道立水産孵化場）・小島 博（北海道立水産孵化場）（19-37）

Influence of individual density on smoltification in wild juvenile masu salmon (*Oncorhynchus masou*) in the Atsuta River.

Kei-ichi Sugiwaka and Hiroshi Kojima

Investigations on the smolt of wild masu salmon *Oncorhynchus masou* were carried out from 1978 to 1984 in the Atsuta River, which discharges into the Japan Sea and is located in the mid-western area of Hokkaido, and some remarkable findings on smoltification were procured. In the developmental progress of smoltification, silvery parrs which appeared in March, developed into early stage smolts in mid to late April. Approximately two weeks later, they changed into middle stage smolts. Late stage smolts appeared in late May. Periods of downstream migration of smolt for each year occurred from early May to early June, and peaks of migration occurred in mid to late May. molts had approximately 1.0-1.5 cm of monthly growth in fork length during the period from April to May. The fork length of 1⁺(2₂) smolts ranged from 8.5 to 15.0 cm, and averaged between 10.6 and 13.0 cm, while range and means of 2⁺(3₃) smolt fork length were 12.3-18.3 cm and 13.5-15.4 cm respectively. Of the 1⁺ smolt population, 23.8-34.1% were male and of the 2⁺ smolt, the rate shifted between 0 and 34.6% from 1978 through 1984. Changes in sex ratio during the course of the 1⁺

smolt run were observed. Usually the rate for males increased gradually during the migration period, though in a few years peaked at the middle of the migratory season. From observations on the sex ratio of 0⁺ juveniles in Autumn, assumed that these phenomena were influenced by sexual differences on growth and phase differentiation in the preceding year. The frequency of 2⁺ smolt varied in a three-year cycle. Emergence of 2⁺ smolt is related to high juvenile density which causes inferiority of growth in 0⁺ age. Therefore, The methodical fluctuation of 2⁺ smolt frequency reflects the periodic variation in the individual density of juveniles, e.g., high density causes high frequency of 2⁺ smolt in the year after next, and low density reduces 2⁺ smolt frequency in the year after next. These results suggest that, in the Atsuta River, according to increase of individual density, total smoltification rate also increases due to the appearance of a multiplicity of 2⁺ smolt. From the estimated regression curves, the rate of smolt produced from one year class group will reach approximately 63% where all smolts are 1⁺ age in the individual density of 0.1 per square meter. Under an exceedingly high density (4/m²), smoltification rate might increase to 100% due to an increase of 2⁺ smolts, especially male smolts. Striking suppression of juvenile's growth as a result of the influences of high density and environmental effects, e.g., floods, resulted in a substantial decrease in the smoltification body length of fish rather than an increase in the smoltification age. This suggests that if the individual density of 0⁺ juveniles becomes extremely high, the smoltification rate would not rise accordingly and be set a limit to approximately 80% of one year class group in the Atsuta River.

3, 池産サクラマス 1⁺ スマルトの降海行動と海水適応
泉 孝行（北海道立水産孵化場）・小島 博（北海道立水産孵化場）・笠原 昇（北海道立水産孵化場）・

伴 真俊 (北海道大学水産学部) · 山内皓平 (北海道大学水産学部) (39-46)

Downstream migratory behavior and seawater adaptability in the yearling hatchery-reared masu salmon (*Oncorhynchus masou*) in an artificial stream.

Takayuki Izumi, Hiroshi Kojima, Noboru Kasahara, Masatoshi Ban and Kohei Yamauchi

The downstream migratory behavior and seawater adaptability in the yearling masu salmon (*Oncorhynchus masou*) reared in Mori branch of the Hokkaido Fish Hatchery were investigated in an artificial stream in relation to the lunar phase around smoltification, from 27 April to 22 June, 1983. The smolts showed downstream migratory behavior around the time of the new moon in May. Moreover, the largest numbers migrated immediately after rainfall following the new moon during the period of middle May through middle June. These results suggest that the new moon and rainfall may be important as environmental factors for the onset of downstream migratory behavior in the masu salmon. Of migrated smolts, ones which occurred the behavior around the time of the new moon had the best hypoosmoregulatory abilities. The present results suggest that masu salmon should be released in the river just before the new moon, and that hatchery-reared masu salmon smolts may be effective as stocked fish.

4, 海産卵サケ稚魚の標識放流試験 第2報 1978年級群の回帰

永田光博 (北海道立水産孵化場) · 外崎 久 (北海道立水産孵化場) · 宮本真人 (北海道立水産孵化場) · 河村 博 (北海道立水産孵化場) · 渡辺克彦 (北海道立水産孵化場) (47-54)

Tagging liberation of fry from adult chum salmon captured in the eastern Hidaka coastal sea-II. Returns of Adults in the 1978 Year Class. Mitsuhiro Nagata, Hisashi Tonosaki, Mahito

Miyamoto, Hiroshi Kawamura and Katsuhiko Watanabe

Ecological studies on adult return from the 1978-year class of chum salmon (*Oncorhynchus keta*) in the Utabetu river were examined by making use of the tagging liberation of fry in the eastern Hidaka coastal sea. Anal-fin-clipped chum salmon fry of 251,414 fish in number were released into the Utabetu river of eastern Hidaka on 21st May in 1979. Marked adults, 411 fish in total were captured from October of 1981 to November of 1983 in the Hidaka coastal sea and the Utabetu river, being 35 fish in the 3-years, 351 fish in the 4-years and 25 fish in the 5-years old one, respectively. Duration of the adult return and their body color, with silvery and pre-nuptial coloration in the coastal sea, corresponded nearly with those of the parental fishes, although the time of full maturation was delayed about 20 days in comparison with them, which was similar to the results of the 1977-year class. From seasonal changes of recaptured points in the coastal sea, it was supposed that most of adults passed over Cape Erimo, then reached to the west boundary of Erimo-cho through the offing, moved in shore and turned toward the Utabetu river along shore line. Average ratio of the 4-years old marked fish to total catch of chum salmon captured with set net in 8 fishing points was computed at 1.59%. Furthermore, from the value, age composition and hauls, adult return percent of marked chum salmon in the 1978-year class was estimated at 1.25%.

5, ハナカジカ (*Cottus nozawae* SYNDER) によるサケ稚魚捕食に関する生態学的研究

永田光博 (北海道立水産孵化場) (55-65)

Ecological studies on the predation of chum salmon fry by fresh water sculpin, *Cottus nozawae* SYNDER.

Mitsuhiro Nagata

The ecological studies on feeding of fresh water sculpin *Cottus nozawae*, a dominant predator of chum salmon fry (*Oncorhynchus heta*) in the eastern streams of Hidaka were experimentally carried out from June to July in 1982 and 1983. Amounts of satiation in the sculpin were investigated by exposing them to three size groups of prey (chum salmon fry) and two different water temperatures under the closed system. Most of the sculpin, which were held without food for about a week, satiated within 2 hours after supplying with the chum salmon fry as a prey in excess. The relationship between the fry weight of satiation (Y_w) and body size of the predator (X) was represented by a linear: $Y_w=0.695X-4.381$, being independent of size in the prey (x). On the other hand, the fry number of satiation (Y_n) decreased with increasing of prey size ($Y_n=0.988X-1.589x+1.492$). The satiation amount was appeared not to be affected by variation of water temperature. The rates of digestion were measured under the two different water temperatures in closed system. The stomach content decreased curvilinearly as represented by polynomial regression. Full digestion time of the fry within the stomach of sculpin increased with fall of water temperature and with increasing in size of the sculpin. Feeding after the satiation was observed by exposing the sculpin with various sizes to two different densities of chum salmon fry for a week under the flow system. The sculpin was appeared not to consume enough the prey until 3rd day after the satiation, but became fed actively from 4th on. Ratio of the accumulative amount consumed by the sculpin for a week after the satiation to the satiation amount increased with decreasing in size of the sculpin, being independent of difference in density of fry as a prey.

6, 卵黄蛋白抗血清を用いた池産サクラマス^の早期雌

雄判定

太田博巳(北海道立水産孵化場)・神力義仁(北海道立水産孵化場)・本間正男(北海道立水産孵化場)・原 彰彦(養殖研究所)・松原孝博(北海道大学水産学部)・東谷隆幸(北海道大学水産学部)・山内皓平(北海道大学水産学部)(67-74)

Early distinction of the sex of hatchery-reared masu salmon, *Oncorhynchus masou*, using antiserum against egg yolk protein.

Hiromi Ohta, Yoshihito Shinriki, Masao Honma, Akihiko Hara, Takahiro Matubara, Takayuki Azumaya and Kouhei Yamaguchi

The sex of the masu salmon, *Oncorhynchus masou*, reared in Mori branch of the Hokkaido Fish Hatchery was examined by Mancini method using antiserum against purified egg yolk protein (lipovitelline) from the chum salmon, *O.keta*. This method is based on the detection of serum vitellogenin of the females before or during vitellogenesis. In April, only three females out of sixteen fish which had oocytes showing primary yolk stage were distinguished by using this method. The remainder was females having oil droplet stage oocytes or males. However, all the females in May and June, oocytes of which developed into primary or secondary yolk stage, could be distinguished from males. These results demonstrated that present technique was useful and easy for the distinction of the sex in the masu salmon.

7, 高密度飼育ニジマスの止水条件下における血液性状と環境水の変化

伊沢敏穂(北海道立水産孵化場)・今田和史(北海道立水産孵化場)(75-82)

Variations of hematological parameters for rainbow trout reared intensively in static water.

Toshio Izawa and Kazushi Imada

Selected hematological parameters of rainbow trout (*Salmo gairdneri*) which held in static

water with heavy loading density (12%), and changes of water quality were investigated in rearing period of 72 hours. At 72 hours after beginning of experiment total ammonia (as nitrogen) and unionized ammonia concentrations reached 17.55 mg/l, 0.047 mg/l respectively. As being total ammonia, COD, phosphate accumulated in rearing water, increase rate of these constituents per hours and Kg body weight tended to reduce gradually. Hematocrit values were significantly higher at 1 hour ($P<0.05$) and 3.5 hours ($P<0.001$) after beginning of experiment than that of control group which held in running water with heavy loading density (10%). When there were significant differences in serum constituents between experiment and control, serum potassium level of experiment were always lower than that of control. However, serum sodium and calcium level were higher than that of control.

8, 養殖テラピアニロチカの血液性状について

寺尾俊郎 (北海道立水産孵化場) ・小川俊文 (北海道立水産孵化場) (83-88)

On the biochemical components in blood of the cultured cichlid fish, *Tilapia nilotica*.

Toshiro Terao and Toshifumi Ogawa

The purpose of this study was to evaluate some physiological characters of healthy cultured cichlid fish, *Tilapia nilotica*, by fish feed oil and vitamins enriched diet in the rearing pond, Hokkaido. We investigated those morphological and physiological characters of this species for each sexual fish on this fish samples. The morphological characters were showed better growth for those body weight, body length and fat factor. The physiological characters of the fish investigated by results of clinical analysis of blood components for each sexual fish. The blood components of female and male fish showed the conservation of the healthy conditions by clinical analysis. The results of these comparison showed

some of the similarities on the proteolytic substances and some of the differences on the lipid substances in these blood components. Those results of the clinical analysis of the blood components will be guess that these show the characters on the physiological and nutritional condition in the tilapia fish.

9, サクラマスノ寄生虫に関する研究-VII 池産サクラマス稚魚のコスチア症について

栗倉輝彦 (北海道立水産孵化場) ・小島 博 (北海道立水産孵化場) ・田中寿雄 (北海道立水産孵化場) (89-96)

Studies on parasites of masu salmon, *Oncorhynchus masou* - VII. Costiasis of pond-reared masu salmon fry.

Teruhiko Awakura, Hiroshi Kojima and Hisao Tanaka

Ichtyobodo necator (HENNEGUY 1883; PINTO 1928) [= *Costia necatrix*] is a cosmopolitan flagellate ectoparasite of fresh water fish which causes lesions in epithelial tissues. It has long been recognized as important pathogen of cultured salmonids in Europe and North America, but it has not been reported regarding masu salmon in Japan. During December, 1983, the Mori Branch of Hokkaido Fish Hatchery reported a high mortality rate among pond reared masu salmon, *Oncorhynchus masou* fry. This incident occurred immediately after first feeding and 73.4% of fish died in one pond during one month. The skin of diseased fish was heavily infested with *Ichtyobodo*, particularly in posterior body, and dorsal, anal, pectoral and caudal fins. The skin of the head was never seen to have been infested by *I. necator*. The presence of *I. necator* led to marked erosion of microridges on the outmost cells. It seems possible that the parasite secretes some form of digestive enzyme or toxic substance which leads to erosion of the microridges. The presence of *I. necator* led to marked hyperplasia

of the malphigian cells of the epidermis underneath the infested area and the almost complete disappearance of goblet cells in the same area.

10, 根室地区11河川水質への多変量解析の適用
今田和史 (北海道立水産孵化場) (97-104)

Multivariate data analysis applied to the river water qualities of Nemuro district, northern part of Hokkaido

Kazushi Imada

Multivariate analysis was applied to the water qualities of several rivers in Nemuro district, northern Hokkaido. These rivers are very important for salmon cultures. The mean data matrix based on 29 stations and 14 variables of COD, BOD, Cl, SO₄, Ca, SiO₂, PO₄, NH₄-N, NO₂-N, NO₃-N, Fe, Turbidity, SS and Tannic acid, were computed with the exception of outliers. COD, Tannic acid and NH₄-N caused from the humus ground around the Lake Furen, represented highly correlations among them in the correlation analysis. From the principle component analysis, three components were extracted (70% accumulative proportion) as follows: First component depends on the humus substances and influence of brackish water. Second component is total iron which is also the index of humus ground. Third component is turbidity of river. By the cluster analysis, dendrogram was drawn by single linkage method with Euclid distance. These results showed that stations were divided into four groups. First group is clear water of upper stream. Second one is middle or lower stream slightly polluted with suspended matters. Third one is influenced by brackish water of the Lake Furen. The last one is polluted with humus, these stations show high concentrations of COD, Tannic acid and NH₄-N.

11, 池産サクラマス標識魚の回帰 (予報)
坂本博幸 (北海道立水産孵化場) · 河村 博 (北海道

立水産孵化場) · 田中寿雄 (北海道立水産孵化場)
(105-111)

Preliminary observations of growth and return of pond-cultured masu salmon (*Oncorhynchus masou*).
Hiroyuki Sakamoto, Hiroshi Kawamura and Hisao Tanaka

Pond-cultured masu salmon (*Oncorhynchus masou*) fry, which had been artificially fertilized in the Mori Branch of the Hokkaido Fish Hatchery and hatched in the Shakotan Hatchery, were released in the Yobetsu River to observe their growth and return of fin-clipped fish from 1982 through 1984. The growth of fry (7,100 fish) released from May to August in 1982 was better than that of a wild fish. The better growth in considered to be due to the larger size of released fry at the time of liberation. The fin-clipped smolt were caught in the mouth of the river in middle June, 1983, when wild smolt usually descended from rivers in the mid and south area of Hokkaido. In the Japan Sea-coasted waters of western Hokkaido, four fin-clipped adult masu salmon, ranging from 41 to 54 cm in fork length and from 0.8 to 1.8 kg in weight, were captured from middle March to middle April in 1984.

12, 池中継代飼育サクラマス零歳魚の銀毛化変態と早熟雄の出現

小島 博 (北海道立水産孵化場) · 喜多正広 (北海道立水産孵化場) (113-121)

Smolt transformation and precocious male parr in cultured zero-year-old masu salmon *Oncorhynchus masou* (BREVOORT).

Hiroshi Kojima and Masahiro Kita

Some observations concerning the smolt transformation of zero-year-old masu salmon (*Oncorhynchus masou*) were carried out using fish populations reared in 1983 and 1984 at the Mori Hatchery. The fish, which had been

successively cultured since 1966, showed the climax of smoltification from early June to early July, and extremely-high smolting rates (40 to 84%). In contrast, the population of dark parr (indicating precocious maturation) was markedly small compared with that of masu salmon reared in other places. The mean body size of the population of smolt containing 52-54% female was larger than that of parr (including undifferentiated parr and precocious male), while there was no significant difference between female and male smolt in the body size. The body colour and behaviour of undifferentiated parr were similar to those of inactive wild yellowish parr in winter. The size of the regressive smolt group (24.5% of the whole smolt population) which reversely transformed from smolt was smaller than that of transformed group, and furthermore, the ratio of male was considerably high. There was a significant correlation ($r=0.956$) between the size measured on May 1st and the smolting rates of zero-year-old fish. Low smolting rates were observed in the low growth group and in the diseased group during the smolt transformation. Based on these results, it is suggested that the Mori fish group have obtained the remarkable characteristics; high growth ability in relation to high smolting rate, low ratio of dark parr and flexibility of smolting season.

13, 暑寒別川に遡上したオシヨロコマについて

斉藤譲二 (北海道立水産孵化場) ・ 杉若圭一 (北海道立水産孵化場) (123-126)

On an anadromous type of dolly varden charr *Salvelinus malma* caught in the Shokanbetsu River

Jouji Saito and Kei-ichi Sugiwaka

On July 16, 1984, a sea-run type Dolly Varden Charr, *Salvelinus malma* (WALBAUM), was caught in the Shokanbetsu River, which discharges into the Japan Sea and located in

northwestern Hokkaido. Comparisons were made between the characteristics of this specimen and those of the other specimens which were reported as anadromous types from Hokkaido. These observations and the fact that the Shokanbetsu River and adjacent regions do not have the anadromous type or resident type of this species suggest that this particular specimen alone had hatched and smoltified in a river in a more northern region than Hokkaido, and upon returning lost its way. This finding is the first report of an anadromous type of Dolly Varden Charr from the river flowing into the Japan Sea in Hokkaido.

第40号 (1985)

1, ニジマスの人為的性統御に関する研究

岡田鳳二 (北海道立水産孵化場) (1-49)

Studies on the artificial sex control in rainbow trout, *Salmo gairdneri*.

Houji Okada

Since Yamamoto (1953, 1958) first reported functional sex reversal in medaka (*Oryzias latipes*) by administration of sex hormones, artificial sex reversal was accomplished in several kinds of fresh water fishes such as in gold fish (Yamamoto and Kajishima, 1968), Tilapia (Clemens and Inslee, 1968), and guppy (Takahashi, 1975a). The results obtained in these studies provide not only information about the process of sex differentiation and genetic bases of male heterogamety (XY), but also suggest the possibilities of practical applications of sex control on fish culture. The present study was carried out to accomplish functional sex reversal by sex steroids and the production of triploids by hydrostatic pressure. The masculinization of genetic females by androgen treatment was tried to get XX male which sire all female progenies. The feminization of

genetic males by the estrogen treatment was tried to get YY males which sire all male progenies. The production of all female triploids was also tried to get sterile fish. The results obtained in this study are summarized as follows;

1) Some genetic females had a gonad showing signs of meiosis at the swim-up stage. Number of oocytes increased at 4 weeks after the swim-up and most of the germ cells changed into oocytes at 6 weeks after the swim-up.

2) Dietary 17α -methyltestosterone (0.8 and 5 ppm in food) effected the masculinization when the oral treatment started within 2 weeks after the swim-up. The treatment which was started 4 weeks or later had no effect on sex differentiation. Long-term treatment (8 weeks) started within 2 weeks after the swim-up with the same doses having a strong effect on the masculinization.

3) The most effective dose of 17α -methyltestosterone and 11-ketotestosterone were 0.5-1.0 ppm and 5 ppm, respectively. An excess dosage of androgen had no effect on masculinization.

4) The androgen induced XX males sired all female progenies in the F_1 generation when mated with normal females. All females produced were normal in reproductive function and produced a 1:1 sex ratio in F_2 generation. The results of these experiments demonstrate that rainbow trout is female homogamety (XX) and functional sex reversed XX males produce all female progenies with normal reproductive function.

5) The gonads of genetic males did not show any signs of meiotic activity at the swim-up stage. The testes were identified by the development of somniferous tubules and the formation of spermatogonial cysts of gonia at 25 weeks after the swim-up, but meiotic activity was not observed.

6) The oral treatment of estradiol- 17β (50 ppm and 100 ppm) from the first feeding had an effect on the feminization of genetic males, but the ratio of sex reversal was low.

7) The estrogen induced XY females sired progenies of which the sex ratio of male to female was 3.0 in the F_1 generation. YY males in F_1 were detected by progeny test and they sired all male progenies in the F_2 generation. All produced males were normal in reproductive function and produced a 1:1 sex ratio in the F_3 generation. The results of these experiments demonstrate that rainbow trout is male heterogamety (XY) and induced YY male produces all male progenies with normal reproductive function.

8) The triploidy was induced by hydrostatic pressure (650 kg/cm², 6 min.). All triploid males matured up to 37 months age after hatching. Matured males represented secondary sex characteristics and produced aneuploid sperm. On the other hand, all of triploid females did not mature. Their germ cells remained in the oogonial stage and were immature until 37 months age.

9) The production of sterile stocks was tried by all female triploidy. After fertilization with hormonal induced XX male with normal females, fertilized eggs were pressed at 650 kg/cm² hydropressure for 6 minutes. Eighty-six percent of the treated fry were triploid females and the others were diploid females.

2, サケ (*Oncorhynchus keta*) 雄の排精に及ぼすサケ脳下垂体ならびにヒト胎盤性性腺刺激ホルモンの効果
寺西哲夫 (北海道立水産孵化場) ・杉若圭一 (北海道立水産孵化場) ・粟倉輝彦 (北海道立水産孵化場)
(51-55)

Effects of chum salmon pituitary and human chorionic gonadotropin on stimulation of spermiation in male chum salmon, *Oncorhynchus keta*.

Tetsuo Teranishi, Kei-ich Sugiwaka and Teruhiko Awakura

Effects of acetone-dried chum salmon pituitary suspension (PS) and human chorionic gonadotropin (HCG) on stimulation of spermiation of chum

salmon (*Oncorhynchus heta*) were studied using mature males captured in the River Schokanbetsu, near Mashike, in October and November. Male chum salmon receiving a single intramuscular injection of HCG at a dosage of 500 MU showed an increase in sperm volume and sperm motility and a decrease in spermatocrit value. HCG at dosages of 50, 100 and 250 MU had no promoting effects on spermiation. In males which had previously been stripped of their semen, HCG at a dosage of 500 MU was almost ineffective in stimulating spermiation. However, a single intraperitoneal injection of PS at dosages of 15 and 75 mg brought about a remarkable increase in sperm volume and a decrease in spermatocrit values in treated males handstripped repeatedly after injection, though it was not effective in prolonging sperm motility. The stimulatory effect of PS, especially at the dosage of 75 mg, on spermiation was retained in treated males at least for 5 days after injection. Thus the treatment of mature males with PS may be fully efficient in obtaining male chum salmon with a high potential for spermiation. The effectiveness of HCG in the stimulation of spermiation is to be determined by further investigations.

3, サクラマスの寄生虫に関する研究－Ⅷ 広節裂頭条虫ブレロセルコイドの寄生状況

栗倉輝彦（北海道立水産孵化場）・坂口清次（養殖研究所）・原 武（養殖研究所）（57-67）

Studies on parasites of masu salmon, *Oncorhynchus masou* -Ⅷ. Observations on the seasonal occurrence of *Diphyllbothrium latum* plerocercoid.

Teruhiko Awakura, Seiji Sakaguchi and Takeshi Hara

From the year 1980 to 1985, a total of 2,478 juvenile, maturing or mature masu salmon, *Oncorhynchus masou*, caught in natural rivers, lakes, offshore and reared in fish ponds, and 63 mature chum salmon, *O.keta*, caught in a river

and 30 pink salmon, *O.gorbuscha*, caught in the offshore of Hokkaido and northern Honshu were examined for the plerocercoid of *Diphyllbothrium latum*. The plerocercoid was found in the southward migrating masu salmon caught offshore from January, but not in juvenile caught in the freshwater and in the sea until November. The infection rate and the number of plerocercoids per fish were 0.75% (0.01) in the sea-migrating masu salmon from May to March and 9.04% (0.61) from April to June. For mature or maturing masu salmon migrating upriver from July to October, it was 19.57% (0.84). The plerocercoid was found also in maturing pink salmon caught in coastal offshore, but it was not found in mature chum salmon caught in a rivers. In the masu salmon caught in the offshore of Japan Sea coast of northern Honshu, the plerocercoid of *D.latum* was only found in these fish having a body length of over 40 cm and having long-distance migration to northern areas. These results suggest that the transmission of *D.latum* plerocercoid to masu salmon is occurring mainly in the southward migrating masu salmon in the Japan Sea coast of Hokkaido.

4, スモルト化時期におけるサクラマス幼魚の食性と摂餌生態

杉若圭一（北海道立水産孵化場）（69-75）

Feeding habit and feeding behavior of juvenile masu salmon, *Oncorhynchus masou*, during the smoltification period.

Kei-ichi Sugiwaka

Stomach contents of juvenile masu salmon collected in the Atsuta River during the smoltification period were examined and some findings on their feeding behavior were obtained. molts had a higher average number of food organisms when compared to stream resident parrs, however, with regard to stomach content, the index for smolts was less than for parrs. There

were some differences between smolt and parr regarding the kinds of food organisms. These differences were not due to the selection of food organisms along with the phase differentiation, but were caused by the variance of feeding conditions. Therefore, it was assumed that smolts were superior in positioning themselves for feeding in the stream. Change in food habits of smolt with passage of time were not observed, however, the relationship between stomach content index and fork length of smolt changed with the location and developmental progress of smoltification. For instance, in the early stage smolt, stomach content index was in inverse proportion to fork length, however middle stage smolt was in direct proportion. These results suggested that feeding behavior of smolt was closely related to changes of behavioral patterns originating in the developmental stage of smoltification.

5, 天然サクラマス幼魚のスマルト変態過程における海水適応能の変化

小島 博 (北海道立水産孵化場) ・泉 孝行 (北海道立水産孵化場) (77-86)

Changes in hypoosmoregulatory ability associated with smolt transformation in wild masu Salmon, *Oncorhynchus masou*.

Hiroshi Kojima and Takayuki Izumi

The changes of the serum sodium concentration which is used as a parameter for seawater adaptability were examined in order to determine the progress of smolt-transformation and the criteria for functional smolt by using wild masu salmon (*Oncorhynchus masou*) captured from a stream.

The sodium-levels of pre-smolt (the fish in an early stage of smoltification) transferred from freshwater directly into seawater (33-34‰) were maintained at 170-190 mEq/l without reaching at 150-160 mEq/l within five days. The sodium concentration of mid-smolt (the fish in a middle

stage) reached at 150-160 mEq/l 48-72 hours after the immersion in seawater. Though the concentration of post-smolt (the fish in a later stage) increased transitorily after 6 hours in seawater, it attained at a freshwater-acclimated serum sodium level (140-150 mEq/l) after 48 hours. The serum sodium concentration after 48 hours in seawater decreased successively with the progress of smoltification; masu salmon improved their ability to adapt to seawater during smolt-transformation and the post-smolt indicated a maximum hypoosmoregulatory ability. The significant difference ($0.005 < P < 0.010$) of ability to adapt to seawater which depended on the size of smolt was obtained; a larger smolt developed higher ability than a smaller smolt. When the seawater adaptability of mid-smolt in different seawater temperatures was examined in the middle of May, there was no significant difference in the serum sodium concentrations between 7°C and 15°C. The salinity tolerance of parr in April was relatively high. However, that of parr from the middle of May decreased, while that of smolt in the same time increased markedly. Furthermore, parr in June were not able to survive three days at most. These results can be used as an aid to determine the progress of smoltification and to grade the fish reared under the hatchery condition.

6, 飼育一年目に特異的なスマルト変態をする池中継代飼育サクラマスにおける0⁺スマルトの出現機構および戻りの分化過程

黒川忠英 (北海道立水産孵化場) ・宮本真人 (北海道立水産孵化場) ・小島 博 (北海道立水産孵化場) (87-94)

Smoltification mechanism in underyearling and differentiation process of regressive smolt from underyearling smolt in masu salmon, *Oncorhynchus masou*, that acquired ability of premature smoltification.

Tadahide Kurokawa, Mahito Miyamoto and

Hiroshi Kojima

Some observations were carried out in order to define the smoltification mechanism in underyearling and regressive phenomenon of underyearling smolt by using Mori strain of masu salmon (*Oncorhynchus masou*) which was reared at the Erimo Hatchery. The rate of population over 6-7 cm (fork length) in May 1st nearly coincided with smolting rate in underyearling. The smoltification has started before the decision of maturity in Mori strain. In 1983 year class, the rate of underyearling smolt was 31.3% and 51.5% of it regressed to parrs by March in 1984. Thereafter 91.9% of this regressive smolts transformed into smolt again and the rest remained parrs in June 1984. The differentiation process of regressive smolt resembled closely the one of undifferentiated parr. From these results, it is suggested that the starting size of smoltification is 6-7 cm (fork length), and the size of it is much smaller than that of natural fish, therefore the smolting rate in underyearling is risen to high level while the rate of precocious male is restrained to low level. And the regressive smolt can be used as fish for yearling smolt release.

7, 鶴川および沙流川におけるシシャモ資源の動態に関する考察

小林美樹（北海道立水産孵化場）・杉若圭一（北海道立水産孵化場）・岡田鳳二（北海道立水産孵化場）(95-101)

Study on the population dynamics of long-finned smelt, *Spirinchus lanceolatus*, stocks in the Mu River and Saru River

Miki Kobayashi, Kei-ichi Sugiwaka and Houji Okada

Studies were made on population dynamics of long-finned smelt (*Spirinchus lanceolatus* Hikita) stocks in the Saru river and the Mu river as well as in the coastal areas in the vicinity of these rivers. The stocks of long-finned smelt in these coastal

areas sharply decreased in 1969, after which it has remained at a low level to date. It is thought that the cause of this decline or low level of long-finned smelt stocks may be attributable to decreases of up-stream migrating parent brood stocks as a result of increased fishing efforts in the coastal areas. Long-finned smelt fishing in coastal areas is usually carried out from early October to mid November with late October as its peak. The decreased status of long-finned smelt stocks in recent years has, however, obscured this peak fishing period. Although the period of up-stream migration for spawning is from late October to late November in both of these rivers, the peak is from late October to early November in the Mu river while it is not clearly recognizable in the Saru river where the level of stocks has declined. These results of the study suggests that it is necessary to take measures with which to strengthen artificial propagation (artificial fertilization, rearing and releasing) program of the fish, and particularly with regard to management and coordination of coastal fisheries.

第41号 (1986)

1, サケ卵, 仔魚の酸素消費量と注水量, 収容密度およびふ化盆の位置の違いが立体式ふ化器内ふ出仔魚の成長に及ぼす影響

永田光博（北海道立水産孵化場）・宮本真人（北海道立水産孵化場）・外崎 久（北海道立水産孵化場）(1-12)

Oxygen consumption in the fertilized eggs and alevins of chum salmon *Oncorhynchus keta*, and influence of flow rate, density and difference in vertical level of the tray on the growth of alevins in the vertical incubator.

Mitsuhiro Nagata, Mahito Miyamoto and Hisashi Tonosaki

The rate of oxygen consumption of chum salmon was determined from fertilization of the eggs to resorption of yolk, by making use of the respiratory

chamber with the flow system at the water temperature ranging 7.0-11.5°C. The oxygen uptake increased curvilinearly until 20% yolk stage (wet yolk weight $\times 100$ /wet total weight) after fertilization, particularly with sharp rise after hatching. However, after 20% yolk stage oxygen uptake decreased. Alevins of chum salmon in the vertical incubator with ten wire mesh-trays were reared from hatching to near resumption of yolk at two levels of flow rate (15, 30 l/min) and three levels of density (20000, 18000, 15000 fish/tray) under the water temperature of 3.7-7.0°C, and at three vertical levels (top, middle and bottom tray) under 15 l/min, 18000 fish/tray and 4.0-7.6°C. From the statistical analysis by making use of randomized block design, alevins reared at high flow rate (30 l/min) were smaller in size and lower in efficiency of yolk utilization (dry weight increment of body $\times 100$ /dry weight decrement of yolk) than those at low flow rate (15 l/min). The effect of the difference of density was less than that of flow rate. Alevins reared at top tray of vertical incubator were larger in size than those at middle and bottom trays. The dissolved oxygen in outlet water of each tray decreased with increasing of oxygen uptake in alevins, and at about 7-8 weeks after hatching, the saturation of dissolved oxygen decreased under 70% in water of the bottom tray. At the same time, though total ammonia also increased to 205 $\mu\text{g/l}$ at the bottom tray, the value of un-ionized ammonia estimated was low at about 0.07 $\mu\text{g-NH}_3/\text{l}$. These results of water quality suggested that the growth of alevins in middle and bottom trays was limited by decreasing of the dissolved oxygen.

2, 歌別川におけるサケ稚魚の降下移動とハナカジカによるサケ稚魚捕食量の推定

永田光博 (北海道立水産孵化場) ・宮本真人 (北海道立水産孵化場) (13-22)

The downstream migration of chum salmon fry, *Oncorhynchus keta*, released into the Utabetu River of eastern Hidaka in Hokkaido, and the estimation of predation amount of the fry by fresh water

sculpin, *Cottus nozawae* SNYDER.

Mitsuhiro Nagata and Mahito Miyamoto

The downstream migration of chum salmon fry after release, density of the fresh water sculpin (*Cottus nozawae*) and the predation of the fry by the sculpin were investigated in the Utabetu River of eastern Hidaka in Hokkaido from May to June in 1983 and 1984. The downstream migration of chum salmon fry showed a diurnal periodicity. The lateral distribution of descending fry was closely and positively related to the current speed. About 50% of the fry released had descended by next day after release. Densities in number of fish per square meter of the sculpin at the area from the mouth of river to roughly 0.5 km upstream and the area from it to site released fry (3.7 km upstream from the mouth), were estimated at 0.15 and 0.02-0.05, respectively. From analysis by making use of the probability graph paper method, the sculpin in the Utabetu River were divided into six size groups. Ratios of the sculpin preyed on the chum salmon fry showed 50.8% in 1983 and 72.2% in 1984. Relationship between the amount(Y) in number of fry consumed by the sculpin and the body length (X) of the sculpin ate the fry was represented by a linear equation: $Y=0.393X-1.715$. Predation by the female of sculpin with the maturation more than 12% in gonad somatic index tended to decline remarkably. By making use of these results and the previous studies (Nagata, 1984), amounts of predation of chum salmon fry by the sculpin during 8 days after release into the Utabetu River were estimated at 6,638 fish (0.3%) in 1983 and 6,254 fish (0.2%) in 1984, respectively.

3, サケの排精におよぼすサケ脳下垂体、合成 LH-RH ならびに 17α , 20β -dihydroxy-4-pregnen-3-one の効果

寺西哲夫 (北海道立水産孵化場) ・伊沢敏穂 (北海道立水産孵化場) ・太田博巳 (北海道立水産孵化場) ・佐々木トキ子 (北海道立水産孵化場) ・杉若圭一 (北海道立水産孵化場) ・粟倉輝彦 (北海道立水産孵化場)

(23-29)

Effects of chum salmon pituitary, LH-RH analogue and $17\alpha, 20\beta$ -Dihydroxy-4-pregnen-3-one on spermiation in male chum salmon, *Oncorhynchus keta*.

Tetsuo Teranishi, Toshio Izawa, Hiromi Ohta, Tokiko Sasaki Kei-ichi Sugiwaka, and Teruhiko Awakura

Effect of acetone-dried chum salmon pituitary suspension (PS), analogue of luteinizing hormone-releasing hormone [des-Gly¹⁰-[D-Ala⁶]-LH-RH ethylamide] (LH-RHa) and $17\alpha, 20\beta$ -dihydroxy-4-pregnen-3-one ($17\alpha, 20\beta$ -diOHprog) on stimulation of spermiation of chum salmon (*Oncorhynchus keta*) was studied using mature males captured in the River Shokanbetsu, near Mashike, in October. In males which had previously been stripped of their semen, a single intraperitoneal injection of 1 and 10 mg/fish of PS brought about an increase in sperm volume and a decrease in spermatocrit values when they were handstripped repeatedly after injection. LH-RHa and $17\alpha, 20\beta$ -diOHprog at dosages of 1 and 10 μ g/kg body weight respectively were almost ineffective in stimulating spermiation, though it induced a slight decrease in spermatocrit values. All of these hormones were not effective in prolonging sperm motility. These data suggest that the treatment of mature males with PS may be most efficient in stimulating spermiation.

4, 等浸透圧環境による馴致がサケ稚魚の海水適応能に対する効果と河川放流におよぼす影響

小島 博 (北海道立水産孵化場)・岩田宗彦 (東京大学海洋研究所大槌臨海研究センター)・小松志知子 (東京大学海洋研究所大槌臨海研究センター)・宮本真人 (北海道立水産孵化場)・黒川忠栄 (北海道立水産孵化場)・松原貞夫 (えりも町漁業協同組合) (31-38)

Effects of preacclimation to isotonic environment on seawater adaptability and seaward migration

of chum salmon, *Oncorhynchus keta*, fry.

Hiroshi Kojima, Munehico Iwata, Shichiko Komatsu, Mahito Miyamoto, Tadahide Kurokawa, and Sadao Matsubara

Improvement of seawater adaptability in chum salmon (*Oncorhynchus keta*) fry, weighing 0.8-2.1g, was examined with plasma sodium (Na) regulatory ability after various process of preacclimation with fresh water (FW), diluted seawater (DSW, 11 ‰ in salinity: isotonic seawater to the fry), and seawater (SW, 33-34‰). After direct transfer of chum fry (1.4 ± 0.02 g) from fresh water to seawater, the plasma Na concentrations reached the maximum (172 ± 4.3 mEq/L) after 24 hours. These fry attained at a seawater-acclimated level ($150-160$ mEq/L) after 48 hours. The plasma Na concentrations of fry acclimated to DSW for 24 hours reached the seawater-acclimated level without showing any peak. When these fry maintained in DSW for 24 hours, then transferred to SW, the plasma Na concentrations increased slightly after 4 hours in SW and reached at the seawater-acclimated level 9 hour after the transfer. When the fry were preacclimated in DSW and FW for 24 hours, then transferred to SW, the plasma Na concentrations were maintained at the seawater-acclimated level over 48 hours. When the fry were maintained in DSW for 24 hours, then returned to FW, the plasma Na level decreased and reached at a freshwater-adapted level of $130-150$ mEq/L. Chum fry acclimated to the DSW for 8 hours in a outdoor pond were released to a small-sized river at 300 meter from the river-mouth where there was no estuary. The plasma Na concentrations of the fry in the acclimation pond at 4 and 8 hours and of migrating fry in the river were maintained at the seawater-acclimated level. Behaviors of chum fry during the acclimation in the pond were similar to the fry in hatchery ponds. The major school of fry migrated downstream within 10

minutes and reached to ocean. The present results suggest that the preacclimation of chum salmon fry with the diluted seawater is effective to improve their seawater adaptability.

5, サクラマス0年魚スモルトにおける退行現象とスモルト変態後の成長との関連

黒川忠栄（北海道立水産孵化場）・小島 博（北海道立水産孵化場）・宮本真人（北海道立水産孵化場）(39-45)

Relationships of the growth of post-smoltification to the desmoltification of underyearling masu salmon, *Oncorhynchus masou*.

Tadahide Kurokawa, Hiroshi Kojima, and Mahito Miyamoto

Although desmoltification (transformation from a smolt into a parr) is observed in almost salmonids smolt, its cause and mechanism are little known. Mahnken (1982) pointed out that the smolt below the critical size — the size of largest parred individual — reversed to parr in juvenile coho salmon. Thus the experiment rearing under two feed conditions (amount of feed; 1:1/6) was carried out in order to clarify the cause of desmoltification in juvenile masu salmon from Sep. 25, 1985 (just after the peak of smolting rate) to Jan. 10, 1986. The differences in mean fork length between two groups (amount of feed; 1:1/6) were always significant (except initial), whereas those between two groups in reversionary rate (the rate of reversionary smolt) were not significant at any time. There was no significant difference in the initial size (because all individuals were distinguished each other by tag, all initial sizes could be known) of this experiment between revertant (reversionary smolt) and normal smolt (keeping smolt form). Though the growth of revertant was slower than that of normal smolt, the growth of revertant before parr transformation was the same as that of normal smolt. The growth of revertant slowed down from

approximately one month before the desmoltification. From these results, it is concluded that desmoltification in juvenile masu salmon is not mediated by the growth condition after smoltification and there is no tendency that the small smolt reverse to parr.

6, 突符川に放流された池産1⁺スモルトサクラマスの降海行動

太田博巳（北海道立水産孵化場）・神力義仁（北海道立水産孵化場）・西村 明（北海道立水産孵化場）・本間正男（北海道立水産孵化場）・松原敏幸（乙部町さくらます孵化場）・佐藤長蔵（乙部町さくらます孵化場）(47-54)

Seaward movement of hatchery-reared masu salmon, *Oncorhynchus masou*.

Hiromi Ohta, Yoshihito Shinriki, Akira Nishimura, Masao Honma, Toshiyuki Matsubara, and Chouzou Satoh

On 14 May 1985, 173,490 1⁺ hatchery-reared smolts of masu salmon, *Oncorhynchus masou*, were released at the 3.5 km upstream from the mouth of the Toppu River facing Japan Sea, southern Hokkaido. And on 6 and 13 May 1986, 148,158 and 253,628 1⁺ smolts were also released at the 0.7km upstream from the mouth. Seaward movement was estimated by the number of smolts recaptured by cast nets at the mouth of the river. Few of the smolts were recaptured immediately after the release, and the peaks in the movement were observed from the end of May to early June. Comparison between the number of smolts recaptured and the variance of environmental factors including water temperature, rainfall, and lunar phase suggested that increases in water temperature presumably acted as the most effective releasing trigger on the smolts.

7, サクラマス耳石表面にみられる年輪様構造

西村 明（北海道立水産孵化場）・北村隆也（北海道立水産孵化場）・神力義仁（北海道立水産孵化場）・

太田博巳（北海道立水産孵化場）・本間正男（北海道立水産孵化場）（55-62）

Annual-ring-like structure observed on the surface of the otolith of masu salmon, *Oncorhynchus masou*.

Akira Nishimura, Takaya Kitamura, Yoshihito Shinriki, Hiromi Ohta, and Masao Honma

The surface of the otolith of masu salmon, *Oncorhynchus masou*, reared in sea cage was observed by light and scanning electron microscopy. The observation showed grooves on the surface of convex distal plane of the otolith. Since the number of groove showed good agreement with their age, and the formation of the groove began in fall, the groove appeared to be annual character formed from fall to winter. There is a possibility that these grooves on the otolith surface can be utilized as information source of their age and growth.

8, 池産サクラマスの共食いによる初期減耗

泉 孝行（北海道立水産孵化場）・小出展久（北海道立水産孵化場）・神力義仁（北海道立水産孵化場）（63-69）

Cannibalistic decrease in the fry stage of hatchery-reared masu salmon, *Oncorhynchus masou*.

Takayuki Izumi, Nobuhisa Koide, and Yoshihito Sinriki

The cause of decrease in the number of fish was investigated with hatchery-reared masu salmon, *Oncorhynchus masou*, fry, in water tanks. The decrease was produced when the difference in length reached more than 1.8 in ratios (66.5 mm versus 37.5 mm in average fork length). This loss was due to a cannibalistic effect between large and small populations of fry. When the length was more than 1.3 (39 mm versus 29 mm), the number of fry dead increased. This maybe caused by oral attacks. These phenomena were associated with the volume of pellet food given to

these fish: the smaller the volume was the larger the a cannibalistic effect resulting in increasing the number of the dead was.

9, 池産サクラマス標識魚の回帰

坂本博幸（北海道立水産孵化場）・河村 博（北海道立水産孵化場）・田中寿雄（北海道立水産孵化場）・永田光博（北海道立水産孵化場）（71-78）

Recapture of marked fish of hatchery-reared masu salmon, *Oncorhynchus masou*, released to the River in Hokkaido

Hiroyuki Sakamoto, Hiroshi Kawamura, Hisao Tanaka, and Mitsuhiro Nagata

Eyed, eggs of masu salmon (*Oncorhynchus masou*), which were spawned artificially in the Mori Branch of the Hokkaido Fish Hatchery, transported to the Shakotan Hatchery on 11th May 1984. Fin-clipped fry, 31,000 in number 5.3 cm in mean fork length and 1.5 g mean body weight, were released into Yobetsu River located at the coast of the Japan Sea in western Hokkaido. The marked smolt collected in the River grew up to 15.4 cm in mean fork length at the late May 1985. Juvenile marked masu salmon transformed to smolt at early June and migrated downstream mainly at late May 1985, these morphological and behavioral changes coincided with those of wild smolt. Twenty seven marked adult caught in late February to early June 1986 at the Japan Sea. The body size of marked ocean adult ranged 30.5 to 63.5 cm in fork length and 0.3 to 5.6 kg in body weight, the growth of marked adult showed a similar tendency of wild adult. Three spent fish found in the Yobetsu River at middle September 1986. As the results of growth and migration of marked ocean adults showed the same way of wild masu salmon. Marked masu salmon migrated in the coast of Shakotan peninsula at late February to early June 1986. The small marked salmon caught in late February to March at the, coast of Shakotan, the

coastal waters of the Yobetsu River, those fish were migrating toward the southern sea for the hibernation. It was cleared that the ocean adult migrated for spawning toward the coast of Shakotan from the southern sea to the coast of Japan Sea in April to early June. It was also confirmed that the liberation of hatchery-cultured masu salmon fry was contribute to the enhancement of masu salmon stock.

10, 暑寒別川産サクラマス幼魚の消化管における線虫、*Cystidicoloides ephemeridarum* (Linstow, 1872)の消長および魚体への影響

北村隆也 (北海道立水産孵化場) (79-88)

Fluctuation of the nematode, *Cystidicoloides ephemeridarum* (Linstow, 1872), in the digestive tract of juvenile masu salmon, *Oncorhynchus masou*, in the Shokanbetsu River, and its influence on the host fish.

Takaya Kitamura

The life history of the nematode, *Cystidicoloides ephemeridarum*, parasitic in the juvenile masu salmon (*Oncorhynchus masou*) was investigated in the Shokanbetsu River facing Japan Sea, Hokkaido Japan. Collection of the fish was carried out from May to October 1985 and in July 1986. Parasitic prevalence of the nematode was lower in August and in September than in other months. The phenomenon was supposed to be closely related to the seasonal occurrence of the intermediate host. Infectious intensity of the nematode did not show remarkable fluctuation from summer to autumn. And the intensity in the smolt fish examined in May to June was slightly larger than that in the parr examined in July to October. The occurrence degree of mature females of the nematode in the digestive tract of the fish indicated that this parasite had two generations (the "spring generation" and the "autumn generation") in a year in the region examined. The spring generation seemed to lay

eggs from May to the end of June, and the autumn generation to do from August to early October. Correlation between the infectious intensity and the condition factor of the host fish could not be found. The fact suggested that the nematode had little harmful effect on the masu salmon under the infectious intensity observed in the present study.

11, 高密度飼育ニジマスの止水条件下における血液性状の変化と回復時間について

伊沢敏穂 (北海道立水産孵化場)・今田和史 (北海道立水産孵化場) (89-100)

Variations in hematological parameters and recovery of rainbow trout, *Salmo gairdneri*, reared with high density in static water.

Toshio Izawa and Kazushi Imada

Selected hematological parameters of rainbow trout (*Salmo gairdneri*) which was held in static water with heavy loading density, and changes of water quality were investigated in rearing period of 70-72 hours. The experiment was carried out two times. Loading density in the first experiment was about 10%, the second was 20%. At 24 hours after beginning of experiment rate of ammonia to total excreted nitrogen was calculated 53% in the first, and 76% in the second. Un-ionized ammonia level in the first and the second reached 0.171 mg/l (at 72h), 0.074 mg/l (at 45h) respectively. It appears from these results described above that un-ionized ammonia is more effective than other pollutants in regard to the stress of water pollution on rainbow trout. Among the selected hematological parameters, hematocrit value, number of erythrocytes, longitudinal diameter of erythrocyte, serum calcium and glucose level were higher than the value of controls which were held in running water, while spleen somatic index (spleen weight \times 100/body weight) was lower than that of controls as the time goes. It was examined by moving the

experimental group into running water from static water how long times changes in these hematological parameters required for recovery. Hematocrit values in the 1st experiment required 2-3 weeks for recovery. Number of erythrocytes and longitudinal diameter of erythrocyte required 1-2 weeks. All selected hematological parameters returned to control levels in the 2nd experiment which was examined only 3 weeks later.

12, 電気泳動法によるワカサギとイシカリワカサギの雑種の判別と両種の遺伝的分化

大久保進一(北海道立水産孵化場)・工藤 智(北海道立水産孵化場)(101-109)

Electrophoretic identification of hybrids between two species of the pond smelt, *Hypomesus transpacificus nipponensis* and *H.olidus*, and their genetic differentiation.

Shin-ichi Ohkubo and Satoshi Kudo

The specimens of two species of the pond smelt, *Hypomesus transpacificus nipponensis* and *H.olidus*, were examined by starch gel electrophoresis to identify their F₁ hybrids and clarify their genetic variability and differentiation. Allele substitutions between the two species were observed at 10 of 20 loci examined, which made possible to identify their F₁ hybrids. The number of F₁ hybrids identified by starch gel electrophoresis was 6 of 200 specimens in Lake Ishikari-furukawa and 1 of 200 specimens in Lake Toro. The introgressive hybridization between the two species did not occur in both lakes. The average genetic distance between the two species was 0.9945, which is relatively large among other fish species. That among populations within species was 0.006 in *H.t.nipponensis* and 0.0096 in *H.olidus*. The level of genetic differentiation among populations in *H.olidus* was higher than that in *H.t.nipponensis*. The estimate of average heterozygosity was 0.023 in *H.t.nipponensis* and 0.070 in *H.olidus*. The values of genetic

variability in *H.olidus* was higher than those in *H.t.nipponensis*.

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1, サクラマス *Oncorhynchus masou* の銀化に伴う血中甲状腺ホルモン, エストラジオール-17 β およびテストステロン量の変化

山田英明(北海道大学水産学部)・太田博巳(北海道立水産孵化場)・山内皓平(北海道大学水産学部)(1-11)

Changes in circulating thyroxine, estradiol-17 β and testosterone concentrations during smoltification in the masu salmon, *Oncorhynchus masou*.

Hideaki Yamada, Hiromi Ohta and Kohei Yamauchi

We have investigated the changes in the concentrations of thyroxine, estradiol-17 β and testosterone in the circulating blood of masu salmon smolts, (*Oncorhynchus masou*), during smoltification. 1986 smolts (born in 1984) were reared under high water temperature in summer of underyearling phase compared with 1985 smolts (born in 1983). Growth in body weight of the 1986 smolts was greater than that of 1985 smolts. The distinct peaks of blood thyroxine, estradiol-17 β and testosterone levels of 1985 smolts were observed during smoltification. In contrast, the similar peaks observed in 1985 smolts were not detected in 1986 smolts. These results suggest that rearing conditions may have an effect on the physiological changes including hormone levels in the circulating blood in the masu salmon during smoltification. Furthermore, the increased levels of estradiol-17 β or testosterone may enhance the sense of smell and sight sensibility of smolts by cooperation with thyroxine, and may effect on the gonadotropin synthesis and its accumulation in the pituitary.

2, イトウ *Hucho perryi* (BREVOORT) 精子の運動

平井尚志（北海道大学水産学部）・川村洋司（北海道立水産孵化場）・泉 孝行（北海道立水産孵化場）・三浦 猛（北海道大学水産学部）・忍関素子（北海道大学水産学部）・山内皓平（北海道大学水産学部）（13-18）

Sperm motility of the Japanese huchen, *Hucho perryi* (BREVOORT).

Hisashi Hirai, Hiloshi Kawamura, Takayuki Izumi, Takeshi Miura, Motoko Ninzeki and Kohei Yamauchi

The effects of NaCl, KCl, CaCl₂ and mannitol solutions on sperm motility in the Japanese huchen, *Hucho perryi* (BREVOORT), were observed. Maximum duration of sperm motility was obtained between 100 and 300 mosmol kg⁻¹ NaCl. Although highest sperm motility observed with CaCl₂ and mannitol were lower than that of NaCl, osmolality range were similar. In contrast, these were immotile in KCl solution at 10~800 mosmol kg⁻¹. The possibility of prolonging sperm motility using NaCl and CaCl₂ was discussed.

3, 池産サクラマス0年魚の銀化に伴う生理的变化
伴 真俊（北海道大学水産学部）・笠原 昇（北海道立水産孵化場）・山内皓平（北海道大学水産学部）（19-26）

Physiological changes in the hatchery-reared underyearling masu salmon (*Oncorhynchus masou*) during smoltification.

Masatoshi Ban, Noboru Kasahara and Kohei Yamauchi

Physiological adaptation to abrupt transfer to seawater of underyearling masu salmon (*Oncorhynchus masou*) reared in Mori branch of the Hokkaido Fish Hatchery were investigated. In fresh water rearing condition, change to silvery body color started at mid-June and smoltification rate was maximum (40%) at early-June. Changes in their number of chloride cells and follicle cell height of thyroid gland were not significantly different.

When smoltification rate was high, some smolts could not survive after abruptly transferring to seawater. Gill Na⁺-K⁺ATPase activity of transferred fish was highest from mid-June to mid-July while serum sodium excretion activity peaked at late-August. Results suggest that underyearling masu salmon smolts are still not capable of adapting to seawater.

4, 池産サクラマス1年魚の銀化に伴う生理的变化
伴 真俊（北海道大学水産学部）・笠原 昇（北海道立水産孵化場）・山内皓平（北海道大学水産学部）（27-35）

Physiological changes in the hatchery-reared yearling masu salmon (*Oncorhynchus masou*) during smoltification.

Masatoshi Ban, Noboru Kasahara and Kohei Yamauchi

Adaptations to abrupt transfer to seawater of yearling masu salmon (*Oncorhynchus masou*) reared in the Mori branch of the Hokkaido Fish Hatchery were investigated physiologically. While still under freshwater conditions, change to silvery body color started at late-April with maximum smoltification rate of 91% occurring in early-June. The number of chloride cell and Na⁺-K⁺ATPase activity in the gill and height of the thyroid gland follicle cells were highest from May to early-June. Between early-April to mid-June, 100% rate survival was attained within 96h after transfer into seawater. The highest serum sodium excretion activity was observed in mid-May. These results show that seawater adaptability of yearling masu salmon smolts are highest at mid-May.

5, 池産サクラマスと天然のサクラマスの遺伝的変異の量

大久保進一（北海道立水産孵化場）（37-44）

Genetic variability in hatchery and natural populations of masu salmon, *Oncorhynchus masou*.

Shin-ichi Ohkubo

Allelic frequencies and genetic variability based on 31 enzyme loci were compared between hatchery and natural populations of masu salmon, *Oncorhynchus masou*. Significant differences of allelic frequencies were observed among natural populations of different rivers. The average heterozygosities of natural populations of rivers ranged from 0.037 to 0.072, while those of hatchery populations were 0.042 in Mori hatchery (Mori branch of Hokkaido Fish Hatchery), and 0.061 in Kuwaiti hatchery (Kuwaiti branch of Hokkaido Fish Hatchery). There was no evidence of reduction in genetic variation in hatchery populations.

6、池中継代飼育サクラマス の回遊と成長

黒川忠栄（北海道立水産孵化場）・小島 博（北海道立水産孵化場）・中島幹二（北海道立水産孵化場）
(45-52)

Migration and growth of hatchery-reared masu salmon (*Oncorhynchus masou*).

Tadahide Kurokawa, Hiroshi Kojima and Kanji Nakajima

To investigate the migration route and growth of hatchery-reared masu salmon (*Oncorhynchus masou*) in the Pacific Ocean, 9,100 yearling tagged smolts were released from Erimo branch of Hokkaido Fish Hatchery into the Utabetu River on 4 June 1986. Forty fish were recaptured in the coastal waters of Hokkaido and Tohoku and in the Utabetu River from June 1986 to September 1987. The migration route was estimated from the locations of recapture of tagged fish as follows: The fish migrated north along the Pacific coast of Hokkaido from June to July 1986 after seaward movement and they stayed in waters around Nemuro Peninsula or in the Okhotsk Sea during summer. Afterwards they turned south and migrated along the Pacific

coast from October 1986 to January 1987 and they stayed in waters around northern Tohoku from February to May 1987. Though spawning migration route was not clear in this study, six tagged fish were recaptured in the coastal waters of Erimo in May 1987 and the Utabetu River from June to September 1987. Their adult return rate was not clear in this study. Their growth in the ocean was represented by the following equations showing relationship between the fork Length (L) and the months (M) after release or the body weight (W) : $L=1.941M+20.261$ ($r=0.838$), $W=0.0056L^{3.221}$ ($r=0.990$). Fork length of recaptured fish at the beginning of second annual ring was estimated by their scales. Fork length of tagged fish in November 1986 was estimated to be around 30 cm by upper equation and estimation. The size of returned tagged adults averaged 42.8 cm in fork length and 1,000 g in body weight. These results suggest that the migration route and growth of hatchery-reared masu salmon were not different from those of wild fish in the ocean.

7、(短報) 異なる銀化過程を経たサクラマスモルト3種の海水適応能と血清サイロキシン

小島 博（北海道立水産孵化場）・岩田宗彦（東京大学海洋研究所大槌臨海研究センター）・宮本真人（北海道立水産孵化場）・黒川忠栄（北海道立水産孵化場）
(53-56)

(Short paper) Seawater adaptability and serum thyroxine of yearling masu salmon (*Oncorhynchus masou*) smoltified in three different process.

Hiroshi Kojima, Munehico Iwata, Mahito Miyamoto and Tadahide Kurokawa

The serum sodium (Na) and thyroxine (T₄) concentration of yearling masu salmon (*Oncorhynchus masou*) were examined with three different groups of smolts after transfer from fresh water to seawater (SW). A strain of masu salmon used in the present study has been selected for greater performance of smoltification in first and second

year. Group N which is the majority of this strain had smoltified in the second spring. The second group of fish had smoltified through the first year and reversed to parr afterward, then smoltified again in the second spring (group R). A group of smolts (group S) had smoltified in the first year and maintained it until the second spring. Three groups of masu smolts were transferred to SW (33-34‰ in salinity) in June of their second year when the smoltification rate of this strain reached maximum. Serum Na concentration of group N reached $180 \pm 5.03 \text{ mEq} \cdot \text{L}^{-1}$ after 24 hr in SW, it came near to seawater-acclimated level of 150-160 $\text{mEq} \cdot \text{L}^{-1}$ after 48 hr, and the T_4 level increased from 14.3 ± 3.9 to $16.4 \pm 2.2 \text{ ng} \cdot \text{ml}^{-1}$ 6hr after SW transfer, then decreased $7.3 \pm 0.4 \text{ ng} \cdot \text{ml}^{-1}$ at 48 hr. Group R showed the maximal Na of $195 \pm 7.72 \text{ mEq} \cdot \text{L}^{-1}$ and minimal T_4 concentration of $6.9 \pm 2.0 \text{ ng} \cdot \text{ml}^{-1}$ at 24 hr in SW. The earliest smoltified fish (group S) expressed the maximal Na value of $201 \pm 9.58 \text{ mEq} \cdot \text{L}^{-1}$ and the minimal T_4 of $0.8 \pm 0.2 \text{ ng} \cdot \text{ml}^{-1}$ 24 hr after SW transfer. The Na concentration remained above 180 $\text{mEq} \cdot \text{L}^{-1}$ at 48 hr in SW. These results indicate that the seawater adaptability of group N and group R may appear in about June of their second spring though the peak of the earliest smoltified fish (group S) seems to have past in spite of their silvery body color. External discrimination with the characteristics of silvery color on body surface and fin pigmentation did not detected the fully smoltified fish acquired seawater adaptability.

第43号 (1988)

1, Generation of aberrant net charges of live host cells by IHN and IPN virus infections.

D.K.Sakai (Hokkaido Fish Hatchery) (1-9)

Net charges of infectious hematopoietic

necrosis (IHN) and infectious pancreatic necrosis (IPN) virus particles were investigated by electrophoresis. IHN virions were positive, and IPN virions were negative. Actual net charges of virus uninfected tissue culture cells (RTG-2 cells) were determined by electrophoresis at 15°C with minimum essential medium (MEM) at pH 7.0. The net charges were neutral. The cells showed net positive charges during electrophoresis with glucose out of MEM. Mixed amino acids out of MEM induced net negative charges. During electrophoresis with MEM, the net neutral charges of RTG-2 cells shifted to negative by the addition of g-strophanthin and iodoacetate. The addition of azide produced net positive charges of the cells. As culture time was prolonged, the net charges of IHN virus infected cells shifted from neutral to negative. IPN virus infected cells showed net positive charge. The results indicate that the virus infections cause the alteration of actual net charges of host cells. Also, these strongly suggest that IHN and IPN virus infections are implicated in the modulation of the electron transport chain of tricarboxylic acid cycle through the metabolism of amino acids and of glycolytic pathway through the metabolism of glucose, respectively. This claim was supported by the determination of ATP contents of the virus infected cells.

2, (総説) 魚類免疫と免疫系

坂井勝信 (北海道立水産孵化場) (11-35)

(Review) Fish immunology and immune system.

D. K. Sakai

This review comprises the following two parts: the present status of fish immunology and immune system. Necessity and view points for fish immunology

1. Comparative immunology

2. Immunity and defense mechanism

(1) Nonspecific defense mechanism

- (2) Specific (immunological) defense mechanism
- 3. Diversity of fish immunity
- 4. Secondary immune response and immunological memory

Fish immune system

- 1. Complement
- 2. Antibody
- 3. Lymphocytes
 - (1) Lymphocyte separation
 - (2) *In vitro* proliferation of lymphocytes
 - (3) Transfer of lymphocytes
 - (4) Functional heterogeneity of lymphocyte subpopulations
 - (5) Cytotoxic lymphocytes
- 4. Immunosuppression
- 5. Blood type of fish

The latter part states the conclusion obtained from the studies of fish immunology only in the Hokkaido Fish Hatchery. This is summarized by the experimental results from 1978 to 1987.

3, 鱗の輪紋から推定したサクラマス¹の尾叉長と成熟卵数との関係

北村隆也（北海道立水産孵化場）・西村 明（北海道立水産孵化場）（37-45）

Correlation between the fork length estimated from scale ridges and the fecundity of masu salmon, *Oncorhynchus masou*.

Takaya Kitamura and Akira Nishimura

Correlation between the estimated fork length and the fecundity was investigated on thirty one masu salmon (*Oncorhynchus masou*) caught in the Shokanbetsu River facing Japan Sea in 1983. Scales were collected from fifty three fish to calculate the estimated fork length. Ovaries were taken out from thirty one of these fish to count the number of eggs. The range of actual adult fork length was 34.5 to 64.5 cm, and the average was 50.6 cm. Estimated fork length of 1⁺ fish was 8.7 to 16.6 cm in range, 12.7 cm at mean, and that of 2⁺ fish was 29.9 to 51.8 cm, average was 43.2 cm. Correlation coefficient (γ) between

the adult fork length and fecundity was 0.7361. As for estimated fork length of 1⁺ and 2⁺ fish, correlation coefficients were 0.2673 and 0.5410, respectively. Therefore, fecundity was considered to have a most close relation to the fork length of fish that have entered in the river. A test of population correlation coefficient (ρ_0) resulted in the fact that the fork length at 1⁺ had no relation to fecundity, directly. The growth rate during the sea life of one year after sea migration was estimated to be a main factor which influenced the number of mature eggs.

4, サケ・マス孵化管理技術の改善に関する研究 仔魚期における仔魚の活動と成長

小林美樹（北海道立水産孵化場）・岩見俊則（北海道立水産孵化場）・岡田鳳二（北海道立水産孵化場）（47-55）

Studies on the improvement of hatchery facilities and technologies in artificial salmon propagation. Movement and growth of chum salmon (*Oncorhynchus keta*) alevins in experimental incubators having different flooring.

Miki Kobayashi, Toshinori Iwami, and Houji Okada

In order to develop more effective salmon hatchery facilities as well as technologies involved and thereby facilitate in producing better quality fry, experiment was made on different, several types of incubation channels. Namely, movement and growth of chum salmon (*Oncorhynchus keta*) during the period from artificial fertilization to complete yolk absorption stages were studied by using several types of incubation channels. As a result, it was found that alevins incubated in the "blind" type channel were more vigorous and active than those incubated in the "gravel" type channel. They swam actively against the water flow at the upper part of the channel. The gravel type incubation channel is the facility which has been used generally in Hokkaido. It's

bottom is covered with gravel of 3 to 4 cm in diameter. Whereas the bottom of blind type incubation channel is covered by window shade etc. and is used in some areas in recent years. The alevins in "honeycomb board" type incubation channel were observed that they could maintain their position much more stable than they could in gravel type and blind type incubation channels. The bottom of "honeycomb board" type incubation channel is covered by honeycomb board and blind. The blind is the same as that of used in the "blind" type. The stable position of alevins observed in honeycomb board type incubation channel may have been supported by vertical water flow within the honeycomb board. This is to say that the fry having yolk can be safely kept within the honeycomb board until they come out of it after yolk absorption stage. Or this may be interpreted that the fish's nature to swim against water flow leads to otherwise unnecessary energy consumption and this could be avoided by honeycomb structure. The alevins which could stay relatively calm within the honeycomb board for 8 weeks after emergence proved to grow larger than other alevins grown in other types of incubation channels. From this observation, it may be safe to say that the honeycomb board type incubation channel would be much more useful than the conventional gravel type from the standpoint of producing more healthy and quality fry.

5, サクラマス¹の生態学的研究 I. 古宇川に放流した池中継代サクラマスの降海行動について

小林美樹（北海道立水産孵化場）・岩見俊則（北海道立水産孵化場）・岡田鳳二（北海道立水産孵化場）・永田光博（北海道立水産孵化場）（57-64）

Ecological studies of masu salmon (*Oncorhynchus masou*). I. Seaward migration of the progeny of pond cultured masu salmon released into the Furuu River.

Miki Kobayashi, Toshinori Iwami, Houji Okada,

and Mitsuhiro Nagata

In order to study smoltification and seaward movement of masu salmon (*Oncorhynchus masou*) in natural conditions, 139,000 underyearling hatchery-reared masu salmon juveniles marked with clipped anal fin, were released into the Furuu River on 28 May, 1986. This river is located in southwestern part of Shakotan Peninsula, Hokkaido and flows into the Sea of Japan. In May to July, 1987, they were captured by cast net together with wild stocks at the sampling station 800 meters upstream from the mouth of the same river. Both of the fishes captured, namely, hatchery-reared and wild born, were in the phase of mid-smolt or more advanced stages. Marking with ribbon tag was made to all the individuals of masu salmon caught during the period from 20 May to 23 June, 1987. By comparing the captured numbers of smolts and also estimated recapture rate of both of these two groups, seaward movement pattern of each group was estimated. Downstream migration of the smolts of stocked (i.e., hatchery-reared and released) group was considerably later than that of wild stocks. It was observed that its peak period lies somewhere between mid to late June in the former and early to mid May in the latter. Though the result of tagging experiment showed higher recapture rate of smolts in May, when compared to that of June, in both groups, it was observed throughout the present study period that the recapture rate of smolts from stocked group was generally higher than that of wild group.

6, (総説) 洞爺湖の酸性化と中性化過程の環境変化
今田和史（北海道立水産孵化場）・伊藤富子（北海道立水産孵化場）・伊沢敏穂（北海道立水産孵化場）（65-75）

(Review) Environmental changes of Lake Toya, with particular references on its acidification and

neutralization.

Kazushi Imada, Tomiko Ito, and Toshio Izawa

Lake Toya, a large caldera lake located in southwestern Hokkaido, had been affected the acidification by waste of mines. In the present study, we review the long-term environmental changes of water quality and the amount of total catches of important fishes, land-locked sockeye salmon (*Oncorhynchus nerka*), Himemasu in Japanese name, and pond smelt (*Hypomesus transpacificus nipponensis*), Wakasagi in Japanese name which were not native fishes in this lake. Himemasu was transferred from Lake Akan into the lake in 1893, and Wakasagi was transferred from Kasumigaura in Honshu Island in 1926. Both fishes had well propagated in the lake and their commercial fisheries developed. However, the catch of these fishes had become very poor since 1965, because the lake water was acidified by drainage of electric power station (EPS). Lake water had been utilized for Sobetu EPS and Toya EPS since 1920, 1939 respectively. Toya EPS's drainage was very acidic water deriving from two sulfur mines. The pH value of lake water decreased rapidly as low as pH 5.0 during 1968 to 1971. Neutralizing treatment of the mine drainage using the lime started in 1972, and the pH value of the lake increased to pH 6.8 to 7.0 in next ten years. The pH value, however did not exceed over pH 7.0 as the level of other oligotrophic lake in Hokkaido. On the other hand, the alkalinity also decreased, and the lowest level as 0.01 meq l^{-1} was observed in 1970. After the treatment of drainage, it increased linearly to 0.15 meq l^{-1} in 1985. However, it is still low level to compare with other oligotrophic lakes with 0.8-0.9 meq l^{-1} . The alkalinity of Toya EPS's drainage, most abundant influent, was 0.16 to 0.17 meq l^{-1} in concentration same as the level of this lake. Recently, since the pH value recovered the level in the previous condition, the catch of Wakasagi

had increased, but the amount of Himemasu is still extremely poor. We supposed that the alkalinity is also one of the important factors to propagate Himemasu. Therefore, it needs to observe the variation of water quality and resources of Himemasu in the future.

7, (短報) 海中で飼育したサクラマス成長について
太田博巳 (北海道立水産孵化場)・西村 明 (北海道立水産孵化場)・佐々木義隆 (北海道立水産孵化場)・民谷嘉治 (北海道立水産孵化場)・北村隆也 (北海道立水産孵化場)・今田和史 (北海道立水産孵化場) (77-80)

(Short paper) Growth of the masu salmon, *Oncorhynchus masou*, smolts reared in a sea pen.
Hiromi Ohta, Akira Nishimura, Yoshitaka Sasaki, Yoshiharu Tamiya, Takaya Kitamura, and Kazushi Imada

Pond-cultured type and wild type 1^+ masu salmon smolts, which had been reared in hatcheries until 5 months after their smoltification respectively, were cultivated for 226 days in a sea pen placed in the Otohe harbor, southern Hokkaido. They were fed up with moist pellet throughout the period. The growth and the survival rate of the pond-cultured type masu salmon during the mariculture showed a tendency to be better than those of the wild type fish. The result suggested that the pond-cultured masu salmon might be more suitable for the mariculture species than the wild type fish.

8, (短報) 海水飼育された池産および天然サクラマスの海水適応能と成長

笠原 昇 (北海道立水産孵化場)・伴 真俊 (東北区水産研究所)・渡辺 寛 (小樽水族館公社)・山内皓平 (北海道大学水産学部) (81-84)

(Short paper) Seawater adaptability and growth in the hatchery-reared and wild masu salmon, *Oncorhynchus masou*, after transfer to seawater.
Noboru Kasahara, Masatoshi Ban, Hiroshi

Watanabe, and Kohei Yamauchi

After transfer of the two-year old hatchery-reared (Mori group) and wild masu salmon (Shokanbetsu group: wild strain in Shokanbetsu River) to seawater (SW) with or without acclimation of 1/3SW for 24hrs, their seawater adaptability and the growth were investigated. Seawater adaptability of Mori group assessed by serum sodium concentrations and gill $\text{Na}^+\text{-K}^+$ ATPase activity showed significantly lower than that of Shokanbetsu group for 24hrs after direct transfer to SW. However, the 24hr-acclimation of 1/3 SW slightly improved seawater adaptability of Mori group. Three months after the transfer, seawater adaptability of both groups indicated the same levels. These fish in both groups grew in SW, showing the higher development of Mori group.

第44号 (1989)

1, 北海道産淡水魚類の寄生虫目録

長澤和也・粟倉輝彦・浦和茂彦 (1-49)

A Checklist and bibliography of parasites of freshwater fishes of Hokkaido.

Kazuya Nagasawa (Hokkaido Fisheries Experimental Station), Teruhiko Awakura (Hokkaido Fish Hatchery) and Shigehiko Urawa (Hokkaido Salmon Hatchery)

This checklist contains information on 96 named species of parasites and those not identified to the species level from 38 species (1 with 2 subspecies) of freshwater fishes from Hokkaido Island, Japan. The 96 named species are distributed among higher taxa as follows: Protozoa-21; Monogenea-11; Trematoda-22; Cestoidea-10; Nematoda-15; Acanthocephala-7; Mollusca-2; Copepoda-6; Branchiura-1; and Isopoda-1. Forty previously unpublished host-parasite-locality records are added to the faunal records, including

17 species (7 unnamed) previously unreported from Hokkaido waters: *Dactylogyrus extensus*, *D.falciformis*, *Dactylogyrus* sp., *Gyrodactylus kherulensis*, *G.kobayashii*, *G.longoacuminatus*, *G.macracanthus*, *G.micracanthus*, *Gyrodactylus* sp.1, *Gyrodactylus* sp.2, *Gyrodactylus* sp.3, *Ancyrocephalus* sp., *Ancyrocephalidaegen.* sp. (*Ancyrocephalus* sp. ?) (Monogenea), *Posthodiplostomum* sp. (Trematoda), *Ergasilus hypomesi*, *Neergasilus japonicus* (Copepoda), and *Argulus japonicus* (Branchiura). Also, 11 new host-parasite records are included. Records of the parasites of non-salmonid fishes are summarized in the form of Parasite-Host and Host-Parasite lists with accompanying bibliography. The Parasite-Host list, arranged on a taxonomic basis, includes for each parasite species its currently recognized scientific name, synonyms occurring in the literature, habitat (freshwater, brackish, or marine), site(s) of occurrence in/on the host(s), species of the host(s), known geographical distribution in Hokkaido, and the published source for each host and locality record. The Host-Parasite list summarizes the species of parasites from each fish species and their geographical distributions. Two appendices provide summarized records of the parasites of salmonids in the form of Parasite-Salmonid and Salmonid-Parasite lists. The following one new name combination is also proposed: *Myxobolus elliptica* (Fujita, 1924) n. comb. for *Lentospora elliptica*.

2, サクラマス の成熟にともなう補体および免疫応答能 鈴木邦夫・布田博敏・坂井勝信 (51-56)

Interrelation between complement and immune response associated with maturation of masu salmon, *Oncorhynchus masou*.

Kunio Suzuki (Hokkaido Fish Hatchery), Hirotohi Fuda (Faculty of Fisheries, Hokkaido University), and D. K. Sakai (Hokkaido Fish Hatchery)

Complement of masu salmon (*Oncorhynchus masou*) was determined by a spontaneous hemolytic (SH_{50}) activity to goldfish red blood cells (GFRBC), using normal serum from the following different stages of maturation: 1⁺ parr (12 months after hatching), 1⁺ smolt (12 months), 2⁺ parr (24 months), 2⁺ pre-mature smolt (24 months), 2⁺ mature smolt (34-36 months), and 2⁺ post-mature smolt (34-36 months, spent fish after the spawning season). The SH_{50} activity of 2⁺ mature smolt was higher than that of 1⁺ parr, 1⁺ smolt, 2⁺ parr and 2⁺ pre-mature smolt. Smolt of 2⁺ post-mature had a lower activity. The immune response of masu salmon to GFRBC (as an antigen) was investigated by the titration of hemolytic antibody (hemolysin). In the kinetics of hemolysin production, the titer appeared on day 4 or 5 and reached a peak after a week in all the fish groups used. The peak of the titer became higher in order of 1⁺ parr, 2⁺ premature smolt and 2⁺ mature smolt. The 2⁺ post-mature smolt had a reduced titer. These results show that fish, with the exception of post maturation, enhance both complement activity and immune response as masu salmon matures. The enhancement of immune response was associated with the increase of complement activity.

3, IHNウイルスのニジマスに対する病原性の差異
鈴木邦夫（北海道立水産孵化場）・坂井勝信（北海道立水産孵化場）（57-62）

A difference of pathogenicity to rainbow trout, *Oncorhynchus mykiss*, in IHN virus strains.

Kunio Suzuki and D.K. Sakai

The cumulative mortalities of fry and large-sized rainbow trout infected with IHN (infectious hematopoietic necrosis) virus were investigated using two virus strains H_{LR}-1 (that was isolated from large-sized rainbow trout affected with IHN) and H_{SR}-3 (from small-sized rainbow trout (fry)). Virus titers of the dead fish were also

examined. The titers were more than 10⁵ TCID₅₀/g tissue. There was no difference between the virus titers of the dead fish infected with strain H_{LR}-1 and with H_{SR}-3. Strain H_{LR}-1 brought about high cumulative mortalities both in the large-sized fish and in the fry; in contrast, although strain H_{SR}-3 showed a high mortality for the fry, it did a low mortality for the large-sized fish. These results indicate that the outbreak of IHN depends on the pathogenicity of the virus strains to rainbow trout as well as the susceptibility of fish to IHN virus.

4, シンヤモの遺伝的変異と集団構造

大久保進一（北海道立水産孵化場）（63-68）

Genetic variation and population structure of Japanese longfin smelt, *Sprinchus lanceolatus*.

Shin-ichi Ohkubo

Genetic variations and population structure among 4 river populations of Japanese longfin smelt, *Sprinchus lanceolatus*, were examined by starch gel electrophoresis. Among 20 loci examined, 4 loci were polymorphic. Average heterozygosity of Japanese longfin smelt was 0.0021. The allele frequencies was very similar among 4 populations, and average genetic distance among 4 populations was 0.0002, which was very low value.

5, ニジマス未受精卵の短期保存条件について

新谷康二（北海道立水産孵化場）・太田博巳（北海道立水産孵化場）・神力義仁（北海道立水産孵化場）（69-75）

Short-term storage of unfertilized eggs of rainbow trout, *Oncorhynchus mykiss*.

Kouji Araya, Hiromi Ohta, and Yoshihito Shinriki

Mature eggs of rainbow trout (*Oncorhynchus mykiss*) were stored under three simple conditions; Intact, eggs squeezed out from the female abdomen were preserved in the plastic airtight

receptacle without washing; Washed, eggs were washed with an artificial coelomic fluid (ACF) consisting of NaCl 155.0 mM, KCl 2.5 mM, CaCl₂ 2.2 mM, MgCl₂ 0.7 mM, NaHCO₃ 5.0 mM, pH 8.5, and preserved; Incubated, eggs were washed with ACF and immersed in ACF of equal volume to the eggs. Eggs of each procedure were stored at 2.5°C, 5°C, 10°C, respectively, and were inseminated with fresh milt at various periods of storage. The washed eggs always showed superior fertility to those of other conditions. And the eggs incubated with ACF showed the lowest fertility. The duration of fertility was decreased with increase of temperature. In all procedures examined, washed-2.5°C condition, in which little change from initial fertility was observed after 48 hours of storage, was the most suitable for short term preservation of unfertilized eggs of rainbow trout.

6, ヒメマスの精子活性について

太田博巳（北海道立水産孵化場）・西村 明（北海道立水産孵化場）・畑山 誠（北海道立水産孵化場）（77-82）

Sperm motility of kokanee salmon, *Oncorhynchus nerka* (Walbaum).

Hiroimi Ohta, Akira Nishimura, and Makoto Hatakeyama

Effects of potassium on sperm motility of kokanee salmon was examined for determining the composition of an artificial seminal fluid. When semen was diluted with NaCl or mannitol solutions between 0-400 mOsm kg⁻¹, spermatozoa were motile. But the sperm motility did not occur at any KCl concentration examined (10-500 mOsm kg⁻¹). Ion concentration of seminal plasma analyzed by atomic absorption spectrophotometer was Na⁺ 127.1, K⁺ 25.1, Ca²⁺ 1.0, Mg²⁺ 1.1 mM⁻¹. In artificial seminal fluid, constituting of 1.0mM CaCl₂, 1.1mM MgCl₂, 5.0mM NaHCO₃, and varying mixture of NaCl and KCl of the constant

amount at 152.2mM, the duration of sperm motility was decreased with increase of KCl concentration, and reached zero at 30mM KCl. It is concluded that the constituent of the artificial seminal fluid for kokanee salmon is optimal as follows, 122.2mM NaCl + 30mM KCl + 1.0mM CaCl₂ + 1.1mM MgCl₂ + 5.0mM NaHCO₃.

第45号（1991）

1, (総説) 河川底質における魚類病原細菌の微生物生態と遺伝子伝達

坂井勝信（北海道立水産孵化場）（1-13）

(Review) Microbial ecology and gene transmission of fish pathogenic bacteria in river sediments.

D.K. Sakai

This review comprises the long lasting microbial survival of *Aeromonas salmonicida* associated with river sand, humic substances and trace nutrients, and further describes the transmission of *A.salmonicida* protease genes to interspecific, interspecific and intergeneric aquatic bacteria in a laboratory model of river sediments. The mechanisms of survival and gene transmission of *A.salmonicida* in river sediments are discussed by a proposed electrostatic interactions among bacterial cells, humic substances, and amino acids on the surface of river sand particles.

2, 突符川に放流された池産1+サクラマスの降海行動-II. 1988, 1989年放流結果

西村 明（現 遠洋水産研究所）・民谷嘉治（現 北海道渡島支庁）・北村隆也（北海道立水産孵化場）・坂本博幸（北海道立水産孵化場）・太田博巳（北海道立水産孵化場）・今田和史（北海道立水産孵化場）・松原敏幸（乙部町役場）（15-22）

Seaward migration of pond-cultured smolts of masu salmon, *Oncorhynchus masou*-II. Results of experiments in 1988 and 1989.

Akira Nishimura, Yoshiharu Tamiya, Takaya Kitamura, Hiroyuki Sakamoto, Hiromi Ohta, Kazusi Imada and Toshiyuki Matsubara

Investigation of seaward migration of pond reared 1⁺ masu salmon (*Oncorhynchus masou*) released into Toppu River in May 1988 and 1989 was carried out using castnets at the mouth of the river. The peaks in seaward migration were observed from late May to early June, though that of natural-native fish was observed about 3 weeks before, in early May. Acquisition of sea water adaptability shown by 48h-sea water challenge test showed good agreement in period with the seawater migration of released fish. Delay in the period of acquisition of seawater adaptability is suggested to be responsible for the time-lag observed in the period of seaward migration between natural-native fish and pond-cultured released fish. The water temperature was suggested to be the most effective trigger on the seaward migration of released fish, than else environmental factors such as rainfall or lunar phase.

3, IHN ウイルスのサクラマス稚魚および幼魚に対する病毒性の差異

鈴木邦夫 (北海道立水産孵化場) ・坂井勝信 (北海道立水産孵化場) (23-27)

Differences in the virulence of IHN virus strains to masu salmon, *Oncorhynchus masou*, fry and juveniles

Kunio Suzuki and D.K. Sakai

Differences in the virulence of four infectious hematopoietic necrosis (IHN) virus strains were investigated by intraperitoneal injections into masu salmon (*Oncorhynchus masou*) fry and juveniles. Used two strains H_{SM}-1 and H_{SM}-2 were isolated from naturally occurring outbreaks of IHN in masu salmon fry, and the other strains H_{LM}-1 and H_{LM}-2 were isolated from juveniles and

adults, respectively. In the experimental infection at 10°C, masu salmon fry (approximately 0.8 g in weight) showed severe mortalities of 100% within 9 days against all the virus strains used. For juveniles (approximately 50 g), two strains H_{SM}-1 and H_{SM}-2 revealed lower mortalities of 45% and 40% during 30 days, although the other two strains H_{LM}-1 and H_{LM}-2 resulted in higher mortalities of 70%. These results indicate that IHN strain are greatly higher virulent for fry than for juveniles and also that the virulence of IHN virus is closely concerned with the weight (or growth) of experimentally used fish as well as of virus-isolated fish sources affected with IHN.

4, 北海道北部河川におけるサクラマス幼魚のスマルト化

杉若圭一 (北海道立水産孵化場) (29-40)

Ecological properties of smoltification of masu salmon, *Oncorhynchus masou*, juveniles in rivers of northern Hokkaido

Kei-ichi Sugiwaka

Ecological properties of smoltification from wild masu salmon parr to smolt were investigated from 1982 through 1988 in two small rivers, the Masuho River and Shimonaefutoro River located in the northern area of Hokkaido. In both rivers, almost masu salmon smolts migrated to the sea in the duration of late May to late June and the peak of seaward migration was early June to mid June. The seaward migration of smolts in the Shimonaefutoro River always delayed rather than in the Masuho River and, sometimes, appeared even in July, because of lower temperatures of the river and coastal sea water. Smolts represented an inferiority of growth in response to high individual densities of juveniles and to the shortened period of an optimal growth temperature specific to northern small rivers; 1⁺ smolts including 27.7% male in the Masuho River were 8.5 to 13.9 cm (mean 11.2

cm) in fork length, while 1⁺ smolts including 33.1% male in the Shimonaeufutoro River were 8.8 to 13.3 cm (mean 10.7 cm). The cause of the higher ratio of male 1⁺ smolts in the latter river was due to their inferior growth responsible for the decrease of mature male during the past 0⁺ age. On the other hand, although high occurrence rates of 2⁺ smolts were expected from the inferiority of 0⁺ juvenile's growth, actual occurrence rates of 2⁺ smolts were 9.3% to 23.8% (mean 15.4%) in the Masuho River and 7.0% to 21.5% (mean 14.6%) in the Shimonaeufutoro River. Such unexpectedly low occurrence rates of 2⁺ smolts were brought about by the results that the strong suppression of 0⁺ juvenile's growth induced a substantial decrease in the smoltification body length rather than an increase the smoltification age of thereafter grown 1⁺ masu salmon. This shows that, to allow 0⁺ juveniles to be prevented from the excess of the population size of 1⁺ small parr in the river, seaward migration is promoted by the smoltification of 1⁺ smolts even though the fish were too small to live in the sea.

5, 池中飼育サクラマス1⁺成熟雄の分化と出現率について

北村隆也 (北海道立水産孵化場) (41-48)

Differentiation and the appearance ratio of 1⁺ precocious male of masu salmon, *Oncorhynchus masou*, reared in the pond.

Takaya Kitamura

1⁺ precocious males of masu salmon (*Oncorhynchus masou*) have appeared prominently in the artificial pond in mid-April. They were distinguished by their stout forms, dark coloration and so on. Testis weight and gonadosomatic index of 1⁺ precocious male were obviously larger than those of 1⁺ male smolt in late April, therefore, it was suggested that development of testis in 1⁺ precocious male took the lead before the appearance of its external characters. Differences of fork

lengths were not recognized between these two types until autumn of two year-old at least, but 1⁺ precocious male was always bigger in body weight. This fact was reflected in differences of condition factors. It was observed that 1⁺ precocious males began to appear from spring and emerged again from the summer on after removal of them. The ratio of 1⁺ precocious males to total number of reared fish about three years from 1985 to 1987 were about 10.5~14% early in summer and 14~19% in autumn. In the year many 1⁺ precocious male occurred, it was a trend that the average size of parr in last autumn was rather small, but their growth was favorable after this. This group was considered to had contained many medium-sized parr in last year that would differentiate to 1⁺ precocious male in next year. It seems that removal of many precocious males will result in a high female percentage of reared fish group and a reduction of labors for rearing.

6, ワカサギとイシカリワカサギの交雑種の遺伝的特徴と形態的特徴

大久保進一 (北海道立水産孵化場)・工藤 智 (北海道立水産孵化場) (49-54)

Genetic and morphological characters of artificial hybrids between two species of pond smelt, *Hypomesus transpacificus* and *H.olidus*.

Shin-ichi Ohkubo and Satoshi Kudo

Artificial hybrids between two species of pond smelt, *Hypomesus transpacificus* and *H.olidus* were produced to clarify inheritances of meristic characters and isozyme patterns, and compare them with the hybrids identified by electrophoresis in Lake Ishikari-furukawa and Lake Toro. All of the artificial hybrids were heterozygous at the isozyme loci where allele substitutions were observed, and the isozyme patterns of the artificial hybrids were identical with them of the hybrids identified in the two lakes. In the artificial hybrids, the mean number of vertebrae and anal

rays correlated to them of the maternal species, while the mean number of pyloric caeca was intermediate. The pneumatic duct of the artificial hybrids attached slightly behind the anterior end of the air-bladder.

7, 池産サクラマス3倍体作製条件の検討

太田博巳 (北海道立水産孵化場)・神力義仁 (北海道立水産孵化場)・笠原 昇 (北海道立水産孵化場)・新谷康二 (北海道立水産孵化場)・小出展久 (北海道立水産孵化場)・岡田鳳二 (北海道立水産孵化場) (55-61)

Induction of triploidy by hydrostatic pressure or heat shocks in masu salmon, *Oncorhynchus masou*.

Hiroimi Ohta, Yoshihito Shinriki, Noboru Kasahara, Kouji Araya, Nobuhisa Koide and Houji Okada

Triploidy induction by application of a hydrostatic pressure or thermal shocks was attempted in masu salmon. The number of nucleoli in a cell was applied to the identification of the ploidy. Hydrostatic pressure of 700 or 750 kg · cm⁻² for 6 min from 10 to 20 min after fertilization (at 14°C) induced higher triploidy than those of 600 or 650 kg · cm⁻². The efficiency of this method was proved in the two times large-scale production (over 200,000 eggs, respectively) using a 800 ml pressure cell, which contains about 5,000 eggs, and an electromotive hydrostatic pressure (about 80% survival at the eyed-eggs stage and over 90% triploidy). Two steps heat-shocks (primary, 25°C-shock for 5 min after 5 min fertilization; secondary, consecutive 29°C-shock for 20 min) also achieved good results (81% survival and 95% triploidy).

8, サクラマスの生態学的研究 II. 古宇川に放流した池中継代サクラマスの降海行動について

小林美樹 (北海道立水産孵化場)・村上 豊 (北海道立水産孵化場)・岩見俊則 (現 北海道釧路支庁)・

岡田鳳二 (北海道立水産孵化場) (63-75)

Ecological studies of masu salmon (*Oncorhynchus masou*) II. Seaward migration of the progeny of pond cultured masu salmon released into the Furuu River.

Miki Kobayashi, Yutaka Murakami, Toshinori Iwami and Houji Okada

To study the smoltification and seaward movement of masu salmon (*Oncorhynchus masou*) in natural conditions, the following three salmon groups were released into the Furuu River from 1986 through 1989: hatchery-reared masu salmon fingerlings in spring from 1987 to 1989, masu salmon juveniles in fall from 1986 to 1989 in the exception of 1987, and masu salmon yearlings in spring from 1987 to 1988. Wild masu salmon captured from the river were also compared with the migratory behavior of the hatchery-reared stock. The onset of downstream migratory behavior in the stocked groups was, considerably later than that in the wild fish. Although the peaks of the wild fish in seaward migration in the years 1988 to 1990 were observed from early to middle May in each year, theirs peaks of the stocked groups in the years 1987 to 1990 appeared from middle to late June in each year. The average fork length of wild and stocked smolts captured were 12-13cm and 12-14cm, respectively. In the stocked groups, larger fish migrated before smaller fish migrated, while there was not such a tendency in wild stocks. Sex ratios were approximately 70% female and 30% male for the wild smolts, and 55% female and 45% male for the stocked smolts. The ratios were relatively constant during the observed years. Thus, the difference in the peaks of the seaward movement of wild and stocked fish remained unchanged in the duration of the observed years, and therefore suggesting that a certain genetic difference between wild and stocked fish have an influence on seaward migration.

9, アリザリン・コンプレクソンによるシシャモ卵の耳石標識

工藤 智（北海道立水産孵化場）・笠原 昇（北海道立水産孵化場）（77-80）

Marking of otoliths by alizarin complexon in eggs of Japanese longfin Smelt, *Sprinchus lanceolatus*.

Satoshi Kudo and Noboru Kasahara

This study was carried out to determine the optimum Alizarin complexon (ALC) concentration and treatment time for marking eggs of the Japanese Longfin Smelt, *Sprinchus lanceolatus*. Various combinations (33 lots) of ALC concentrations and treatment times were tested. Appropriate conditions of 100-500mg · l⁻¹ for 12-24 hrs were found to for marking the eggs. These results were strongly suggested to be applied to field surveys on the Japanese Longfin Smelt populations.

第46号（1992）

1, サクラマスおよびニジマスに対する IHN ウイルスのワクチン効果

鈴木邦夫（北海道立水産孵化場）・坂井勝信（北海道立水産孵化場）（1-8）

Efficacy of vaccination with IHN virus strains on masu salmon and rainbow trout.

Kunio Suzuki and D.K. Sakai

IHN (infectious hematopoietic necrosis) virus (IHNV) isolated from infected masu salmon (masu salmon isolates) and rainbow trout (rainbow trout isolates) induced low mortality rates in rainbow trout and masu salmon, respectively, while high mortality rates were produced in fish species challenged with IHNV isolated from the same species. To investigate the live vaccine of IHN in the combinations of masu salmon versus

rainbow trout isolates and rainbow trout versus masu salmon isolates, masu salmon fry (1.8 g) and rainbow trout fry (0.8 g) infected by immersion (2,000 PFU ml⁻¹, 10°C, 1hr) with the mutually different group of IHNV strains were challenged with immersion (2,000 PFU ml⁻¹) with masu salmon isolates and rainbow trout isolates, respectively. Survival rates of challenged fry increased from 37% (no vaccination as a control) to 50-70% in masu salmon fry, and from 34% to 46-63% in rainbow trout fry. Similar effects of vaccination (from 37% to 67-95%) were obtained in masu salmon juveniles (100 g) challenged by intraperitoneal injection (200PFUg⁻¹). No or only little viral neutralizing titer was detected in the infected masu salmon and rainbow trout juveniles (100-150 g) up to 120 days after the vaccination. Thus, considerable efficacy of live IHNV vaccine was observed in alternate combinations of fish species versus IHNV isolates.

2, サクラマス仔稚魚における耳石日周輪形成

西村 明（現 水産庁遠洋水産研究所）・畑山 誠（北海道立水産孵化場）（9-16）

Daily growth increments in the otolith of masu salmon, *Oncorhynchus masou*.

Akira Nishimura and Makoto Hatakeyama

The validity of the otolith microstructure for determination of the age in days was examined in larval and juvenile masu salmon, *Oncorhynchus masou*, by light microscopy. Rearing experiments of juvenile fish and time-marking experiments of juvenile fish showed that the first increment occurs at the embryonic stage of eye pigmentation, after which increments are formed on a daily basis. The hatching ring was recognized as broad dark ring. A linear relationship between the body length and the otolith length was observed for hatched larval and juvenile fish. Otolith growth increments were also observed in the otoliths of wild adult masu salmon collected in the sea, and

the possibility is suggested that the otolith microstructure can be utilized as an information source of ecological events in the early life history of wild populations of masu salmon.

3, 海水馴致処理を経たサケの回帰

小島 博（北海道立水産孵化場）・新谷康二（北海道立水産孵化場）・山下幸悦（北海道立水産孵化場）・佐々木義隆（北海道立水産孵化場）・宮本真人（北海道立水産孵化場）・黒川忠栄（養殖研究所）・松原貞夫（えりも町漁業協同組合）・岩田宗彦（養殖研究所日光支所）（17-22）

Returns of adult chum salmon, *Oncorhynchus keta*, in relation to preacclimation to isotonic environment.

Hiroshi Kojima, Kouji Araya, Kouetsu Yamashita, Yoshitaka Sasaki, Mahito Miyamoto, Tadahide Kurokawa, Sadao Matsubara, and Munehico Iwata

Effects of preacclimation of chum salmon, *Oncorhynchus keta*, fry to an isotonic environment on the return of adults were investigated in Hokkaido, Japan. One hundred thousand marked chum salmon fry were acclimated to one-third seawater for 8 hours and then released into Utabetu River in the evening on May 22, 1986 (1985-year-class) and 1987 (1986-year-class). One hundred thousand marked control fish were released at the same time in both years. Twenty-nine marked fry were recaptured with round haul nets and stationary nets in coastal waters within 35 days after the release. The number of recaptured fry of the preacclimated group was almost equivalent to that of the control group. However, the numbers of return adults from the preacclimated group were significantly greater than those from the control ($P < 0.05$). In 1989, 66 marked adults of the 1985-year-class were captured in Utabetu River from September to November, and 107 marked adults of 107 fish of the 1985-year-class and 190 fish of the 1986-year-class were captured in 1990. The ratios of the

preacclimation group to the control in the returning adults of the 1985-year-class were 58 to 42 in 1989 and 59 to 41 in 1990, respectively. The ratio of the preacclimation group to the control in the 1986-year-class was 56 to 44 in 1990. There was no significant difference in the size of returning adults between the preacclimation and the control groups. The present results suggest that the preacclimation of chum salmon fry with diluted seawater produces an increase of about 30% in the number of returning adults.

4, 池中継代飼育サクラマス幼魚の放流後の分散と成長
大森 始（北海道立水産孵化場）・岩見俊則（現 北海道釧路支庁）・小島 博（北海道立水産孵化場）（23-29）

Performance of dispersion and growth of bloodstock hatchery-reared underyearling masu salmon (*Oncorhynchus masou*) released in Masuhoro River. Hajime Ohmori, Toshinori Iwami, and Hiroshi Kojima

Bloodstock (Mori-group) and wildstock (Shiribetsu-group) hatchery-reared underyearling masu salmon (*Oncorhynchus masou*) were released into Masuhoro River on May 29, 1989 and 1990 to estimate the differences in their dispersion and growth patterns. The fork length of the Mori and the Shiribetsu at the release time in 1989 was 6.6 and 5.9 cm respectively. In 1990, it was 5.3 and 5.5 cm, respectively. The Shiribetsu spread their habitat extensively within 15 days after release, and downstream migration was superior to upstream in 1989 and 1990. The Mori failed to make their habitat extensive, and most of the Mori fish migrated upstream. In 1990, although there was no significant difference in the initial size between the Mori and the Shiribetsu, the two groups showed similar tendencies to the previous year. The Mori grew from 6.6 to 7.4 cm in a mean fork length for 60 days, while the Shiribetsu grew from 5.9 to 6.9 cm in 1989. In 1990, the increment in the mean fork length of the

Mori was smaller than that of the Shiribetsu, and there was a significant difference in the mean fork length 43 days after the release. The relative growth rate of the Mori was lower than the Shiribetsu in 1989 and 1990. This suggests that long-term bloodstock hatchery-reared masu salmon lose the perfect performance of dispersion and growth in river.

5, ウグイ属魚類3種の顎骨と懸垂骨について

内藤一明 (31-34)

Jaws and suspensorium in three *Tribolodon* Species (Cyprinidae).

Kazuaki Naito (Hokkaido Fish Hatchery)

The jaws and suspensorium in three *Tribolodon* species are described. The results of comparative osteology are relatively uniform except for following two characters, presence or absence of the process of the hyomandibular and angle of the anterior suspensorium. In these two characters, *T.brandti* and *T.ezoe* share the same character states. The significance of the two characters is considered from morphological and functional viewpoints.

6, (短報) 温度処理によるニジマスの第1卵割阻止条件の検討

太田博巳 (北海道立水産孵化場)・神力義仁 (北海道立水産孵化場) (35-37)

(Short paper) Induction of tetraploidy by two-step heat shock in rainbow trout, *Oncorhynchus mykiss*. Hiromi Ohta and Yoshihito Shinriki.

Tetraploidy induction by suppression of the 1st cleavage of the egg was attempted in rainbow trout. Eggs were fertilized with normal spermatozoa and maintained in 8.3-8.5°C water. Three different temperatures of two-step heat shock (primary, 20°C-shock for 5 min; secondary, consecutive 25, 27, or 29°C shock for 25 min) were applied at 5°C-h (in cumulative temperature) intervals from 35 to 70°C-h after fertilization. A significant decrease in

survival rate at the eyed stage was observed when 25 or 27°C shock were initiated 40-55°C-h after fertilization. The 27°C shock initiated at 55°C-h and 70°C-h induced high rates of tetraploidy (24.0% and 21.1%, respectively). The 29°C shock resulted in 0% survival irrespective of the timing of the shocks. The results showed that the two-step heat shock, treatment of 20°C for 5 min followed by 27°C for consecutive 25 min initiated at 55°C-h after fertilization, induced suppression of the 1st cleavage of the rainbow trout eggs.

7, (短報) 遊楽部川の遺伝的組成が異なるサクラマス幼魚集団について

大久保進一 (北海道立水産孵化場) (39-42)

(Short paper) Genetic Differentiation of Juvenile Masu Salmon (*Oncorhynchus masou*) in the Yurappu River.

Shin-ichi Ohkubo

Genetic relationships among tributary populations of juvenile masu salmon, *Oncorhynchus masou*, in the Yurappu River were investigated by starch gel electrophoresis. A clear difference in allele frequencies was observed at the *PGM-1** locus between the Saranbe River population and other tributary populations. The genetic distance between tributary populations calculated from the allele frequencies at 29 loci indicates that the Saranbe River population is distinct from the other tributary populations. This suggests that there are two genetically different populations of juvenile masu salmon in the Yurappu River.

第47号 (1993)

1, 海洋生活期のサクラマスから見出された淡水産二生吸虫 *Dimerosaccus oncorhynchi* (Opecoelidae) について

島津 武・粟倉輝彦 (1-5)

Occurrence of a freshwater digenean, *Dimerosaccus oncorhynchi* (Opecoelidae), in masu salmon (*Oncorhynchus masou masou*) caught at sea.

Takeshi Shimazu (Nagano Prefectural College) and Teruhiko Awakura (Hokkaido Fish Hatchery)

The digenetic trematode previously reported by Awakura (1989) as *Allocreadium* sp. from the digestive tract of juvenile and maturing masu salmon (*Oncorhynchus masou masou*) taken from the Sea of Japan off central Honshu and northern Hokkaido and Sea of Okhotsk off northern Hokkaido, Japan, proved to be the adult of a freshwater species, *Dimerosaccus oncorhynchi* (Eguchi, 1931) Shimazu, 1980 (Opecoelidae: Plagioporinae). It is described and figured. Its origin and usefulness as a potential natural tag for ecological studies on masu salmon in the sea are briefly discussed.

2, 北海道増毛沿岸域 (北部日本海) におけるサケ稚魚放流期のプランクトン環境

浅見大樹 (北海道立水産孵化場) ・平野和夫 (現 北海道立中央水産試験場) (7-14)

Plankton environment during the release of juvenile chum salmon, *Oncorhynchus keta*, into the coastal area off Mashike, Japan Sea, northern Hokkaido.

Hiroki Asami and Kazuo Hirano

Plankton and its environment were investigated during the release of chum salmon, *Oncorhynchus keta*, from 1990 to 1992 into a shallow coastal area of northern Hokkaido, Japan Sea. Water

temperature increased from March to May, and water specific gravity dropped sharply between late March and early April of all three years. This would suggest water inflow from terrestrial area. In 1990, water temperature from February to March was higher ($>5^{\circ}\text{C}$) and the period of low water specific gravity (<25.0) shorter than in 1991 or 1992. Phytoplankton biomass (chlorophyll a) remained between $0.1-2.0 \mu\text{g l}^{-1}$ during three years and the timing of the peaks was associated with the supply of nutrients brought by the inflow of terrestrial water. Total zooplankton density fluctuated between 10 to 2600 inds. m^{-3} from 1990 to 1992. Harpacticoid copepods (mainly *Harpacticus uniremis*), an important prey of juvenile chum salmon, were predominant in 1991 and 1992 but very low level in 1990. This may have been due to the high temperature and weak influence of terrestrial water in 1990.

3, 仁雁別川におけるカラフトマス稚魚の降海行動

佐々木義隆 (北海道立水産孵化場) ・山下幸悦 (北海道立水産孵化場) ・中島幹二 (北海道立栽培漁業総合センター) (15-20)

Downstream migratory behavior in wild pink salmon in Nikanbetsu River.

Yoshitaka Sasaki, Kouetsu Yamashita and Kanji Nakajima

Downstream migratory behavior in the wild pink salmon, *Oncorhynchus gorbusha*, in relation to environmental factors was investigated in 1988 and 1989 at Nikanbetsu River, located in southern Hokkaido. The numbers of descending fry caught at the mouth of the river with a fish trap showed downstream migratory behavior from late April to late May of both years. Water temperature of the river started to rise during this period. No differences in range and mean of body weight could be found among fry caught from late April to late May. Most of the descending fry was caught from dusk (6:00 p.m.) to early

morning (8:00 a.m.). Particularly the large numbers of the fry were caught at night just after the rise of the amount of flowing water caused by rainfall and melted snow. The result suggest that volume of flowing water in addition to water temperature and darkness are important environmental factors for the onset of downstream migration in wild pink salmon.

4, 成長に伴うカラフトマス卵および仔, 稚魚の海水適応能の発達と脂質クラス成分の変化

笠原 昇 (北海道立水産孵化場) ・佐々木義隆 (北海道立水産孵化場) ・李 培翼 (東京水産大学) ・中野 広 (中央水産研究所) (21-26)

Changes in sea water adaptability and lipid class content during early development of pink salmon *Oncorhynchus gorbuscha* (Walbaum).

Noboru Kasahara, Yoshitaka Sasaki, Baeik Lee and Hiroshi Nakano

Changes in lipid and water content in the body following transfer from fresh to sea water were measured during egg and larval stages of the pink salmon, *Oncorhynchus gorbuscha*. Water content after transfer to sea water decreased before absorption of yolk. But after this absorption, water content after transfer did not decrease. The fish lived for 48 hours after transfer. Triglyceride content decreased rapidly after hatching, and when swimming and feeding first started, it increased accompanied by decrease in phospholipid content. Triglyceride content increased after absorption of the yolk to a body size of about 40mm. Phospholipid content increased for a while after absorption and continued to do so at the same rate. Free fatty acid content increased at the start of swimming and absorption of the yolk, and increased with growth. Based on these results, We could be estimated that the acquirement of osmoregulation of pink salmon was concerned with changes in lipid class content and the smoltification started in a body size of about

30mm.

5, (短報) 北海道の神恵内沿岸で漁獲されたサクラマスの遺伝的組成について

大久保進一 (北海道立水産孵化場) ・小林美樹 (北海道立水産孵化場) (27-31)

(Short paper) Allele frequencies of masu salmon (*Oncorhynchus masou masou*) collected from the Kamoenai area, Hokkaido.

Shin-ichi Ohkubo and Miki Kobayashi

Masu salmon, *Oncorhynchus masou*, from the Kamoenai area in Hokkaido were analyzed by starch gel electrophoresis. Allele frequencies at the *PGM-1** locus of samples collected in December, 1987 and 1988, were significantly lower than in river populations of Hokkaido. It would thus appear that some populations of masu salmon that migrate to the Kamoenai area in December are distinct from those originating in Hokkaido.

第48号 (1994)

特集：北海道における淡水魚類の寄生虫と疾病に関する研究の進歩

Special issue: Recent advances in research on parasites and diseases of freshwater fishes in Hokkaido.

1, まえがき (Preface)

Leo Margolis (1-2)

2, 北海道における魚病研究の歴史

木村喬久 (3-10)

History of fish pathology in Hokkaido.

Takahisa Kimura (Laboratory of Microbiology, Faculty of Fisheries, Hokkaido University)

Fish disease research at Hokkaido was initiated at the beginning of this century by Dr. T.

Fujita. His research subject was principally fish parasitology, and he was a pioneer of this field in Japan. In 1937, he published the first textbook of "Fish Pathology" in Japanese. Fish disease research, including microbial diseases, was continued by Dr. S. Takeda. Unfortunately research of this field was interrupted during World War II. But in 1963, Kimura and his colleagues reinitiated research in this field and work was principally on bacterial and viral fish diseases. The activities increased continually until the present. Now, staffs at Laboratory of Microbiology, Faculty of Fisheries, Hokkaido University, and Fish Diseases Prevention Section, Hokkaido Fish Hatchery, and Fish Disease Laboratory, Hokkaido Salmon Hatchery are continuing the fish disease researches. In this paper, history of fish pathology, especially bacterial and viral fish disease, in Hokkaido were introduced.

3, 北海道における淡水魚類の寄生虫学の歴史的概観 粟倉輝彦 (11-14)

Historical review of parasitology of freshwater fishes in Hokkaido.

Teruhiko Awakura (Hokkaido Fish Hatchery)

Hokkaido is the principal site of producing Pacific salmon (*Oncorhynchus* spp.) in Japan. Salmonids and other freshwater fishes are released into lakes and rivers, and pond culture of freshwater fishes is conducted. On the basis of such a background, fish parasitology has a long history in Hokkaido and research has focused on the parasites of salmonids. In 1889, the first paper on parasites of freshwater fishes was published by Professor Isao Ijima of the University of Tokyo. From 1904 to 1941, Professor Tsunenobu Fujita of the Hokkaido University published many papers on myxozoan and helminth parasites from fishes of Hokkaido and nearby oceanic waters. He published "Fish Pathology", the first textbook in this scientific field in Japan. From

the 1950's to the present, a number of papers dealing with parasites of freshwater fishes have been published in Hokkaido. Although much information has been accumulated, many problems still remain unsolved: taxonomic problems still exist and the life cycles and transmission of many parasites are to be worked out with involvement of freshwater fishes. The author hopes that young researchers solve those problems in the near future.

4, 北海道における淡水魚のウイルス病 吉水 守 (15-24)

Viral diseases of freshwater fishes in Hokkaido. Mamoru Yoshimizu (Laboratory of Microbiology, Faculty of Fisheries, Hokkaido University)

Infectious hematopoietic necrosis virus (IHNV) and infectious pancreatic necrosis virus (IPNV) were isolated in 1971 and 1972 in Hokkaido, Japan. Since then, three new viruses have been isolated in Hokkaido. These included the *Oncorhynchus* masou virus (OMV), chum salmon virus (CSV), and retrolike virus of salmonids (RLVS). The causative agent of viral erythrocytic necrosis (VEN) was observed by electron microscopy. IHN and OMV infection of rainbow trout are major problems and cause economic losses in Hokkaido. No viral disease was reported in other freshwater fishes and no virus was isolated from other freshwater fishes.

5, サケマス類補体の個体発生とその非特異的ウイルス感染防御活性

坂井勝信・鈴木邦夫・粟倉輝彦 (25-31)

Ontogenesis of salmonid complement and its nonspecific defense to viral infections.

D.K. Sakai (Hokkaido Fish Hatchery), Kunio Suzuki (Hokkaido Fish Hatchery), and Teruhiko Awakura (Hokkaido Fish Hatchery)

The incidence of viral diseases from 1976

through 1984 in Hokkaido, was investigated in fish farms and hatcheries of rainbow trout, coho salmon, chum salmon, masu salmon and/or sockeye salmon. Infectious hematopoietic necrosis (IHN) virus was isolated from 33 out of 201 fish farms. Infectious pancreatic necrosis (IPN) virus was isolated from 3 farms. The viruses were detected exclusively from fry and coelomic fluid (of matured fish). Juveniles and adults resulted in no virus detection. Chum salmon fry had no virus. The results showed a difference in the defense of fish to the viruses. Complement activity first appeared on 5 and 6 months after hatching in sera of masu salmon and rainbow trout fry, respectively. Three-month-old chum salmon fry already had a high complement activity, comparable to that of the juveniles. The coelomic fluid of those matured fish had no complement activity, though the serum showed a high complement activity. Serum from juveniles and adults showing high complement titers had an antiviral action especially to IHN virus. In the experimental IHN and IPN virus infections, chum salmon fry having high complement activity showed low mortality. Rainbow trout and masu salmon fry having no complement activity were high mortalities. The results indicate that complement have an antiviral action involved in the nonspecific defense mechanisms of salmonid fish.

6, 伝染性造血器壊死症 (IHN) : サケ科魚類における病毒性と種特異性に関する総説
鈴木邦夫 (33-37)

Infectious hematopoietic necrosis (IHN): an overview of virulence and species specificity in salmonids .

Kunio Suzuki (Hokkaido Fish Hatchery)

Infectious hematopoietic necrosis (IHN) was considered to be a disease of salmonid fry and early juveniles. Recently, outbreaks of IHN in larger fishes and high host-specificities of IHN

virus strains have been reported in Japan and USA. However, mechanisms of different virulence of virus strains dependent on fish size and host fish species are not completely understood. The different virulence of IHN virus strains, susceptibility of virus strains to defense mechanisms of fish and development of live vaccine were reviewed.

7, 北海道における淡水魚の細菌性疾病
野村哲一 (39-46)

Bacterial diseases of freshwater fishes of Hokkaido.

Tetsuichi Nomura (Research Division, Hokkaido Salmon Hatchery, Fisheries Agency)

There are some excellent reviews of diseases occurred in Hokkaido and in these reviews, soft egg disease (or soft shell disease), furunculosis, bacterial gill disease and bacterial kidney disease were recorded as the bacterial diseases occurring in freshwater fishes in Hokkaido. In this report, the author wants to make a review only about the etiological conditions in these four diseases: soft egg disease, furunculosis, bacterial kidney disease and bacterial gill disease. Soft egg disease was the oldest disease reported in Hokkaido and many reports pointed out that the disease was bacterial disease. Many reports of furunculosis were published and etiological condition of the diseases was revealed by these reports. BKD is serious disease in Hokkaido, because the disease is distributed widely and there is no effective control method now.

8, 北海道における淡水魚類の原虫病
浦和茂彦・粟倉輝彦 (47-58)

Protozoan diseases of freshwater fishes in Hokkaido
Shigehiko Urawa (Research Division, Hokkaido Salmon Hatchery, Fisheries Agency of Japan) and Teruhiko Awakura (Hokkaido Fish Hatchery)

Twenty-nine species of parasitic protozoans (2 flagellates, 1 apicomplexan, 4 microsporidia, 17 myxosporidia, and 5 ciliates) have been found in freshwater fishes of Hokkaido, northern Japan. These species include important disease agents of cultured and wild fishes, such as *Ichthyobodo necator*, *Microsporidium takedai*, *Chilodonella piscicola*, and *Trichodina truttae*. This paper provides biological information on the life history, pathogenicity, and control of protozoans infecting freshwater fishes in Hokkaido.

9, 北海道の淡水魚類に寄生する単生類
小川和夫 (59-67)

Monogenean parasites of freshwater fishes of Hokkaido, Japan.

Kazuo Ogawa (Department of Fisheries, Faculty of Agriculture, the University of Tokyo)

Eleven identified and more than three unidentified monogeneans parasitic on freshwater fishes of Hokkaido, Japan have been reported, including four species, viz. *Ancyrocephalus cruciatus*, *Tetraonchus alaskensis*, *Gyrodactylus longoacuminatus* and *G. micracanthus*, first reported from Japanese fishes in this paper. The number of unidentified species of *Gyrodactylus* from six species of fishes could not be determined, and are listed as *Gyrodactylus* spp. *Oncorhynchus nerka* is a new host for *Gyrodactylus masu*.

10, 北海道産淡水魚に寄生する成虫期二生吸虫 (総説)
島津 武 (69-78)

Adult digenetic trematodes parasitic in freshwater fishes of Hokkaido, Japan: a review.

Takeshi Shimazu (Nagano Prefectural College)

Freshwater species of adult digenetic trematodes known from freshwater fishes in Hokkaido, Japan, are classified into 13 named species (11 valid and 2 questionable) and 1 unidentified species in 6 genera. These genera plus 1 additional species of

an undetermined genus belong to 4 families. They are listed with their figures and the published and unpublished information on their synonyms, locations, hosts, localities, and records. A key to these species is given. Possible future studies of the adult digenetic trematodes of freshwater fishes in Hokkaido are discussed. A host-parasite list is attached.

11, 北海道の淡水魚に寄生する条虫類
粟倉輝彦 (79-82)

Cestodes of freshwater fishes of Hokkaido.

Teruhiko Awakura (Hokkaido Fish Hatchery)

Ten named species and 11 or more species that were not identified to the species level have been reported from freshwater fishes of Hokkaido. This note is intended to summarize information on the Cestoidea of freshwater fishes and particularly on *Diphyllobothrium nihonkaiense* and *Digramma interrupta* in Hokkaido.

12, 北海道の淡水魚類に寄生するカイアシ類とエラオ類
長澤和也 (83-85)

Parasitic copepoda and branchiura of freshwater fishes of Hokkaido.

Kazuya Nagasawa (National Research Institute of Far Seas Fisheries, Fisheries Agency of Japan)

Eight species of parasitic crustaceans (seven Copepoda and one Branchiura) have been reported from freshwater fishes of Hokkaido. Information on the hosts, distribution, and pathogenicity is given for individual species. Research to elucidate the fauna of freshwater parasitic crustaceans in this island is needed for biogeographical comparison between Far Eastern Russia, Honshu, and Hokkaido.

13, (短報) アメマス, サケ幼魚およびウグイから得られたサケジラミ
長澤和也・鷹見達也・村上 豊 (95-97)

(Short paper) *Pheirus salmonis* (Copepoda: Caligidae) from white-spotted charr (*Salvelinus leucomaenis*), juvenile chum salmon (*Oncorhynchus keta*), and Japanese dace (*Tribolodon hakonensis*) from northern Japan.

Kazuya Nagasawa (National Research Institute of Far Seas Fisheries, Fisheries Agency of Japan), Tatsuya Takami (Hokkaido Fish Hatchery, Makkari Branch) and Yutaka Murakami (Hokkaido Fish Hatchery, Makkari Branch)

The salmon louse (*Lepeophtheirus salmonis*) was found on the body surface of white-spotted charr (*Salvelinus leucomaenis*) and Japanese dace (*Tribolodon hakonensis*) caught in the Furuu River, western Hokkaido, Japan. These findings of *L. salmonis* constitute new host records. *Lepeophtheirus salmonis* was also found on the body surface of juvenile chum salmon (*Oncorhynchus keta*) caught in the western North Pacific Ocean off the east coast of Aomori Prefecture, Japan. This is the first record of *L. salmonis* infection of Japanese salmonid juveniles in their early ocean life-history stage.

14, (短報) 海水馴致放流した1+サクラマス近郊河川への遡上

内藤一明 (北海道立水産孵化場) (99-100)

(Short paper) Upstream migration of 1+ masu salmon (*Oncorhynchus masou*) released in coastal waters.

Kazuaki Naito

Two coastally released masu salmon (*Oncorhynchus masou*) were recaptured in the river adjacent to the release point 110 days after release. The two fish were both male. One had matured, and the other had not. Although the actual process is unclear, the upstream migration of coastally released masu salmon is noteworthy.

第49号 (1995)

1, 池産系, 尻別川系サクラマス及びその交雑魚の降海時期

小山達也 (北海道立水産孵化場) ・永田光博 (北海道立水産孵化場) (1-7)

Seaward migration of domestic, wild origin and interstrain hybrids of masu salmon (*Oncorhynchus masou*).

Tatsuya Koyama and Mitsuhiro Nagata

Masu salmon (*Oncorhynchus masou*) juveniles from domestic, wild strains and their interstrain hybrids with different fin-clippings were released into the Kokamotsu River of southwestern Hokkaido in spring 1988 and/or 1989 to compare the timing of seaward migration among them. Domestic masu salmon were the progeny of successive generations of domestication at the Mori branch of the Hokkaido Fish Hatchery. The origin of this strain mainly came from the Tohero River of easternmost Hokkaido in the 1960's. Wild masu salmon originated from spawners in the Shiribetsu River, which is about 150 km straight north of the Kokamotsu River. Interstrain hybrids were obtained from a cross between Mori domestic females and Shiribetsu wild males. The released fish smolted and migrated to the sea the following spring. The peak of seaward migration of wild smolts as well as Kokamotsu native smolts was from late April to early May. In contrast, the peak of domestic smolts was from early to middle June, one month later than those of wild and native smolts. Most hybrids migrated from middle to late May, between the migration of domestic and wild strains. The results suggest that the timing of seaward migration of masu salmon from the river is mainly controlled by a genetic factor.

2, サクラマスの海洋生活初期における生態研究 1. えりも沿岸における回遊時期と体長組成から見た分布

特性

隼野寛史（北海道立水産孵化場）（8-16）

Early life ecology of masu salmon (*Oncorhynchus masou*) in marine environments. 1. Migration and distribution in the coastal waters of Erimo, Hokkaido, Japan.

Hirofumi Hayano

Juvenile masu salmon (*Oncorhynchus masou*) were collected by set nets to investigate migration and distribution in the coastal areas of Erimo in spring, 1994. Juvenile masu salmon appeared in mid-May when the water temperature rose to 5°C. The number of captured juveniles reached a peak from late May to early June at water temperatures of 8~12°C, and then gradually decreased till late July when the water temperature rose to more than 14°C. The appearance of juveniles was thought to be intensively dependent upon water temperature. Frequency distributions of fork lengths of juveniles could be divided into large, middle and small size groups by a probability graph paper method. It was found that smaller juvenile masu salmon were distributed near the shore, while larger juveniles migrated offshore within 300-2500m. The results, therefore, suggests that the difference in the distribution of juveniles is associated with their body sizes. From loading identification marker tags, it was found that caught juvenile masu salmon mixedly included fish released from different regions (Japan sea, Pacific Ocean of Honshu, and the South Pacific coast of Hokkaido).

3, 北海道能取湖における植物プランクトンと栄養塩の周年サイクル

浅見大樹（北海道立水産孵化場）・今田和史（北海道立水産孵化場）・安富亮平（北海道立水産孵化場）・伊沢敏穂（北海道立水産孵化場）（17-23）

Seasonal cycles of phytoplankton and nutrients in Lake Notoro, eastern Hokkaido, Japan.

Hiroki Asami, Kazushi Imada, Ryohei Yasutomi

and Toshio Izawa

Lake Notoro, located in eastern Hokkaido, is important for Hokkaido inland fisheries. Seasonal cycles of phytoplankton associated with physical and chemical environments were studied from May 1991 to April 1992. Phytoplankton spring blooms composed of diatoms were observed under the surface layer of less saline water (<32.4) after ice covered periods, however, completely terminated in early summer. Nutrient conditions (N/P ratio) under ice and nitrate concentrations in spring may play important roles in the spring blooms. The occurrence of Dinoflagellatae blooms (predominant *Prorocentrum* spp.), corresponding with the inflow of high saline water (>33.4) originating from the warm Soya sea current, was found from summer to autumn. When water temperatures dropped and silicate concentrations increased in late autumn, silicoflagellates (mainly *Distephanus speculus*) began to grow and reached a maximum in early winter, in spite of low cell density (10^4 cells m^{-3}) in comparison with diatoms and dinoflagellate blooms (10^6 cells m^{-3}). Thus phytoplankton successions were thought to be intensively dependent on nutritional and physical environment factors in Lake Notoro.

4, 網走市4湖沼（網走湖，能取湖，涛沸湖、藻琴湖）の水質環境の特徴

安富亮平（北海道立水産孵化場）・今田和史（北海道立水産孵化場）・伊沢敏穂（北海道立水産孵化場）・坂崎繁樹（網走市水産化学センター）・川尻敏文（西網走漁業協同組合）・小林耕一（網走漁業協同組合）（25-36）

Chemical characteristics of four brackish lakes in Abashiri, northern Hokkaido.

Ryohei Yasutomi, Kazushi Imada, Toshio Izawa, Shigeki Sakazaki, Toshifumi Kawajiri, and Kouichi Kobayashi

There are four different types of lakes in

Abashiri City. We attempted to make a comparison between lake types and water quality in 1991. Lake Notoro was oligotrophic and had stable saline conditions. On the other hand, Lake Abashiri, Lake Tofutsu and Lake Mokoto were eutrophic and had irregular and variable salinity and water qualities. Chemical parameters in these lakes were affected by their influx, especially humic acid. COD correlated to the optical density of ultraviolet absorption at 220 nm and 240 nm ($p < 0.001$). The river water flowing into the lake water also influenced the water quality and inflow of nutrients, for example, nitrate, phosphate and silicate. In Lake Notoro, the blooming of phytoplankton in early spring was caused by these influent nutrients that were accumulated under the ice. In 1991, from summer to autumn, we found photosynthetic bacteria, one of the chlorobiaceae, in Lake Abashiri at the boundary of the low saline and high saline layers. This bacterial layer broke the upward diffusion of high concentration of phosphate in saline water. The N/P ratio, estimated from total nitrate and total phosphates, varied in a wide range. The ratios in Lake Notoro were almost constant between 3 to 10, but those of the other lakes alternated from 2 to 100. From the results, Lake Notoro had constant biological production but the others did not. The investigation suggested that horizontal diffusion and water conditions are very important in these blackish lakes.

5, 網走市4湖沼（網走湖，能取湖，涛沸湖、藻琴湖）の湖盆形態と塩分環境

今田和史（北海道立水産孵化場）・坂崎繁樹（網走市水産化学センター）・川尻敏文（西網走漁業協同組合）・小林耕一（網走漁業協同組合）（37-48）

Lake basin and saline environments profiles of four brackish lakes in Abashiri, northern Hokkaido.

Kazushi Imada, Sigeki Sakazaki, Toshifumi Kawajiri and Kouichi Kobayashi

Abashiri City, Northern Hokkaido of Japan, has four brackish lakes producing a lot of commercial scallop, pond smelt and oyster. Lake Notoro, Lake Abashiri, Lake Tofutsu and Lake Mokoto are covered with ice from December to early April every year. Their surface areas are 58.5, 32.9, 8.0 and 1.1 km² respectively. They also have wide drainage areas. The ratios of their drainage areas to their surface areas are 4, 43, 16 and 164 times, respectively. These lakes have different salinities caused by the width of the drainage area. Lake Notoro had a constant salinity of 33 from summer to autumn, but in winter and early spring the surface layer under the ice was less than 30.3 to 31.5 because of dilution by the inflow of river water. Lake Abashiri had two separated layers. The surface layer (0 to 5 m) showed low salinity of 2 to 3, and the bottom layer (5 to bottom) maintained a high saline level (about 20) in all seasons. This high saline layer, about 45% of the lake volume, did not contain dissolved oxygen. This stable layer had an influence on the water quality of the upper layer. In Lake Tofutsu and Lake Mokoto, the salinity of surface water varied widely from 0.1 to 30. In winter, river water produced a very thin layer under the ice, whereas at the bottom of Lake Mokoto salinity was constantly about 32. The residential time of Lake Notoro was 3.4 years long, while Lake Abashiri, Lake Tofutsu and Lake Mokoto were only 0.1 or 0.2 year. Lake Notoro was oligotrophic but the other lakes were eutrophic. Therefore, the drainage area of these lakes correspondingly affected their salinity and water quality resulting in the changes in fishery production.

6, 阿寒パンケ湖の生物生産過程に関する研究 (1) 湖沼環境条件の変化

安富亮平（北海道立水産孵化場）・今田和史（北海道立水産孵化場）・川村洋司（北海道立水産孵化場）・

伊澤敏穂（北海道立水産孵化場）・有末二郎（北海道環境科学センター）・日野修次（北海道環境科学センター）・三上英敏（北海道環境科学センター）（49-57）

Process of biological productivity in oligotrophic Lake Akan-Panke, Hokkaido Japan. (1) Comparison of physical and nutrient factors of the lake environment.

Ryohei Yasutomi, Kazushi Imada, Hiroshi Kawamura, Toshio Izawa, Jiro Arisue, Shuji Hino and Hidetoshi Mikami

The process of a biological productivity in oligotrophic Lake Akan-Panke was studied from May 1992 to March 1994 to clarify the high catch efficiency of kokanee salmon in this lake. The characteristics of Lake Akan-Panke were estimated by physical and nutrient factors, and were compared with those of Lakes Toya and Shikotsu from a view point of biological and fishery productivity. As concentrations of nutrients (nitrogen and phosphorus), COD (chemical oxygen demand), and dissolved oxygen, and the pH value did not vary as compared with the literature of previous data of Lake Akan-Panke, the oligotrophic state of the lake was maintained the same as the past natural and water environments. However, the results did not support the high catch efficiency of adult kokanee salmon in Lake Akan-Panke, and differed from Lakes Toya and Shikotsu. To clarify the high productivity of the oligotrophic lakes, it is necessary to study the metabolism of organic and inorganic matter, and the ecosystem of microorganisms maintained in the lakes.

7, (短報) オホーツク海沖合で初記録された標識サクラマス

内藤一明・上野康弘 (59-62)

(Short Paper) The first recovery of tagged masu salmon (*Oncorhynchus masou*) in waters offshore of The Sea of Okhotsk.

Kazuaki Naito (Hokkaido Fish Hatchery) and

Yasuhiro Ueno (National Research Institute of Far Seas Fisheries)

A tagged domestic masu salmon released from southwestern Hokkaido was recovered from waters offshore of the Sea of Okhotsk. This paper is the first record of the masu salmon in the area that originated in Japan.

8, (短報) 天然サクラマスモルトの標識放流結果について

宮腰靖之（北海道立水産孵化場）・大久保進一（北海道立水産孵化場）・神力義仁（北海道立水産孵化場）・鈴木研一（北海道立水産孵化場）（63-65）

Recovery of wild masu salmon, *Oncorhynchus masou*, by tagging experiment.

Yasuyuki Miyakoshi, Shin-ichi Ohkubo, Yoshihito Shinriki, and Ken-ichi T. Suzuki

Tagging experiment of wild masu salmon smolts was performed in the Shokanbetsu River and Nobusha River, northwestern Hokkaido. During May and June of 1993, wild masu salmon smolts in the downstream run were captured by cast nets, tagged on the base of the dorsal fin using ribbon tags, clipped in the adipose fin, and released. 1,259 smolts were released during the course of this study. In the following year 28 tagged masu salmon were recaptured in the coastal waters of Hokkaido and in their natal rivers. The recovery rate of tagged fish was 2.2%.

9, (短報) 北海道南西部日本海沿岸域における春季の動物プランクトンとサケ稚魚の食性

三坂尚行（北海道立水産孵化場）・内藤一明（北海道立水産孵化場）（67-68）

(Short paper) Notes on zooplankton and feeding habits of juvenile chum salmon (*Oncorhynchus keta*) in the Japan Sea coast of southwestern Hokkaido.

Naoyuki Misaka and Kazuaki Naito

Feeding habits of released chum salmon (*Oncorhynchus keta*) juveniles and the occurrence of coastal zooplankton were investigated along the coast of Taisei, the Japan Sea coast of southwestern Hokkaido in 1994. Most of the zooplankton were copepods in the coastal water. The number of copepods increased from early April, reached a peak in the middle April, and quickly decreased. When the number of zooplankton from the stomach were counted using chum salmon juveniles captured at the Ainumanai Fishery Port, Kumaishi, about 18km southeast of Taisei, copepods and polychaetes were predominant, which differed from the composition of coastal zooplankton.

第50号 (1996)

1, 北海道北部増幌川におけるサクラマスモルトの
個体数推定 —1995年の降河尾数について—

James R. Irvine・宮腰靖之・隼野寛史・藤原 真・
杉若圭一・宮本真人・永田光博 (1-16)

Assessment of hatchery origin and wild masu
salmon (*Oncorhynchus masou*) smolts in the
Masuhoro River, 1995.

James R. Irvine (Fisheries and Oceans, Pacific
Biological Station), Yasuyuki Miyakoshi
(Hokkaido Fish Hatchery), Hirofumi Hayano
(Hokkaido Fish Hatchery), Makoto Fujiwara
(Hokkaido Fish Hatchery), Kei-ichi Sugiwaka
(Hokkaido Fish Hatchery), Mahito Miyamoto
(Hokkaido Fish Hatchery), and Mitsuhiro Nagata
(Hokkaido Fish Hatchery)

In the fall of 1994, juvenile masu salmon were stocked in the Masuhoro River in northern Hokkaido. In the spring of 1995, a mark-recapture study was undertaken to estimate the numbers of surviving hatchery origin and wild masu salmon smolts. A partial fence was installed in the Masuhoro River a short distance above the Soya Branch Hatchery to catch fish for

marking. To sample migrating smolts below the partial fence, a rotary screw trap was operated 14.8km downstream. Population estimates were generated using the statistical package SPAS (Stratified Population Analysis System) described by Arnason et al. (1996). Maximum likelihood estimates of the total number of smolts, the number of wild smolts, and the number of hatchery origin smolts (95% confidence intervals in brackets) were 32,837 (19,327, 46,347), 49,369 (23,865, 74,872), and 2,647 (1,367 and 3,928) respectively. In order to increase the accuracy and precision of estimates in the future, the sampling efficiency at each site should be increased, and the period of time that the traps operated should be extended, especially at the downstream site.

2, 襟裳岬周辺海域に出現するサクラマス幼魚の回遊
生態

真野修一 (北海道立水産孵化場) (17-28)

Apparent movement patterns of juvenile masu
salmon (*Oncorhynchus masou*) in the coastal wa-
ters near Cape Erimo, Hokkaido, Japan.

Shuichi Mano

Although some aspects of the migration and resulting distribution of juvenile masu salmon in the coastal waters near Cape Erimo are reasonably understood, many aspects are not. Juvenile masu salmon were collected from two sampling areas near Cape Erimo from May to July, 1995. The author compared results obtained previously from the western area of Cape Erimo with results obtained during 1994 at the same location. As well, the abundance of juvenile masu in 1995 was compared between the western and eastern areas. During the investigation, 887 juveniles were collected from the western area, and 39 juveniles were collected from the eastern area. The peak in the number of juveniles in the eastern area was about 10 days later than the peak in the western area. The author concludes as juvenile masu

salmon grow, they move to the east, resulting in a migration past Cape Erimo as well as movement to offshore and/or deeper water.

3, サクラマス天然魚と放流魚の体成長およびカロリーの比較

永田光博（北海道立水産孵化場）（29-36）

Growth and caloric contents of wild and hatchery masu salmon, *Oncorhynchus masou* during their first growing season in a Hokkaido stream.

Mitsuhiro Nagata

Approximately 93,000 hatchery-reared juvenile masu salmon marked by removal of their right ventral fin were scatter-released into five sites of the Furuu River of midwestern Hokkaido in 1985 and their growth and caloric levels were subsequently compared with wild juveniles. Although wild juveniles were significantly shorter in fork length than sympatric hatchery ones in June one month after stocking, they were as large as hatchery fish in September, and by November were largest at most sampling stations. Although the caloric content of hatchery juveniles was similar to that of wild fish in May at release, the caloric contents of hatchery fish decreased in June and remained low until September. The slow growth and low caloric content of hatchery fish after release in the natural stream were considered to be caused by a loss of ability to adapt in natural environments due to artificial rearing.

4, 北海道南西部における降海型アメマスの成長と食性

鷹見達也・村上 豊・森 稔（37-44）

Growth and feeding habits of anadromous white-spotted charr (*Salvelinus leucomaenis*) in southwestern Hokkaido, Japan.

Tatsuya Takami (Hokkaido Fish Hatchery), Yutaka Murakami (Hokkaido Fish Hatchery), and Minoru Mori (San-nai Salmon Hatchery)

Using data from tagging experiments in the

Furuu River, the growth rates at sea of anadromous white-spotted charr (*Salvelinus leucomaenis*) were determined to be higher than those in rivers. Although sea-inhabiting charr preyed mainly on fishes, most ascended charr seem to have abstained from eating in the river from June through November.

5, (短報) 河川におけるアメマスによるサケ稚魚およびサクラマス幼魚の捕食

鷹見達也・長澤和也（45-47）

(Short paper) Predation on chum salmon (*Oncorhynchus keta*) fry and masu salmon (*O.masou*) juveniles by white-spotted charr (*Salvelinus leucomaenis*) in a river in northern Japan.

Tatsuya Takami (Hokkaido Fish Hatchery) and Kazuya Nagasawa (National Research Institute of Far Seas Fisheries, Fisheries Agency of Japan)

Chum salmon (*Oncorhynchus keta*) fry were found in the stomachs of anadromous white-spotted charr (*Salvelinus leucomaenis*) from the Furuu River, southwestern Hokkaido, Japan, in spring. The charr fed on the fry when both species were descending to the ocean. It is concluded that white-spotted charr also fed on masu salmon (*O.masou*) juveniles during winter and/or spring because ribbon tags placed on juvenile salmon in the previous winter were found in the stomachs of charr. This is the first record of predation on masu salmon juveniles by white-spotted charr in a river.

第51号 (1997)

1, スモルト化時期におけるサクラマス水分量およびカロリー量

永田光博 (北海道立水産孵化場) (1-9)

Water and caloric contents of wild and hatchery masu salmon, *Oncorhynchus masou* during smolting in a Hokkaido stream

Mitsuhiro Nagata

Approximately 93,000 hatchery-reared juvenile masu salmon marked by removal of their right ventral fin were scatter-released into the Furuu River in mid-western Hokkaido in May, 1985. Water and caloric contents of parr, presmolts and midsmolts of hatchery and wild masu salmon were subsequently determined during the smolt run in 1986. Peak timing for hatchery-origin smolts occurred in June, one month later than for wild smolts. The relationships of caloric contents (kcal g⁻¹ dry weight) to body dry weight (g) of each type of hatchery and wild juveniles were expressed by the allometric equations ($Y=aX^b$), showing that caloric contents increase with body dry weight. Intercept constant (a) of the body dry weight-caloric contents regression equation in both groups of fish decreased with smolting. Furthermore, there were significant differences between hatchery and wild fish in the intercept constant (a) of the body dry weight-caloric contents regression equation obtained from the midsmolts pooled through the sampling time. These results are interpreted as showing that caloric contents of midsmolts from hatchery juveniles tended to be lower than those of wild ones. Such low caloric contents of hatchery smolts were considered to be caused by decreased feeding ability due to successive domestication in the hatchery ponds or by altered smolting time for hatchery smolts. The relationships of water contents (as percentage of body wet weight) to body dry weight(g) of each type

of hatchery and wild juveniles were also expressed as allometric equations ($Y=aX^b$) showing that water contents decrease with increasing body dry weight. Intercept (a) of the body dry weight-water contents regression equation in both groups of fish increased with smolting. As well, there were significant linear relationships between water and caloric contents. These suggest that caloric contents of masu salmon juveniles are determined by their water contents.

2, 増毛沿岸におけるサケ稚魚放流期の餌料豊度 (特に、底生性カイアシ類) と親魚の回帰率

隼野寛史 (北海道立水産孵化場)・浅見大樹 (北海道立水産孵化場)・平野和夫 (北海道立中央水産試験場) (11-16)

Abundance of micro-animals (especially, Harpacticoid copepods) during the release of juvenile chum salmon, *Oncorhynchus keta* and adult return rate into the coastal area off Mashike, Japan Sea, northern Hokkaido.

Hirofumi Hayano, Hiroki Asami and Kazuo Hirano

Abundance of micro-animals were investigated during the release of chum salmon, *Oncorhynchus keta*, from 1990 to 1992 into a shallow coastal area of Mashike, northern Japan Sea. Total micro-animal density fluctuated between 10-2600 individuals.m⁻³ from 1990 to 1992. Harpacticoid copepods, *Harpacticus* spp., an important prey of juvenile chum salmon, were predominant in 1991 and 1992 but very low level in 1990. In 1990, water temperature from January to March was higher (>5°C) than in 1991 or 1992. Juvenile chum salmon released into Shokanbetsu River during this investigation, were returned after 2-5 years. Rates of adult return in 1990, 1991 and 1992 releasing year groups were 0.09%, 0.31%, and 0.34% (only 2-4 years old) respectively. Return rate in the 1990 class was lowest. Therefore, this may have been due to low density of Harpacticoid

copepods during the release of juvenile chum salmon.

3, 増幌川に設置したスクリュートラップにおける魚類採捕個体数の日周変化

隼野寛史（北海道立水産孵化場）・藤原 真（北海道立水産孵化場）・杉若圭一（北海道立水産孵化場）・James R. Irvine（カナダ海洋漁業省太平洋生物研究所）（17-22）

Diurnal variation of fish numbers collected with rotary-screw traps in the Masuhoro River, northern Hokkaido, Japan.

Hirofumi Hayano, Makoto Fujiwara, Kei-ichi Sugiwaka, and James R. Irvine

Diurnal variation of fish numbers were observed by using a rotary-screw trap on 6-7 June and 30 June-1 July, 1995 in the Masuhoro river, northern Hokkaido. The timing of fish appearing in the trap was in the day time (4:00am-7:00pm) or night time (7:00pm-4:00am). The data showed that there was a tendency for chum salmon, dace and crustacea to be collected in the night ($P < 0.01$), and that threespine stickleback were collected in the day ($P < 0.01$). Many others showed a tendency to be collected in the night. The diurnal variation of fish numbers collected was not changed by water temperature or discharge. It was considered that arctic lamprey and chum, pink and masu salmon smolts were migrating downstream, and that threespine stickleback and dace were migrating upstream.

4, 網走湖におけるイサザアミ (*Neomysis intermedia*) の幼体の個体数密度、雌雄比、抱卵雌のサイズと抱卵数の季節変化

浅見大樹（北海道立水産孵化場）・川尻敏文（西網走漁業協同組合）（23-29）

A few ecological informations of *Neomysis intermedia* in Lake Abashiri, eastern Hokkaido, Japan.

Hiroki Asami, Toshifumi Kawajiri

A few ecological studies on *Neomysis intermedia*, known as one of the most important prey of smelt juveniles, were conducted in Lake Abashiri, north-eastern Hokkaido from May to October 1995. Juvenile *Neomysis* were collected by vertical haul of a Norpac net from bottom to surface at night near Yobito Fishing Port in Lake Abashiri. Adult *Neomysis* were collected opportunistically with purse seine nets. Mean individual densities of *Neomysis* juveniles varied between about 70 and 800 inds.m³, in which the maximum density was in July. This maximum density was thought to be primarily juveniles released from ovigerous females in May and June. The ratios of ovigerous females / total individuals sampled were high both in spring (40%) and autumn (60%) and, therefore, it appears there might be at least two generations of *Neomysis* from spring to autumn. Sex ratios were not constant. Adult females were most abundant in spring and autumn, while the proportion of adult males increased in summer. The carapace length of ovigerous females decreased between spring and autumn and egg numbers also decreased. Sexual maturation of females was strongly related to water temperature. The fecundity of *Neomysis intermedia* in Lake Abashiri was about three times higher than in Lake Kasumigaura, Honshu, where detailed information is also available. More detailed studies on the population dynamics of *Neomysis intermedia* are needed in Lake Abashiri.

5, 網走湖における動物プランクトンの季節変動および年変動

浅見大樹（北海道立水産孵化場）（31-43）

Seasonal and annual changes of zooplankton in Lake Abashiri, eastern Hokkaido, Japan.

Hiroki Asami

Seasonal and annual changes on zooplankton were investigated between 1994 and 1995 at the central part in brackish water, Lake Abashiri,

northeastern Hokkaido. Water temperature, salinity and chlorophyll a concentration were also measured at the same time. The physical environments represented by the water temperature and salinity showed large fluctuations both in seasons and years. Especially, while water temperature (20-26°C) and salinity (2.1-2.6) were high in 1994, temperature (18-23°C) and salinity (1.2-1.7) were low in 1995 from June to September. The dominant taxa of zooplankton were rotifers, copepods and copepod nauplii. The zooplankton community, however, was also composed of cladocerans only in summer 1994. Three species of rotifers (*Keratella cruciformis*, *Keratella quadrata* and *Filinia longiseta*) almost dominated more than 80% in both years. *K.cruciformis* clearly dominated in spring, and *K.quadrata* and *F.longiseta* dominated from spring to autumn in two years. The density of *K.cruciformis* was higher in 1994 than in 1995. The maximal individual densities of *K.quadrata* and *F.longiseta* were higher in 1995 than in 1994. The individual density and dominant species successions of rotifers seemed to be influenced by physical environments such as water temperature and salinity. The brackish water species of *Sinocalanus tenellus* were always dominant in the copepods community in both years. Copepodite stages of *S.tenellus* increased in spring and autumn. The reproductions of *S.tenellus*, therefore, were accomplished two times through spring to autumn at least. However, the fluctuations of density in *S.tenellus* were different between 1994 and 1995. The fluctuations of *S.tenellus* might be independent of physical factors such as salinity in Lake Abashiri. Because this calanoida species is an important prey organism for smelt juveniles which dominate in Lake Abashiri, it is thought that biological factors such as grazing by the fishes would play one of the important roles in the fluctuations of *S.tenellus*.

6, 網走湖産ワカサギ稚魚 (*Hypomesus transpacificus nipponensis*) の胃内容物および摂餌日周性について
浅見大樹 (北海道立水産孵化場) ・川尻敏文 (西網走漁業協同組合) (45-52)

Stomach contents and feeding rhythm of juvenile smelt (*Hypomesus transpacificus nipponensis*) in Lake Abashiri, a brackish lake, eastern Hokkaido, Japan.

Hiroki Asami, Toshifumi Kawajiri

Feeding ecology focused on stomach contents and feeding rhythms of juvenile smelt (*Hypomesus transpacificus nipponensis*) was studied monthly in Lake Abashiri from July to September 1994. *Sinocalanus tenellus* (copepod) was the most important prey species. *S.tenellus* observed in the stomachs of juveniles in July were large size classes compared to the size distributions of *S.tenellus* sampled by the plankton net in the lake. It is suggested that juvenile smelts have size-selective feeding against this copepod. *Diaphanosoma* (cladocerans) was abundant in smelt stomachs only in August. *Neomysis intermedia* (mysid) and fish larvae were often found in the stomachs, and the large size juveniles had a tendency to feed on these animals. Stomach fullness indices were largely different in both sampling date and time. The indices fluctuated from 0.5 to 32.3 % in July, 0.0 to 61.6 % in August and 0.0 to 63.7 % in September. The average stomach fullness indices were higher in the afternoon than in the morning, and feeding rhythm became clearer as the smelts grew. For future investigation, the amount of food consumption of juvenile smelt must be estimated, based on these data.

7, (短報) サクラマス の海洋生活期における成長
春日井潔・内藤一明・三坂尚行・工藤智・青山智哉
(53-56)

(Short paper) Individual growth of released masu salmon, *Oncorhynchus masou*, in sea water.

Kiyoshi Kasugai (Hokkaido Fish Hatchery), Kazuaki Naito (Hokkaido Fish Hatchery), Naoyuki Misaka (Hokkaido Fish Hatchery), Satoshi Kudo (Hokkaido Fish Hatchery), and Tomoya Aoyama (Hokkaido Fish Hatchery)

A total of 9380 individually marked smolts of hatchery reared masu salmon were released in the Ken-ichi River, Japan Sea coast of southwestern Hokkaido on May 1994. Some of them were recaptured in winter to the next spring. Higher recapture rates were obtained from larger reared fish released. There were no significance between size at release and growth rate. Since the mean growth rate in fork length ($0.120 \text{ cm day}^{-1}$) was smaller than that in spring and summer, it was suggested that retardation of size growth was seen in winter.

8, (短報) 北日本の沿岸におけるアメマスによるサケ幼稚魚の捕食

鷹見達也・青山智哉 (57-61)

(Short paper) White-spotted charr predation on juvenile chum salmon in coastal waters in northern Japan.

Tatsuya Takami (Hokkaido Fish Hatchery) and Tomoya Aoyama (Hokkaido Fish Hatchery)

Stomach content analysis showed marked temporal changes in white-spotted charr predation on chum salmon juveniles in coastal waters in southwestern Hokkaido in spring. Predation on salmon juveniles frequently occurred immediately after the salmon were released from a hatchery. It is concluded that white-spotted charr are important predators on chum salmon released in this region.

9, (短報) 降海型アメマスの日本海における長距離移動

青山智哉 (北海道立水産孵化場) (63-65)

(Short paper) Long distance movements of

anadromous white-spotted charr (*Salvelinus leucomaenis*) in southern Hokkaido, Japan.

Tomoya Aoyama

The tagging surveys of white-spotted charr (*Salvelinus leucomaenis*) were performed in two rivers in southern Hokkaido in 1990-1993. Two recaptured fish traveled 185km along the coasts of the Sea of Japan from the mouth of the river where they had been released. This is a record of the longest movements of white-spotted charr. These fish were thought to descend to the sea in late autumn or early winter and to spend winter there.

第52号 (1998)

1, Assessment of hatchery origin and wild masu salmon (*Oncorhynchus masou*) smolts in the Masuhiro River, 1996.

Yasuyuki Miyakoshi (Hokkaido Fish Hatchery), Hirofumi Hayano (Hokkaido Fish Hatchery), Makoto Fujiwara (Hokkaido Fish Hatchery), Keiichi Sugiwaka (Hokkaido Fish Hatchery), and James R. Irvine (Fisheries and Oceans, Pacific Biological Station) (1-10)

Twenty thousand juvenile masu salmon were stocked in the Masuhiro River, northern Hokkaido, in the fall of 1995. A mark-recapture study was conducted to enumerate hatchery origin and wild masu salmon smolts in the spring of 1996. A partial fence and a rotary screw-trap were operated to capture downstream migrating smolts. Seven hundred and fifty three wild smolts and 203 hatchery origin smolts were tagged and released at the partial fence. Fifty two tagged wild and 14 tagged hatchery origin smolts were recaptured at the rotary screw-trap 14.8 km downstream from the partial fence. Estimates of wild and hatchery origin smolts [95% confidence

intervals in brackets] were 25,870 [20,997-32,375] and 2,053 [1,467-2,997], respectively. The proportion of hatchery fish stocked in the fall of 1995 that went to the sea as smolts for the next year was estimated to be 10.3%. Four thousand and fifty six hatchery-raised smolts were tagged and released to compare their catchabilities by the rotary screw-trap with those of wild and hatchery origin fish. Although the catchabilities of wild and hatchery origin fish were quite similar, those of hatchery-raised fish were lower.

2. Seawater tolerance of white-spotted charr (*Salvelinus leucomaenis*) related to water temperature.

Tatsuya Takami (Hokkaido Fish Hatchery) (11-19)

Seawater tolerance of white-spotted charr derived from southwestern Hokkaido, northern Japan, was examined by 24-hour seawater challenge tests. Seawater tolerance of charr (1+) did not change seasonally. High water temperature (>16°C) restrained osmoregulation but low temperature (<4°C) did not.

3. Individual growth and life-history divergence of juvenile masu salmon (*Oncorhynchus masou*) in a northern Japanese stream.

Tatsuya Takami (Hokkaido Fish Hatchery), Tomoya Aoyama (Hokkaido Fish Hatchery), Mitsuhiro Nagata (Hokkaido Fish Hatchery), Mahito Miyamoto (Hokkaido Fish Hatchery), Shin-ichi Ohkubo (Hokkaido Fish Hatchery), and Hiloshi Kawamura (Hokkaido Fish Hatchery) (21-29)

In upper reaches of the Shakotan River, northern Japan, individual growth and life-history variation in a wild juvenile masu salmon population were examined in 1995-1996. Specific growth rates of juveniles showed marked seasonal

changes; the juveniles grew rapidly in spring to summer period while slowly in summer to autumn. In the first growth season in their life, potential 0+ early mature males grew relatively faster, and potential 1-year-old smolts and potential 1+ parr followed. The potential 1+ smolts and potential 1+ parr differed markedly in size in August in their first year. The potential 1+ smolts continued to grow even in autumn-winter in the first year unlike the potential 1+ parr.

4. ヤマトシジミ稚貝の生残に及ぼす塩分、水温ならびに餌料の影響

寺西哲夫 (北海道立水産孵化場)・増田政司 (天塩漁業協同組合)・山下和則 (エコニクス) (31-35)

Effect of salinity, water temperature and feeding on the survival of juvenile bivalves, *Corbicula japonica*.

Tetsuo Teranishi, Seiji Masuda and Kazunori Yamashita

Tolerance to salinity, and influence of feeding on the growth of brackish water bivalve, *Corbicula japonica* were examined. Small size (shell length, 0.4-1.25mm) and large size juvenile bivalves (5-12mm) were used for this experiment. Salinities ranging from 0‰ to 25‰ were not lethal to small and large size juvenile bivalves for 40 days. However, both size juvenile bivalves exposed to seawater (31.4‰ and 32.2‰ of salinity) showed no survival by 31 days and 25 days, respectively. Small juvenile bivalves had higher tolerance to salinity than large ones. Large juvenile bivalves showed 90% survival ratio in seawater after gradual acclimation from 0‰ to 20‰ salinity. Most (95%) of small juvenile bivalves survived for 30 days at 0.1°C. When the small juvenile bivalves were fed chlorella, the best survival ratio and growth of the shell length were obtained. These data suggest that the survival of juvenile bivalves is largely effected by high salinity and by feeding.

5, サクラマスワイヤータグ標識部位と脱落率

永田光博（北海道立水産孵化場）・James R. Irvine（Pacific Biological Station）・宮本真人（北海道立水産孵化場）・大久保進一（北海道立水産孵化場）・小林美樹（北海道立水産孵化場）（37-43）

Tag loss of masu salmon marked with coded wire tags in different tag placements.

Mitsuhiro Nagata, James, R. Irvine, Mahito Miyamoto, Shin-ichi Ohkubo and Miki Kobayashi

Coded wire tags (CWT's) implanted in snout have been used broadly in North America to elucidate migration routes, and to evaluate effectiveness of fish enhancement and management. Interesting cultural differences between North Americans and Japanese might necessitate novel approaches to resource assessment of young salmon in Japan. Since Japanese normally eat the heads from salmon, they catch or buy the fish as they are. So, this is not a suitable location for tag implantation. Also, the use of stainless steel tags might not be permitted when there is a possibility the consumers might accidentally eat the tag. Therefore, experiments were conducted on masu salmon examining: (1) influences of tagging location on tagging rates, tag loss, tag visibility, growth and mortality related to tagging; and (2) the utility of gold (non-magnetic) CWT's. Standard stainless steel CWT's were introduced to the snout, adipose eye tissue, adipose fin, and dorsal fin and gold CWT's were placed in the adipose eye tissue, adipose fin, and dorsal fin of groups each of about 400 smolts. Smolts (~15cm in fork length) were tagged in April 1995, each group was given a unique fin clip and fish were placed in concrete raceways. Fish were examined after 1 week, 7 months, and 13 months. There were no consistent differences in growth between fish tagged with stainless steel CWT's and gold CWT's. CWT retention and tagging speed were highest when fish were tagged in the snout

(traditional North American tag site) and the adipose eye tissue. Tag visibility, an important consideration when it is necessary to sample fish at fish markets, was good when fish were tagged in the eye tissue as well as the adipose fin. It is concluded that when CWT'ing fish in Japan, the adipose eye tissue and the adipose fin appear to be suitable tagging sites.

6, サクラマス稚幼魚の成長における河畔植生の役割
永田光博（北海道立水産孵化場）・佐藤弘和（北海道立林業試験場）・宮本真人（北海道立水産孵化場）・大久保進一（北海道立水産孵化場）・柳井清治（北海道立林業試験場）・長坂 有（北海道立林業試験場）（45-53）

Roles of riparian vegetation in the river environment of masu salmon juveniles, *Oncorhynchus masou*.

Mitsuhiro Nagata, Hirokazu Sato, Mahito Miyamoto, Shin-ichi Ohkubo, Seiji Yanai and Yu Nagasaka

Much riparian vegetation in Hokkaido has been lost due to logging and construction activities. However, little is known how these activities influence habitat quality for masu salmon and their growth and survival. Shakotan River in midwestern Hokkaido was straightened to control floods in the upper reaches twenty years ago. As a result, riparian vegetation was lost from the streamside area. Fortunately, some of the riparian vegetation has recovered. The aim of this study was to estimate effects of loss of riparian vegetation on stream temperature, and on growth and survival of masu salmon juveniles. Five study stations were established along the straightened stream to monitor changes in stream temperature, growth, condition factors and population density of juvenile masu salmon in 1994 and 1995. Sts.0 (1995 only) and 1 were located in the upper reaches where overhead tree cover varied between 36 and 60%. St.2 was in the middle reach where

there were few riparian trees and overhead cover from grass was 14%. Sts.3 and 4 were in the lower river with tree cover between 43 and 85%. The 1994 summer was so hot that stream temperature exceeded 20°C at Sts.2, 3 and 4. Stream temperatures rose most rapidly in the middle reach with the least overhead cover. In contrast, the 1995 summer was cool and stream temperatures in Sts.2-4 rarely exceeded 20°C. Masu salmon juveniles at Sts.2-4 almost stopped growing, and their condition factor and population density also decreased from July to August in 1994. In contrast, masu salmon juveniles at Sts.2-4 continued to grow and their condition factors rose from July to August in 1995. Furthermore, summer decreases in population density in this year were not higher than those in 1994. These results suggest that overhead cover by riparian vegetation contributes to maintaining low summer stream temperatures which enable masu salmon juveniles to undergo rapid growth during the summer.

7, サクラマス0+スモルトの出現に関する遺伝率の推定
小山達也(北海道立水産孵化場)・佐々木義隆(北海道立水産孵化場)・大森 始(北海道立水産孵化場)・小出展久(北海道立水産孵化場)(55-63)

Estimates of heritability in rates and timing of smoltification for underyearling masu salmon (*Oncorhynchus masou*).

Tatsuya Koyama, Yoshitaka Sasaki, Hajime Ohmori, and Nobuhisa Koide

Four males were mated with twelve females according to a hierarchical breeding design and full-sibs were divided into two or three lots to estimate heritability in rates and timing of smoltification for underyearling masu salmon. Each lot was distinguished by a unique fin-clip and fish were combined into a single circular tank. Underyearling smolts appeared commencing in mid-May, eight months after fertilization and

by October, 30% of the fish had smolted in underyearling. A great variation was observed in underyearling smolt rates, ranging from 0% to approximately 90%. In addition, there was a great range in smolt timing. In spite of this variability, fish within full-sib groups tended to have similar rates and timings of smoltification. Analysis of variance determined that heritability based on sire components for underyearling smolt rates was 0.68, and heritability based on sire components for timing was 0.66. Our results demonstrate that artificial selection may be an effective tool in the enhancement of underyearling masu salmon smolts.

8, 阿寒湖における動物プランクトンの個体数密度と組成の季節変化

浅見大樹(北海道立水産孵化場)・坂本博幸(北海道立水産孵化場)(65-73)

Seasonal changes of zooplankton density and composition in Lake Akan, eastern Hokkaido.

Hiroki Asami and Hiroyuki Sakamoto

Seasonal changes of zooplankton density and composition were studied to understand the dietary environments of smelt juvenile (*Hypomesus transpacificus nipponensis*) by sampling with a 100 μ m net at the central station in Lake Akan, eastern Hokkaido, between 1994 and 1995. Zooplankton densities were high in spring and autumn and low in summer in both year, and, the density and biomass in summer was higher in 1995 than in 1994. Zooplankton communities were consisted of rotifers, cladocerans, copepods, copepods nauplii and protozoa. Rotifers increased in spring and autumn. Cladocera and Copepoda were predominant in summer during juvenile stage of smelt in both year. However, their densities and compositions were different in 1994 and 1995. Small size *Bosmina* (Cladocera) increased 1994, and, large size *Daphnia* (Cladocera) dominated in 1995. Calanoida copepod, *Eurytemora*

affinis were mainly occupied in copepods communities in both years. The density of *E.affinis* reached the maximum in July and decreased toward November. In 1995, the density of *E.affinis* was higher than that in 1994 during the declining period of this species, and adult stages were abundant in 1995. The relationship between life histories of these zooplankton and environmental factors must be studied in detail.

9, (Short paper) Recoveries of masu salmon strayed into Shokanbetsu river, northern Hokkaido, Japan. Yasuyuki Miyakoshi (Hokkaido Fish Hatchery) (75–77)

Masu salmon, *Oncorhynchus masou*, are believed to be very precise in their homing and no straying had previously been recorded. In 1993 and 1995, two marked masu salmon adults were captured in the Shokanbetsu River, northern Hokkaido, Japan. As marked fish have never been stocked in the Shokanbetsu River and the marked fish were much bigger than unmarked fish, these marked fish were considered to have strayed into the Shokanbetsu River.

10, (Short paper) Influence of high water temperature on feeding responses and thermal death of juvenile masu salmon under aquarium settings. Tatsuya Takami (Hokkaido Fish Hatchery) and Hirokazu Sato (Hokkaido Forestry Research Institute) (79–82)

Appetite of juvenile masu salmon (*Oncorhynchus masou*) decreased at $>24^{\circ}\text{C}$ in aquarium settings. Thermal death of masu salmon occurred at $26\text{--}28^{\circ}\text{C}$.

第53号 (1999)

1, 2⁺サクラマス の 卵 巢 卵 数 の 推 移 と 尾 叉 長 と の 相 関 について — 池 中 飼 育 魚 と 沿 岸 来 遊 魚 の 比 較 —
北村隆也 (北海道立水産孵化場) (1–10)

Changes in the numbers of ovarian eggs and the correlation to fork length in 2⁺ masu salmon, *Oncorhynchus masou*: comparison of pond-reared and seashore-captured fish.

Takaya Kitamura

It is known that there is a large difference in the fecundity (= number of ovarian eggs that are considered possible for spawning) between pond-reared and sea-caught masu salmon, *Oncorhynchus masou*. Egg number seems to be related to body size; in fact, the former has smaller fecundity than the latter. To investigate the time at which the difference of fecundity arises and the time the fecundities are determined for the pond-reared fish and the seashore-captured fish (containing the river-captured), ovarian eggs from January to August in the spawning year were counted using both these groups. The correlation between the number of ovarian eggs and the fork length was calculated, and the influence of body growth on the egg numbers was discussed. The number of eggs decreased toward the maturation season. Although each group had 2,900 eggs in January, their average fecundities in August were 500 1,900, respectively. The significant difference between the developing egg numbers of both groups was initiated in January, and the numbers were smaller in the pond-reared fish than in the seashore-captured fish. But, as a result of comparison at each month, though the egg numbers of seashore-captured fish almost always exceeded those of pond-reared fish, significances were not always observed. The fecundities were determined in July for pond-reared fish and in June for the seashore-captured fish. The correlation between the fecundity and the fork length had

became higher toward their maturation. Fork length in the maturation season of the pond-reared fish was 28.6cm and that of the seashore-captured fish was 47.0cm in average and each fecundities were matched with their body sizes. The correlation coefficient, however, was significant ($\rho_0 \neq 0$) only in the pond-reared fish in September, and not significant in all other cases. Accordingly, the correlation was considered not to be stable until the maturation season. These results suggested that in the case of masu salmon, *Oncorhynchus masou*, the number of ovarian eggs decreased to a number that matched its final body size in the maturation season, and that the degree of reduction in egg numbers was controlled by the preceding body growth.

2, 厚田川におけるサクラマス産卵床の分布と構造

杉若圭一（北海道立水産孵化場）・竹内勝巳（北海道立水産孵化場）・鈴木研一（北海道立水産孵化場）・永田光博（北海道立水産孵化場）・宮本真人（北海道立水産孵化場）・川村洋司（北海道立水産孵化場）（11-28）

Distribution and structure of spawning redds of masu salmon in the Atsuta River.

Kei-ichi Sugiwaka, Katsumi Takeuchi, Ken-ichi T. Suzuki, Mitsuhiro Nagata, Mahito Miyamoto, and Hiloshi Kawamura

Some distributional and structural profiles of spawning redds of masu salmon (*Oncorhynchus masou*) were demonstrated by the study which was carried out during 1989-1995 in the Atsuta River located in the central area of Hokkaido. Numbers of spawning redds had annual fluctuations. Redds were distributed through the entire river system except the downstream area of the main stream. Average redd density (numbers per km) ranged from 3.09 to 9.20 during 1990-1994, and it was higher in upstream and small tributaries than that in midstream. Generally, redds

were located along the banks of riffles which had pools just above them. Moreover, 62.5% of redds were made under plant covers. Mounds of the redds were generally oval shape or long-fan shape. On the other hand, though many fan-shaped pits were found, pits often showed oval or handshake. The range of the mound length of redds was 60-330 cm, and their annual averages ranged 141-168 cm. Similarly, the mound width and pit length showed a wide range of values; 50-240 (mean 85-100) cm in mound width, 50-340 (mean 105-136) cm in pit length. Velocities of the flow on the mound were from 20.9 to 101.7 $\text{cm} \cdot \text{sec}^{-1}$, and the mean value was 52.6 $\text{cm} \cdot \text{sec}^{-1}$. Redds of 68 (63.0%) out of 108 which were excavated to survey their internal structures had several (2-6) egg pockets, and the average number of egg pockets was 2.0. The number of eggs in the egg pocket ranged 15-1,080 (mean 323), and the redds accommodated 15-2,214 (mean 640) eggs. In the redd which had plural egg pockets, the egg pockets in the posterior parts of the redd had a tendency to have more eggs than the ones in the anterior parts of the redd (mean egg numbers; 384 in the 1st pocket, 285 in the 2nd, 192 in the 3rd, 176 in the 4th). Average interval distances between egg pockets, 48.9 cm, were almost equal to the average fork length of a female adult (48.2cm). The mound length was increasingly proportional to the river width, redd density, and female adult length. The numbers of egg pockets and the total numbers of eggs in redds increased in proportion to the mound length. Moreover, the total numbers of eggs in redds lineally paralleled the increasing redd density. These results suggested that characteristics of spawning redd of masu salmon, e.g., the size of redds, the number of egg pockets and the number of eggs in redds, were affected by the environmental factors controlled by the magnitude of habitat and the mass of adults. Therefore, we considered that there was a

spawning strategy of masu salmon depending on the adult density: the female adult would make a large redd which has many egg pockets and many eggs and be easy to protect from dislocation by another females under the condition of high adult density. In contrast, under the condition of a low density, the females would prefer to make several small redds with few eggs in various places. Because of the assurance of the survival in her offspring, she would choose the above-mentioned way to avoid fatal damage by flood rather than digging damage by another female.

3, 北海道尻別川におけるニジマスの自然繁殖

青山智哉（北海道立水産孵化場）・鷹見達也（北海道立水産孵化場）・藤原 真（北海道立水産孵化場）・川村洋司（北海道立水産孵化場）(29-38)

Natural reproduction of rainbow trout, *Oncorhynchus mykiss*, in the Shiribetsu River in Hokkaido, Japan Tomoya Aoyama, Tatsuya Takami, Makoto Fujiwara, and Hiloshi Kawamura

Spawning redds, ages, and growth of introduced rainbow trout, *Oncorhynchus mykiss*, were investigated in a tributary of the Shiribetsu River, northern Japan in 1997-1998. The rainbow trout spawned in late April through mid June. A total of 19 redds was found in the 1km reach during the study period. Observed redd size was approximately 90cm in length and 50cm in width. The number of egg per redd were varied between 8 and 835. The fish caught in the tributary were 0+ to 6+ in age and 4 to 46cm in fork length. The results suggest that rainbow trout reproduced under the natural river environments.

4, 北海道北部増幌川におけるサクラマス幼魚の秋季放流試験 1. サイズの異なる4群の栄養状態と冬季の生残率

隼野寛史（北海道立水産孵化場）・永田光博（北海道立水産孵化場）・宮腰靖之（北海道立水産孵化場）

(39-47)

Experimental stockings of juvenile masu salmon in fall in northern Hokkaido. 1. Size-related body constituents and over winter survival.

Hirofumi Hayano, Mitsuhiro Nagata, and Yasuyuki Miyakoshi

Four size-groups of hatchery-reared masu salmon *Oncorhynchus masou* juveniles were stocked in the Masuho River, northern Hokkaido, in October 1997. To investigate the relationships between body constituents, over winter survival and body size, 100 fish of each size-group were held in the tanks without feeding from October 1997 to March 1998. The portions of fish held in the tanks and stocked in the river were sampled for measurement of body size, body constituents and caloric value. The relationships between caloric value (kcal g⁻¹ wet weight) and wet body weight (g) of juveniles were expressed by the allometric equations ($Y=aX^b$), showing that caloric value was paralleled with wet body weight (g). Caloric value of juveniles decreased in winter, and that of the large-sized group usually was higher than that of the small-sized. The fat (% g⁻¹ wet weight) of the body declined with caloric value and wet body weight in winter. Over winter survival rate (%) of the large-sized group was higher than that of the small-sized group. These tendencies were observed in both fish stocked in the river and held in the tanks without feeding.

5, 北海道北部増幌川におけるサクラマス幼魚の秋季放流試験 2. サイズの異なる4群の放流魚の冬季間の生残率とスモルト降河尾数

宮腰靖之（北海道立水産孵化場）・隼野寛史（北海道立水産孵化場）・永田光博（北海道立水産孵化場）(49-58)

Experimental stockings of juvenile masu salmon in fall in northern Hokkaido. 2. Size-related over winter survival and their smolt numbers.

Yasuyuki Miyakoshi, Hirofumi Hayano, and Mitsuhiro Nagata

A total of 40,000 hatchery-reared masu salmon *Oncorhynchus masou* juveniles were stocked in the Masuho River, northern Hokkaido, in October of 1997. The fish had been divided into 4 size groups and given group-specific marks by fin clipping. In the spring of 1998, the numbers of downward migrating smolts were estimated by a mark-recapture experiment. In July of 1998, the numbers of stream resident fish which had been stocked in the previous fall were estimated by two-stage sampling surveys. Estimated over winter survivals were varied ranging from 13.7 to 19.3 percent. It should be effective to stock large juveniles for enhancement of masu salmon because the larger fish would have an advantage to survival through winter and becoming smolts in the following spring.

6, 北海道北部河川に移殖放流されたサクラマス
の回帰魚体サイズ

宮腰靖之 (北海道立水産孵化場) (59-66)

Body sizes of masu salmon transplanted and subsequently returned to rivers in northern Hokkaido.

Yasuyuki Miyakoshi

Fork lengths and weights of masu salmon *Oncorhynchus masou*, returned to three rivers, Nobusha River, Furenbetsu River, and Shokanbetsu River, located in northern Hokkaido, were measured in 1992-97. Weights of masu salmon of the Shiribetsu River strain (Shiribetsu River is located in southern Hokkaido) transplanted in the Nobusha River were significantly larger than those of wild fish in the Nobusha River, whereas the sizes of fish transplanted in the adjacent rivers were not always different from those of the wild fish when they returned as adults. It is concluded that the sizes of masu salmon transplanted

were strongly correlated to those of masu salmon in their natal rivers.

7, 発眼期シシャモの卵黄囊上皮に存在する塩類細胞
隼野寛史 (北海道立水産孵化場)・小島 博 (北海道
水産林務部)・村上 豊 (北海道立水産孵化場)・金
子豊二 (東京大学海洋研究所) (67-72)

Chloride cells in the yolk-sac membrane of eyed-stage embryos of long-finned smelt, *Spirinchus lanceolatus* (Hikita).

Hirofumi Hayano, Hiroshi Kojima, Yutaka Murakami, and Toyoji Kaneko

For the detection of chloride cells (CCs), whole-mount preparations of the yolk-sac membrane of long-finned smelt, *Spirinchus lanceolatus* (Hikita), were immunocytochemically stained with an antiserum specific for Na^+ , K^+ -ATPase. A large number of immunoreactive chloride cells with immunonegative nuclei were detected in the epithelia covering the outer surface of the yolk-sac membrane. To assess the activity of the CCs in different salinities, changes in sectional area of the chloride cells were examined after transfer to 12 (BW) and 34 (SW) ‰ Sea water. The area of the chloride cells was significantly increased 14 days after transfer to SW, whereas such increase was not observed in the embryos exposed with fresh water and BW. Some CCs appeared to be closely associated with each other to form a cellular complex, as evidenced by the presence of more than one immunonegative nucleus. The activated CCs in the yolk-sac membrane in the SW group probably function in place of the gills as ion-extruding sites during embryonic stages of long-finned smelt.

8, (短報) 北海道日本海南部に回遊するサクラマス
成魚の胃内容物

春日井 潔 (北海道立水産孵化場) (73-75)

(Short paper) Stomach contents of adult masu salmon, *Oncorhynchus masou*, migrating to the

coast of the Sea of Japan along the southwestern Hokkaido, Japan.

Kiyoshi Kasugai

Stomach contents of masu salmon, *Oncorhynchus masou*, caught in the Sea of Japan along the coast of southwestern Hokkaido from February to April in 1996, were examined to clarify their feeding behavior. Sand lance, *Ammodytes personatus* as fish species, krill, *Euphausia pacifica* and amphipod, *Themisto japonica* as planktonic crustacean species, were observed in the stomach contents. Plankton occupied most of food items in number throughout almost all the months examined. However, in weight sand lance occupied most of the stomach contents. From these results, sand lance was assumed to be an important prey for masu salmon.

9, (短報) サクラマス幼魚の体サイズと死亡との関係
鷹見達也 (北海道立水産孵化場) ・青山智哉 (北海道立水産孵化場) ・川村洋司 (北海道立水産孵化場)
(77-80)

(Short paper) Relation between size and mortality of juvenile masu salmon.

Tatsuya Takami, Tomoya Aoyama, and Hiloshi Kawamura

The growths of marked juvenile masu salmon (*Oncorhynchus masou*) were individually examined during their first growing season in a northern Japanese stream. The sizes of the marked juveniles that were survived and subsequently recaptured did not differ from those of all the marked fish at the same months. Therefore the size-related mortality of the 0+ juveniles would be absent in the river.

10, (Short paper) Occurrence of sea-run migrant brown trout (*Salmo trutta*) in Hokkaido, Japan.
Tomoya Aoyama (Hokkaido Fish Hatchery), Kazuaki Naito (Hokkaido Fish Hatchery), and

Tatsuya Takami (Hokkaido Fish Hatchery) (81-83)

Four specimens of sea-run migrant brown trout were captured on the coast and in the river of Hokkaido. Although introduced Japanese brown trout were previously described as non-anadromous form, this paper is the first record on anadromous form in Japan.

第54号 (2000)

1, 滝の上流に移殖されたミヤベイワナの生活史

下田和孝 (北海道立水産孵化場) ・吉田徳市 (北海道立水産孵化場) ・山下幸悦 (北海道立水産孵化場) ・竹内勝巳 (北海道立水産孵化場) (1-5)

Life-history of miyabe charr stocked above a waterfall.

Kazutaka Shimoda, Tokuichi Yoshida, Kouetsu Yamashita, and Katsumi Takeuchi

In order to clarify the life-history of miyabe charr *Salvelinus malma miyabei* stocked above a waterfall in the Torizaki River, Hokkaido Japan, their age, sexual maturity and growth were studied. About 40% of the individuals matured into both males and females in the autumn. Males matured from 0⁺ of age and females matured from 1⁺ of age. These results suggested that they live in streams throughout their life, because they can never go up the waterfall. Their life history is considered to be a land-locked type. This population was different from the original lake-run population inhabiting the Shikaribetsu Lake system. From the analysis of their otolith radius length, the average body size of females inhabiting the Torizaki River was larger at 1⁺ of age than those in the Shikaribetsu Lake system. Therefore, like the case of the other salmonid fish, the rapid growth rate in the juvenile stage would lead to maturation in the river.

2, 北海道北部河川におけるサクラマス幼魚の越冬時の微生息場所とその物理環境

鈴木研一（北海道立水産孵化場）・永田光博（北海道立水産孵化場）・中島美由紀（北海道立水産孵化場）・大森 始（北海道立水産孵化場）（7-14）

Microhabitat and physical environment of wintering juvenile masu salmon in northern Hokkaido stream.

Ken-ichi Suzuki, Mitsuhiro Nagata, Miyuki Nakajima, and Hajime Ohmori

The physical environment and habitat used by wintering juvenile masu salmon, *Oncorhynchus masou* were investigated in the Masuhoro River, in northern Hokkaido, Japan. The study site including riffle, glide, and pool was divided into 135 cells; each cell was 1m × 1m. Water depth, water current velocity, overhanging and aquatic cover, and substrate were measured in each cell after electrofishing. The Morishita's *I₀* index was 10.66, which indicated contagious distribution. Current velocity of the cells used by juvenile masu salmon was significantly slower than that of the unused cells. Moreover, juvenile masu salmon favored cells with a large amount of cover. Principal component analysis and Jacobs's electivity index, using five variables including current diversity, showed that juvenile masu salmon preferred the habitat not only with low current velocity and abundant cover, but also with deep water. Therefore, current velocity, water depth, and cover are considered to play an important role in the microhabitat for wintering juvenile masu salmon.

3, 北海道東部沿岸におけるサクラマス幼魚の胃内容物
三坂尚行（北海道立水産孵化場）・真野修一（北海道立水産孵化場）（15-22）

Stomach contents of juvenile masu salmon (*Oncorhynchus masou*) in the coastal waters of eastern Hokkaido, Japan.

Naoyuki Misaka and Shuichi Mano

The stomach contents of juvenile masu salmon (*Oncorhynchus masou*) collected by set nets in the coastal areas of Erimo arid Kushiro in eastern Hokkaido, were investigated in the spring of 1997. Juveniles were caught from late May to mid-July in Erimo and from mid-June to late July in Kushiro. The fish, Euphausiids, Amphipods, and Decapod larvae fed on were identified from the stomach contents of the juveniles. Fishes and Euphausiids were important prey items on both coasts. In Erimo, the variability in the stomach contents was high among the sampling dates and in the distances off the coast, but body size did not affect the stomach contents at the same points. Stomach contents from Kushiro differed from those of Erimo in the same period. These data suggest that stomach contents of masu salmon juveniles in these areas differ in accordance with period, place and distance from the coast.

4, サケ (*Oncorhynchus keta*) の産卵後死体（ホツチャレ）への水生動物のコロニゼーション

中島美由紀（北海道立水産孵化場）・伊藤富子（北海道立水産孵化場）（23-31）

Aquatic animal colonization of chum salmon (*Oncorhynchus keta*) carcasses in Hokkaido, northern Japan.

Miyuki Nakajima and Tomiko Ito

Aquatic animals, particularly macroinvertebrates, colonizing chum salmon carcasses were studied in Hokkaido, northern Japan 1997-1999. In the Naibetsu River, a spring stream in Chitose City, *Hydatophylax* spp. (Trichoptera) and Gammaridea (Amphipoda) were abundant on the surface of salmon carcasses. In the Namari River, a mountain stream in Yakumo Town, Ephemerellidae (Ephemeroptera), Capniidae (Plecoptera) and Chironomidae (Diptera) were abundant on salmon carcasses. In the Naibetsu River, *Hydatophylax* larvae mostly colonized well-decomposed carcasses

in October and November. Gammaridea colonized salmon carcasses regardless of the degree of decomposition or season. In a depositing experiment, *Hydatophylax* larvae and Gammaridea colonized carcasses in the spring streams, Naibetsu River and Kutanida Creek in Eniwa City. In both field observations and the depositing experiment, macroinvertebrates rarely colonized carcasses when water fungi covered them. *Lethenteron reissneri* (Petromyzontiformes) colonized a few carcasses in the Naibetsu River.

5, (短報) サクラマス1⁺スモルトの生殖腺指数の変化とジャックの分岐

下田和孝 (北海道立水産孵化場) (33-35)

(Short paper) Divergence of jack and gonad somatic index in 1⁺ aged masu salmon smolts.

Kazutaka Shimoda

Temporal changes in the male gonad somatic index (GSI) in 1⁺ aged masu salmon (*Oncorhynchus masou*) smolt and their body length were studied from April to September in 1995 under artificial rearing conditions. About half the number of male individuals and increased their GSI from June, and also became sexually mature in September. The maturing individuals were larger than the immature ones in body length from June to September. These observations revealed that the triggering of maturation in jacks occurs from May to June. Moreover, the body size representing growth and maturation in the jacks are positively correlated.

第55号 (2001)

1, サクラマス雌の再生産形質と成長履歴との関係

下田和孝 (北海道立水産孵化場) (1-6)

Relationships between reproductive characters and growth history in female masu salmon *Oncorhynchus masou*.

Kazutaka Shimoda

The relationships between the reproductive characters and growth history of pond-reared female masu salmon were studied by the method of individual tagging from smolt stage (age of 0⁺, in April) to maturation (age of 1⁺, in August and September). Number and size of mature eggs were associated with growth history. The maximal correlation coefficient between mature egg number and body weight appeared at April in the maturation year. Mature eggs number was strongly associated with growth in body weight during the period (11 months) of smolt stage to April in the maturation year. Mature eggs' size was strongly associated with specific growth rate from April to maturation in the maturation year. These results suggested that the mature eggs number seemed to be determined by body size in April in the maturation year, and the mature eggs' size was influenced by the growth rate after April in the maturation year. Mature body size was strongly associated with body size of the past. But mature body size was not associated with the specific growth rate of the past. Therefore, larger females produced a larger number of eggs, but the mature eggs' size was not correlated with the mature body size.

2, サクラマスの成熟体サイズの大型化に関する人為選択の効果

下田和孝 (北海道立水産孵化場)・山下幸悦 (北海道立水産孵化場)・小林美樹 (北海道立水産孵化場) (7-12)

The effects of artificial selection on the increase of mature body size in masu salmon *Oncorhynchus masou*.

Kazutaka Shimoda, Kouetsu Yamashita and Miki Kobayashi

The purpose of this study was to investigate the relationships between parents body size and

their progeny body size in masu salmon *Oncorhynchus masou*. We estimated realized heritability of mature body size by breeding experiment under artificial rearing condition. In addition, the body size of the progeny was examined by tagging experiment in the ocean. Realized heritability based on the breeding of large parents was 0.782-0.921 and of small parents was 0.246-0.409. Mature fork length of the progeny was analyzed by three-way layout ANOVA testing for difference among the sex of the progeny (male or female), the dam size (large or small) and the sire size (large or small). There was no difference between the sexes of the progeny. However, the progeny of large parents were larger than the progeny of small parents. Interaction between sex of the progeny and sire size was found. These results indicate that artificial selection is an effective method to increase mature body size, especially for males. Twenty-nine samples were captured in the ocean. Relationship between captured body size and their parents body size was not clear.

3, サクラマスジャックの分岐に関わる成長および雄親の生活型の影響

下田和孝 (北海道立水産孵化場) (13-17)

Effects of growth and sire type on the divergence of jack in masu salmon *Oncorhynchus masou*.

Kazutaka Shimoda

The effects of growth, body size and sire type on the divergence of precociously 1⁺ maturing males (jacks) in masu salmon (*Oncorhynchus masou*) were studied under artificial rearing conditions. Eggs from normally 2⁺ maturing females were fertilized with milt from both normal 2⁺ maturing males (hooknose) and jacks. Following the individual marking at the smolt stage, their fork length, specific growth rates and incidence of jacks were monitored. Mean fork lengths at the smolt stage were equivalent among jacks and

non-jacks. But specific growth rates of the jacks remained relatively high after smolting till the early summer. Moreover the jacks were larger than the non-jacks in the early summer. Mean growth rate and fork length of the progeny were equivalent among the jack-sired and the hooknose-sired families. But the frequency of jacks was different between the sire type; it was 83% in the jack-sired families and 56% in the hooknose-sired families.

4, 網走湖産ワカサギ仔魚の食性

浅見大樹 (北海道立水産孵化場 現所属、北海道立中央水産試験場) (19-25)

Gut contents of smelt larvae (*Hypomesus nipponensis*) in Lake Abashiri, a brackish lake, eastern Hokkaido.
Hiroki Asami

Gut contents of 669 individual smelt larvae were investigated with feeding ratios in Lake Abashiri, a brackish lake, from May to June in 1995. The feeding ratio of larvae, that is the ratio of numbers of larvae in which any preys were observed in their gut contents of the total number of larvae examined. The ratios increased from about 21% in middle May to 89% in late May, while yolk larvae decreased from about 68% to 1% in this period. Zooplankton density also increased in this period. The start of feeding of the larvae in the 1995 year class corresponded to the peak of zooplankton abundance. Rotifer (*Keratella cruciformis*), its egg (*K. cruciformis* egg), copepod eggs, copepod nauplii and copepod (*Sinocalanus tenellus*) were main components of gut contents. The larvae fed on preys of small size (*K. cruciformis*, egg, *K. cruciformis*, copepod nauplii) to large size (*S. tenellus*), as larvae grew. From these feeding characteristics, it might be a favorable dietary condition for smelt larvae that zooplankton compositions shift from rotifer to copepods in environments.

5, Induction of apoptosis by infectious hematopoietic necrosis virus.

Makoto Hatakeyama (Hokkaido Fish Hatchery), D.K.Sakai (Hokkaido Fish Hatchery) (27-33)

The apoptosis of fish induced by infection of infectious hematopoietic necrosis (IHN) virus was investigated with a fish cell line (rainbow trout gonad cells, RTG-2 cells) and masu salmon *Oncorhynchus masou*. Terminal nucleotidyl transferase mediated dUTP nick end labeling (TUNEL) and chromosomal DNA electrophoresis were used to detect apoptosis. RTG-2 cells infected with IHN virus demonstrated apoptosis evidenced by chromatic fragmentation and DNA cleavage into nucleosomal oligomers. On masu salmon, the apoptosis of lymphocytes was clearly observed. On 5 days post infection, dead, surviving and non-infected fish had 100, 21 and 3 percent TUNEL-positive lymphocytes, respectively. Extracted DNA revealed DNA ladder due to chromosomal DNA fragmentation exclusively in lymphocytes. The reduction of circulating lymphocytes due to apoptotic cell death strongly suggests a new aspect of IHN pathogenesis, because the roles of lymphocytes are closely correlated to immune system and defense mechanism of fish.

6, (短報) 酪農地帯を流れる川の底生動物：北海道西別川水系の例

伊藤富子（北海道立水産孵化場）・中島美由紀（北海道立水産孵化場）・北村隆也（北海道立水産孵化場）・川村洋司（北海道立水産孵化場）・伊澤敏穂（北海道立水産孵化場）・村上 豊（北海道立水産孵化場）(35-40)

(Short paper) Benthic macroinvertebrates in polluted rivers in the dairy area: an example in the Nishibetsu river system, eastern Hokkaido, northern Japan.

Tomiko Ito, Miyuki Nakajima, Takaya Kitamura, Hiloshi Kawamura, Toshio Izawa and Yutaka Murakami

The benthic macroinvertebrates were compared between the lightly polluted and heavily polluted tributaries of the Nishibetsu River System in the dairy area, eastern Hokkaido, northern Japan, on 11, July 1998. The taxa collected, number of taxa and total density were hardly different between the two tributaries. However, the cluster analysis of the individual number of taxa in 16 quadrates showed that the community of the quadrate was more similar in each tributary than between tributaries.

7, (短報) 阿寒湖および阿寒パンケ湖の水草

片桐浩司（株式会社セ・プラン）・伊藤富子（北海道立水産孵化場）・川村洋司（北海道立水産孵化場）(41-48)

(Short paper) Water plants in the Lakes Akan and Akan-Panke, Hokkaido, northern Japan.

Koji Katagiri, Tomiko Ito and Hiloshi Kawamura

Water plants were studied in the Lakes Akan and Akan-Panke, Hokkaido, northern Japan, 1999. Seven species of water plants were collected in the Lake Akan. The plants almost inhabited the littoral zone shallower than 3m. Five species of water plants were recorded in the Lake Akan-Panke for the first time.

第56号 (2002)

1, Ecological studies on the dispersal of newly emerged masu salmon fry, *Oncorhynchus masou*. Mitsuhiro Nagata (Hokkaido Fish Hatchery) (1-87)

Experiments on newly emerged masu salmon fry were undertaken in artificial and natural streams to elucidate physical and biological factors that affect dispersal of masu salmon fry, its ecological significance, and to propose a hypothesis to explain dispersal. In the artificial channel

experiments, masu salmon fry exhibited both up- and downstream movements; downstream movements were typically nocturnal, but upstream movements were predominantly diurnal. The number of up- and downstream migrants was affected by changes in water velocity; high velocity promoted downstream movement and decreased upstream movement. Moreover, larger fry tended to move upstream or remain in the spawning area and feed more than small fry. Masu salmon dispersal was concluded as follows; Dispersal after emergence mainly commences at loss or recovery of positioning with change in light intensity at sunrise and sunset. Quantitative relationships between upstream migrants, residents and downstream migrants are controlled by individual swimming ability associated to flow intensity in stream and social interaction. More wild fry in the artificial channel migrated downstream than upstream, in contrast domesticated fry tended to migrate upstream or remain in the channel. In the natural stream experiments, however, most masu salmon fry, irrespective of origin, moved downstream or remained near the spawning areas because of high water velocity. Masu salmon juveniles at downstream sites with low density grew rapidly so that their size exceeded those in high density planting sites in summer. I discovered that more male fry moved upstream or remained in the spawning area than female fry. Early mature males were always larger than immature male in early summer, and more mature types upstream and near spawning areas than downstream. Therefore, it was concluded that dispersal of newly emerged masu salmon fry has two ecological roles; the first is to regulate population density by the spatial redistribution between life history stages (alevin and parr) to enhance their feeding opportunities. The second role is to share the instream habitat between resident (early mature) and sea run types to contribute to accelerating the life history

divergence. A hypothesis of mechanisms for dispersal including sex biased distribution and early maturation for masu salmon was proposed based on the present results and previous studies for salmon and trout. Masu salmon develop different metabolic activities that are genetically controlled. Males having the genetic potential to mature early will be included in the high metabolic group of masu salmon. More males than females remain near the spawning area because the males with high metabolic rates have high growth, and subsequently, they are greater in swimming and/or competitive ability than other fish. As high metabolic males can grow rapidly at initial feeding in spring when the daylength is increasing, when the fish are sensitive to photoperiod stimulation of their gonadotrophic hormone system, maturation can be commenced. In contrast, other males and females tend to move downstream because of low metabolic rates, reduced swimming ability and/or subordinates. Males that moved downstream accelerate their growth in summer due to reduced population density, but maturation will not be triggered because body size and growth rate are not above a genetically determined level in spring when gonadotrophic system is sensitive to photoperiod. Visual and electrofishing observations were conducted in the Atsuta and Shakotan rivers of Hokkaido to investigate changes in habitat use and preference for newly emerged masu salmon fry. Fry favored stream margins with shallow, slow moving water, aquatic vegetation and large gravel. As fry grew and energetic requirements increased, they moved to new habitats with faster, deeper water, and less cover where food was presumably more abundant. To optimize growth and survival of young stream-rearing masu salmon, it is desirable to restore and conserve stream margins with habitats suitable for these valuable fish.

2, 池産及び天然サクラマスモルトの生化学的性状の違い

三坂尚行（北海道立水産孵化場）・水野伸也（北海道立水産孵化場）・下田和孝（北海道立水産孵化場）・佐々木義隆（北海道立水産孵化場）・内藤一明（北海道立水産孵化場）・安藤大成（北海道立水産孵化場）・北村隆也（北海道立水産孵化場）・笠原昇（北海道立水産孵化場）（89-96）

Biochemical differences between hatchery-reared and wild masu salmon *Oncorhynchus masou* smolts.

Naoyuki Misaka, Shinya Mizuno, Kazutaka Shimoda, Yoshitaka Sasaki, Kazuaki Naito, Daisei Ando, Takaya Kitamura and Noboru Kasahara

Comparative biochemical investigation between hatchery-reared and wild masu salmon *Oncorhynchus masou* smolts was carried out to estimate their suitability for ocean ranching. Triglyceride content in hatchery-reared smolts were lower than that in wild smolts. RNA/DNA ratios and protein content of hatchery-reared smolts before releasing, which showed a lower specific growth rate than wild smolts, had decreased in the spring, even though RNA/DNA ratios and protein content had increased in wild smolts. Hatchery-reared smolts under different feeding conditions indicated that the differences in RNA/DNA ratios and protein content closely linked their specific growth rates during the spring. These results suggest that the energy store of hatchery-reared smolts was lower than that of wild smolts.

3, 春季の成長率および体サイズがサクラマスの0⁺モルト化に与える影響

下田和孝（北海道立水産孵化場）（97-105）

Effects of growth rate and body size in spring season on 0⁺ smoltification in masu salmon *Oncorhynchus masou*.

Kazutaka Shimoda

Individual body sizes, growth and 0⁺ smoltification of masu salmon *Oncorhynchus masou* fingerlings were monitored during 0⁺ spring season under artificial rearing conditions. The rate of 0⁺ smoltification was studied in relation to the specific growth rates and fork length. On 14 March all the individuals were at parr. The rates of 0⁺ smoltification were 14.1% on 25 April and 85.9% on 3 June. Of the individuals that were 9 cm (in fork length) and longer on 14 March 80% or more became 0⁺ smolts on 3 June. The individuals under 9 cm on 14 March the 0⁺ smoltification rates of 3 June were associated with the specific growth rate from 14 March to 25 April. Of the individuals 11 cm and over on 25 April 82% became 0⁺ smolt on 3 June. The individuals below 11 cm on 25 April 0⁺ smoltification rates on 3 June were associated with the specific growth rates from 25 April to 3 June. On 14 March and 25 April the potential 0⁺ smolts were larger than the potential parr in consideration of their mean fork length. However, the critical size between the potential 0⁺ smolts and the potential parr was not clear. These results show that the 0⁺ smoltification of masu salmon is influenced by body size and specific growth rates in the 0⁺ spring.

4, シンヤモ (*Spirinchus lanceolatus*) 粘着性除去卵に付着した鉄の濃度と孵化への影響

武田典子（北海道立水産孵化場）・楠田聡（北海道立水産孵化場）・寺西哲夫（北海道立水産孵化場）・今田和史（北海道立水産孵化場）（107-113）

Effect of iron concentrations on hatching rates of adhesive-eliminated osmerid fish (*Spirinchus lanceolatus*) eggs from the surface .

Noriko Takeda, Satoshi Kusuda, Tetsuo Teranishi and Kazushi Imada

Expecting the artificial culture of a huge number of osmerid fish (*Spirinchus lanceolatus*) eggs in hatching bottles, we preliminarily attempted to

investigate incubation water conditions for the elimination of egg adhesives using by tannic acid. There was a serious problem: that was, the eggs were covered with certain dark-brown particulates. We identified the particulate substances, and also determined their influences on hatching rates. The eggs examined, spontaneously spawned eggs and artificially fertilized eggs, were collected from the fish returned to the Kushiro River and Mukawa River. The eggs used were incubated from November 2000 to April 2001 in the Mukawa Hatchery. Since we detected iron from the particulates, total iron concentrations in the culture water and eggs were determined. Total iron concentrations in the water were 1 mg L⁻¹ or greater over the incubation period, while iron concentrations of tannic acid - treated eggs increased up to 250-300 μ g per 20 eggs (total iron dissociated from the surface of 20 eggs) by the end of the incubation. Spontaneously spawned eggs showed a lower concentration of 50 μ g per 20 eggs or less. Hatching rates of spontaneously spawned eggs were higher than 90%, while those of eggs covered with high iron levels were 70% or less. From the difference in the iron concentrations, we need a method for eliminating surface adhesives from eggs to reduce iron attachment from the water.

5, 北海道におけるブラウントラウトの年齢と成長および性成熟

青山智哉（北海道立水産孵化場）・鷹見達也（北海道立水産孵化場）・下田和孝（北海道立水産孵化場）・小山達也（北海道立水産孵化場）（115-123）

Age, growth and sexual maturity of brown trout, *Salmo trutta*, in Hokkaido, Japan .

Tomoya Aoyama, Tatsuya Takami, Kazutaka Shimoda and Tatsuya Koyama

A total of 175 brown trout, *Salmo trutta*, were sampled from the Chitose River and Atsuta River basin systems in Hokkaido, northern Japan, from

April to November in 2000. By comparing fork length with age, determined by scale analysis, a correlation between fork length and age was obtained as follows: 7-13 for 1⁺, 12-27 for 2⁺, 18-33 for 3⁺, 29-31 for 4⁺, 31-46 for 5⁺, and 56-57 cm for 6⁺ years. Two fish from the samples showed better growth than the others. These two individuals had probably migrated to the sea during their second spring. The length and age at the first sexual maturity were 11 cm and 1⁺ for males and 19 cm and 2⁺ for females, respectively. The results suggest that, since serial life stages were sampled from the rivers, brown trout introduced to rivers have a high capacity to adapt to the environments in Hokkaido.

6, Lymphocytic apoptosis by infectious hematopoietic necrosis in host.

Makoto Hatakeyama (Hokkaido Fish Hatchery) and Katsunobu D. Sakai (Hokkaido Fish Hatchery) (125-130)

For the pathogenesis of a viral disease, infectious hematopoietic necrosis (IHN), fish infected with IHN virus was studied on the apoptosis of lymphocytes. Healthy rainbow trout *Oncorhynchus mykiss* fingerlings (2.4 g in mean body weight) were injected with the virus at a lethal dose of 10⁵ TCID₅₀ per fish. Based on the detection method of terminal nucleotidyl transferase mediated dUTP nick end labeling (TUNEL), lymphocytic apoptosis induced by IHN virus infection in the hosts was confirmed, but erythrocytic apoptosis was not induced. DNA ladder pattern specific for apoptosis was detected from isolated lymphocytes by agarose gel electrophoresis. Many DNA samples of lymphocytes isolated from infected fish showed DNA ladder pattern. To determine the interrelation between signs of infected fish and the degree of apoptotic response, apoptosis by DNA ladder was categorized into the following three patterns: "pattern I", absent DNA ladder;

“pattern II”, weak DNA ladder; “pattern III”, clear DNA ladder. The “pattern II” was detected from two in the 5 samples on day 2 post-infection. On day 7 post-infection, all samples (N=10) showed positive for the ladder patterns including three “pattern II” and seven “pattern III”. From the data, apoptotic responses of lymphocytes demonstrated lasting processes from incipient stages to death.

7, Cell apoptosis caused by recombinant protein from infectious hematopoietic necrosis virus genes.

Makoto Hatakeyama (Hokkaido Fish Hatchery) and Katsunobu D. Sakai (Hokkaido Fish Hatchery) (131–138)

The apoptosis of lined fish cells, RTG-2 cells, induced by recombinant proteins encoded in infectious hematopoietic necrosis (IHN) virus genome was investigated by detecting cytopathic effects (CPE) and chromosomal DNA ladder. Recombinant proteins from IHN virus genes, including N, M and G genes, were obtained by using the *E.coli* expression method. RTG-2 cells were incubated with the obtained recombinant N, M and G proteins at 15 or 20°C. Apoptosis was detected by DNA laddering assay. The RTG-2 cells showed morphological changes when incubated with recombinant M protein at doses of 40–200 μ g per ml medium at 20°C for 72 h. Morphological changes were characterized by cell shrinkage and marginal chromatin condensation associated with a typical CPE of cells infected with IHN virus. Simultaneously, we confirmed that the cells indicating the morphological changes underwent apoptosis. This CPE was shown to be due to apoptosis induced by the M protein. RTG-2 cell apoptosis induced by extracellular contact with recombinant M protein clearly explained that the M protein is essential to induce CPE formation and apoptosis in host

tissues infected with IHN virus.

8, 塘路湖およびシラルトロ湖の水草

片桐浩司 (株式会社セ・プラン) ・伊藤富子 (北海道立水産孵化場) ・安富亮平 (北海道立水産孵化場) ・三上英敏 (北海道環境科学研究センター) ・石川靖 (北海道環境科学研究センター) ・五十嵐聖貴 (北海道環境科学研究センター) ・永洞真一郎 (北海道環境科学研究センター) ・高野敬志 (北海道立衛生研究所) (139–142)

Water plants in Lakes Toro and Shirarutoro, Hokkaido, northern Japan.

Koji Katagiri, Tomiko Ito, Ryohei Yasutomi, Hidetoshi Mikami, Yasushi Ishikawa, Seiki Igarashi, Shinichiro Nagahora and Keishi Takano

Water plants were studied in Lakes Toro and Shirarutoro, the Kushiro Mire, Hokkaido, northern Japan, in 2001. Seven species of water plants were collected in Lake Toro and eight in Lake Shirarutoro. In the two lakes, number of species of water plants could have decreased abruptly in the last decade.

9, (短報) サクラマス幼魚の遊漁による釣獲サイズについて

安藤大成 (北海道立水産孵化場) ・宮腰靖之 (北海道立水産孵化場) ・竹内勝巳 (北海道立水産孵化場) ・永田光博 (北海道立水産孵化場) ・佐藤孝弘 (北海道立林業試験場) ・柳井清治 (現所属; 北海道工業大学環境デザイン学科) (143–147)

(Short paper) Size of juvenile masu salmon *Oncorhynchus masou* caught by recreational fishing.

Daisei Ando, Yasuyuki Miyakoshi, Katsumi Takeuchi, Mitsuhiro Nagata, Takahiro Sato and Seiji Yanai

We compared fish size and capture method, by angling, cast-netting and electrofishing, to examine the size-selectivity of juvenile masu salmon (*Oncorhynchus masou*) landed. In 1999, hatchery-

reared 0+ masu salmon were marked by clipping the adipose fin and then stocked in the Ichiban River, in central Hokkaido. The size of stocked juvenile masu salmon caught by angling was significantly larger than those of fish caught by cast-netting or by electrofishing between July and August. The results suggest a size-selectivity by angling just after stocking. However, there was no difference in October when all fish grew larger than the threshold size vulnerable to angling. In the stream survey using cast-net and electrofishing, unmarked pre-stocked 1+ \leq stream-resident type fish and 0+ fish originated from eggs planted the previous year, were also captured. A comparison of the ratios of unmarked 0+ and 1+ \leq fish captured in June and October suggested that survival of 1+ \leq fish was higher than 0+ fish. Therefore, there may be a size-independent difference in the catchability of masu salmon.

10, (短報) 腎臓における傍糸球体細胞数を用いたサクラマススモルトの海水適応能評価

水野伸也 (北海道立水産孵化場) · 三坂尚行 (北海道立水産孵化場) · 佐々木義隆 (北海道立水産孵化場) · 村上 豊 (北海道立水産孵化場) · 安藤大成 (北海道立水産孵化場) · 北村隆也 (北海道立水産孵化場) · 神力義仁 (北海道立水産孵化場) · 笠原 昇 (北海道立水産孵化場) (149–152)

(Short paper) Assessment for seawater adaptability of smolting masu salmon using juxtaglomerular cell number in the kidney.

Shinya Mizuno, Naoyuki Misaka, Yoshitaka Sasaki, Yutaka Murakami, Daisei Ando, Takaya Kitamura, Yoshihito Shinriki and Noboru Kasahara

The interrelationship between juxtaglomerular cell number and the seawater adaptability index (SWAI) in smolting wild and hatchery-reared masu salmon (*Oncorhynchus masou*) was examined to determine whether the cell number would

be a useful indicator of seawater adaptability. Juxtaglomerular cell number correlated with the SWAI value in both smolting wild and hatchery-reared masu salmon. The results indicate that juxtaglomerular cell number is a useful indicator for seawater adaptability in smolting masu salmon.

11, (短報) 人為選抜に伴うサクラマスのジャックの出現率低下

下田和孝 (北海道立水産孵化場) · 大森 始 (北海道立水産孵化場) · 佐々木義隆 (北海道立水産孵化場) (153–155)

(Short paper) Reduction of jacking rates by artificial selection of masu salmon *Oncorhynchus masou*.

Kazutaka Shimoda, Hajime Omori and Yoshitaka Sasaki

In the Mori experimental branch of the Hokkaido fish hatchery, masu salmon *Oncorhynchus masou* males were matured for 5 months (jacks) or 17 months (hooknose) after smoltification, under artificial rearing conditions. Eggs from 2+ maturing females had been fertilized with milt from hooknose. Thereafter we monitored their jacking rates from 1989 to 2000. Jacking rates were gradually reduced from generation to generation. The data suggests that jacking of masu salmon is influenced by genetic factors.

第57号 (2003)

1, DNA form homologous to the M2 gene RNA of infectious hematopoietic necrosis virus in salmonid fishes.

Kunio Suzuki (Hokkaido Fish Hatchery) and D. K. Sakai (Hokkaido Fish Hatchery) (1–11)

Infectious hematopoietic necrosis (IHN) virus belonging to the family Rhabdoviridae with an

unsegmented single-stranded and negative-sense RNA genome causes severe and acute epizootics among most salmonid fishes. Here, we report on the DNA form of M2 gene RNA (one of the six genes encoded in the viral RNA genome) in salmonid fishes. The M2 gene DNA form was investigated in seven lots of chum salmon, *Oncorhynchus keta*, from eyed-egg embryos to asymptomatic fry derived from adults homed in four rivers in Hokkaido, Japan, by PCR. Consequently, the M2 gene DNA form was detected in five out of seven lots. Then, the specificity of the amplified DNA was confirmed by digestion patterns with restriction endonuclease, *Xho* I and by DNA sequencing. The DNA form was also detected in IHN virus-infected salmonid fishes and IHN virus-infected cell lines (CHSE-214 cells and RTG-2 cells). The copy number of the M2 gene DNA form in these samples was quantified by PCR. Virions were detected from IHN virus-infected salmonid fishes and cell lines, but not from asymptomatic chum salmon fry. Transfection of chum salmon eyed-egg embryo nucleic acids digested with DNase I or RNase A into CHSE-214 cells revealed that the M2 gene DNA form was detected when transected with chum salmon eyed-egg embryo RNA and subcultured five times. Moreover, M2 mRNA was detected from the transected subculture cells supplemented with chum salmon eyed-egg embryo DNA. These results suggest that M2 gene RNA is reversely transcribed into the M2 gene DNA form in fish, and also that the generated DNA form, in turn, is transcribed into mRNA with no association with the virions.

2, 硝酸イオンがオオエゾヨコエビ産卵数と落葉付着微生物活性に及ぼす影響実験

伊藤富子（北海道立水産孵化場）・川村洋司（北海道立水産孵化場）（13-17）

Effect of nitrate on clutch size of an amphipod, *Jesogammarus jesoensis*, and microbial activity of

leaves: a bioassay.

Tomiko Ito and Hiloshi Kawamura

The effect of nitrate ($10 \text{ mg} \cdot \text{l}^{-1}$ as NO_3) on clutch size (number of eggs) of an amphipod, *Jesogammarus jesoensis* (Gammaridea, Anisogammaridae), and microbial activity on leaves was studied experimentally. The precopula of the amphipod was reared in the treated water for 20 days. The reduction of clutch size was clearly detected in nitrate at $10 \text{ mg} \cdot \text{l}^{-1}$ in comparison with untreated control. After 4 weeks exposure with the treated water ($10 \text{ mg} \cdot \text{l}^{-1}$ as NO_3), the microbial activity on leaves was higher than that with the untreated control. Thus the reduction of the clutch size could be derived from physiological effects of nitrates, but not from the deterioration of food nutrients.

3, Effect of salmon carcasses on growth of a freshwater amphipod, *Eogammarus kygi*: an experimental study.

Tomiko Ito (19-27)

The effect of salmon carcasses on the growth of a freshwater amphipod, *Eogammarus kygi* (Gammaridea, Anisogammaridae), was studied experimentally. The growth rate was determined by rearing juveniles of the amphipod with four food treatments (“leaves”, “salmon”, “leaves and salmon”, and “leaves with salmon leachate”) for 20 days. The mass loss and oxygen consumption of leaves were also measured for the three treatments with leaves. The oxygen consumption rate of leaves was lower in treatment of “leaves” than in either “leaves and salmon” or “leaves with salmon leachate”, indicating that the microbial activity on leaves was enhanced by the presence of salmon carcasses. The mass loss of leaves did not differ among the three treatments with leaves. Growth rate of the amphipod was higher in “leaves and salmon” than in “leaves

with salmon leachate” and also higher in “salmon on” than in “leaves”, indicating that the salmon carcass directly facilitates the growth of the amphipod. Since the growth rate was higher in “leaves with salmon leachate” than in “leaves”, the carcasses also indirectly facilitate the amphipod growth through leaf fertilization.

4, 朝鮮半島と北海道の沿岸で漁獲されたサクラマス の形態比較

春日井潔（北海道立水産孵化場）・成 基百（大韓民国国立水産振興院襄陽内水面研究所）（29-35）

Comparison of morphometric and meristic characters of masu salmon from the coasts of the Korean Peninsula and Hokkaido Island, Japan in the Sea of Japan.

Kiyoshi Kasugai and Seong Ki Baek

To clarify the relationship between cohorts of masu salmon (*Oncorhynchus masou*), which were caught near the coasts of the Korean Peninsula and Hokkaido Island, Japan, in the Sea of Japan (East Sea), morphometric and meristic characters of masu salmon were compared. Seven morphometric characters (fork length, head length, body depth, predorsal length, upper jaw length, snout length, and caudal peduncle depth) and four meristic characters (lateral line scale, pyloric caeca, dorsal fin ray, and pectoral fin ray) were used for analyses. From discriminant function analysis on the morphometric characters, masu salmon from the Korean Peninsula had relatively larger caudal peduncle depth and smaller predorsal length than those from Hokkaido Island. As for the meristic characters, significant differences were observed in the number of lateral line scales, pyloric caeca, and dorsal fin rays among locations; masu salmon from the Korean Peninsula had more lateral line scales, and fewer dorsal fin rays and pyloric caeca. Differences in the morphometric and the meristic characters of masu salmon between the Korean Peninsula and Hokkaido

Island suggested that masu salmon caught near Hokkaido Island were not identical with those near the Korean Peninsula.

5, ホマカイ川における倒流木と魚類の生息密度との 相互関係

下田和孝（北海道立水産孵化場）・小林美樹（北海道立水産孵化場）・工藤 智（北海道立水産孵化場）・船岡輝幸（現所属；社団法人水産物検査協会）（37-43）

The mutual relationship between coarse woody debris and fish population density in the Homakai river.

Kazutaka Shimoda, Miki Kobayashi, Satoshi Kudo and Teruyuki Funaoka

Types of accumulation of coarse woody debris (CWD) and the effects of CWD on pool formation were investigated in the Homakai river, Hokkaido, Japan. A total number of 31 CWD were observed according to the grouping method by Abe and Nakamura (1996) and 77% of them were composed of debris from riverside forest by bank erosion. CWD was responsible for creating 79% of the total number of 72 pools. We determined the fish population density in large and small CWD areas. Population densities of three fish species (Sakhalin ninespine stickleback, *Pungitius tymensis*; Siberian stone loach, *Noemacheilus barbatulus*; Lamprey, *Lethenteron* sp.) were high in the large CWD area. These results suggest that CWD play important role in creating fish habitats by increasing pools. Thus, the conservation of the riverside forest was related to the creation of fish habitats in the Homakai river.

6, (短報) 秋放流されたサクラマス幼魚の河川間移動 安藤大成（北海道立水産孵化場）・河村 博（北海道立水産孵化場）（45-48）

(Short paper) Migration of juvenile masu salmon stocked in autumn into another river.

Daisei Ando and Hiroshi Kawamura

Some of juvenile masu salmon *Oncorhynchus masou* stocked in the lower area of a river in autumn, 2001, were recaptured in another stream in winter. It was evident that those juveniles had been dispersed from the stocking river to nearshore water with the heavy flood of rain, and that then they moved up another stream through the freshwater layer on nearshore water. From the results, we consider that masu salmon migration from the originating stream to a pioneering stream is important in the expansion of the habitat, even though it is feared that an undesirable influence of the stocking on the ecosystem may occur.

7, (短報) 河川下流域に放流されたサクラマスモルトの遊漁による釣獲尾数の推定

安藤大成 (北海道立水産孵化場)・宮腰靖之 (北海道立水産孵化場) (49-53)

(Short paper) Estimates of catch numbers by recreational fishing for masu salmon smolts stocked in the lower area of a river.

Daisei Ando and Yasuyuki Miyakoshi

The number of hatchery-reared masu salmon (*Oncorhynchus masou*) smolts caught by recreational fishing was estimated by using creel census with counting the number of anglers by visual observation. For two days, just after the opening day of fishing for masu salmon, 0.78% of stocked masu smolts seemed to be caught by angling in the lower area of a river. Stocking masu smolts in the river will be an effective method to protect masu salmon juveniles from angling if there is an appropriate regulation.

8, (短報) 別寒辺牛川水系ホマカイ川の魚類相

下田和孝 (北海道立水産孵化場)・小林美樹 (北海道立水産孵化場)・工藤 智 (北海道立水産孵化場)・小島 博 (北海道立水産孵化場) (55-58)

(Short paper) Fish fauna of Homakai river involved in the Bekaubeushi river system.

Kazutaka Shimoda, Miki Kobayashi, Satoshi Kudo and Hiroshi Kojima

Freshwater-fish fauna of Homakai river involved in the Bekaubeushi river system, Hokkaido Japan, was investigated in 2000. Twelve species out of 7 families were identified. The most common species in the Homakai River was sakhalin ninespine stickleback (*Pungitius tymensis*). Fish species were investigated to compare between upper and lower sampling stations from the dam of the river. Three diadromous species (Japanese dace, *Tribolodon hakonensis*; floating goby, *Gymnogobius urotaenia*; river sculpin, *Cottus amblystomopsis*) were not distributed in the upper-dam stations, but their population densities were very high in the lower-dam station. These results show that the dam has a great influence on the freshwater-fish distribution of the Homakai river.

第58号 (2004)

1, Mass Loss of Chum Salmon Carcasses: Observations in Field and Laboratory

Tomiko Ito (Hokkaido Fish Hatchery), Miyuki Nakajima (Hokkaido Fish Hatchery) and Kazutaka Shimoda (Hokkaido Fish Hatchery) (1-7)

The mass loss process of chum salmon carcasses was observed both in the field and the laboratory. In a spring stream, Naibetsu River, Chitose, Hokkaido, northern Japan, the mass loss was almost completed in about 30-40 days in fall and 70-80 days in winter. On the other hand, it took about 250 days for almost complete mass loss in the laboratory, where the carcasses were put in spring water filtered by a sponge filter to remove any macroinvertebrates. The average mass loss rate ($\text{weight loss} \cdot \text{initial weight}^{-1} \cdot \text{day}^{-1} \cdot 100$) was 2.41 in fall, 1.35 in winter and 0.37 in laboratory, respectively. Since water temperature,

water quality and flow speed were similar in the field and laboratory and macroinvertebrates were abundant in the spring stream, these results might be accounted for by the lack of macroinvertebrates in the laboratory. Numerous females of a copepoided Crustacea, *Acanthocyclops vernalis* (Fisher), colonized the carcasses in laboratory.

2, 酸性河川の底生動物：北海道南部・南茅部町八木川水系の例 (9-15)

伊藤富子 (北海道立水産孵化場)・安富亮平 (北海道立水産孵化場)・村上 豊 (北海道立水産孵化場)・田島則善 (北海道渡島東部地区森づくりセンター)

Benthic Macroinvertebrates in an Acidified River: An example in the Yagi River, Minami-kayabecho, Hokkaido, Northern Japan

Tomiko Ito, Ryohei Yasutomi, Yutaka Murakami and Noriyoshi Tajima

The benthic macroinvertebrates were compared between the acidified (pH 3.7-5.7) and neutral (pH 6.6-8.1) tributaries of the Yagi-gawa River, Hokkaido, northern Japan, in 2002. Taxa and biomass were lower in the acidified sites than the neutral site, but individual numbers were not different between the sites. *Baetis* and other Ephemeroptera, *Lepidostoma* (Trichoptera) and *Sternomoera rhyaca* (Amphipoda) were very scarce or completely absent in the acidified sites, although they were abundant in the neutral site. On the other hand, Nemouridae and Capniidae (Plecoptera) were abundant even at acidified sites.

3, 固定方法の違いによるサケ・マス稚幼魚の体サイズ変化 (17-32)

安藤大成 (北海道立水産孵化場)・宮腰靖之 (北海道立水産孵化場)

Changes in the fish size of salmonid fry and juveniles by the difference in fixation methods

Daisei Ando and Yasuyuki Miyakoshi

Relationships between live and preserved fish size at the fry and juvenile stages of chum salmon, *Oncorhynchus keta* and pink salmon, *O. gorbuscha* were investigated. Three fixation methods were tested: 1) 5% formalin diluted with distillation water (formalin fixation), 2) 67.9% ethanol (ethanol fixation), and 3) 67.9% ethanol preservation after 5% formalin fixation for 24h (formalin-ethanol fixation). Fork length after fixation with formalin or formalin-ethanol shrank at a rate of 3.3-5.8%, however the length in ethanol fixation showed two patterns, shrinking and elongating. On the other hand, the changes in weight were greater than that in length. Body weight after fixation with formalin increased 8.6-17.7%, but decreased 6.6-22.3% in the formalin-ethanol fixation. In the formalin-ethanol fixation, shrinkage occurred within 7-11 days and became more stable after 31-38 days in ethanol preservation. In the formalin-ethanol fixation, the degree of shrinkage depended on the time of the first formalin fixation and the initial fish size. Decreases in weight were relatively greater in the smaller fish than in the larger ones. The most important factor affecting the shrinkage of fish size was the kind of diluted solution of the first formalin fixation. Shrinkage rates with formalin fixation were significantly larger in seawater than in freshwater. To forecast shrinkage in the formalin-ethanol fixation, it is important that the first formalin fixation should be conducted under the constant conditions, and fish size should be measured more than one month after the second ethanol preservation.

4, The First Capture Report on Histological Observation of Largemouth Bass, *Micropterus salmoides*, Ovary in Hokkaido (33-39)

Tetsuo Teranishi (Hokkaido Fish Hatchery) and Hideki Ohhama (Yamanashi Prefectural Fisheries Technological Center)

Largemouth bass (HB) was caught for the first time in a small lake in Hokkaido on July 2001. The ovary of HB was observed histologically to see whether the largemouth bass spawned or not. The ovaries of the largemouth bass (YB) caught in Yamanashi Prefecture was compared with HB. The GSI value of the HB was 2.42%. The GSI values of the YB in July showed a range of 2.5% to 5.6%. The ovary of HB contained mainly atretic oocytes at the pre-matured stage (the yolk globule stage and the migratory nucleus stage) and the follicle atresia. Post-ovulatory follicles were not present in the ovary of the HB. In July ovary samples of the YB indicated levels were equal to GSI values of the HB. The YB also contained oocytes from pre-mature through to the ripe oocyte stage. These results suggest that the oocytes of the HB developed on the eve of finishing the vitellogenesis but degenerated without spawning.

5, 融雪水が小河川の酸性化とシロサケ稚魚およびサクラマス幼魚の浸透圧調節機能へ与える影響 (41-51)
渡辺智治 (北海道立水産孵化場) ・安富亮平 (北海道立水産孵化場) ・今田和史 (北海道立水産孵化場)

Effects of meltwater on acidification in small stream and osmoregulation in chum salmon juveniles and masu salmon fry

Tomoharu Watanabe, Ryouhei Yasutomi, and Kazusi Imada

We observed the reduction of tributary pH and alkalinity during snowmelt season in the Shokanbetu river in northern Hokkaido, Japan. The lowest pH was 6.28 in the rillet of a tributary during early snowmelt on March 26, while SO₄, NO₃, and electric conductivity increased. On the other hand, the mainstream recorded pH 6.87. The results suggest small acidification during snowmelt season in northern Hokkaido. When chum salmon *Oncorhynchus keta* fry and masu salmon *O.masou* yearlings were experimentally

exposed with acid meltwater (pH4.9) for 3 days, a significant decrease in blood sodium level was observed in chum salmon fry, but not in masu salmon yearlings. The findings suggest that chum salmon fry are more sensitive to acidification with meltwater than masu salmon yearlings.

6, (短報) 北海道石狩北部濃昼川の魚類相と河川工作物との関係 (53-58)

下田和孝 (北海道立水産孵化場) ・中島美由紀 (北海道立水産孵化場) ・伊藤富子 (北海道立水産孵化場)
Relationship between Artificial Construction and Fish Fauna of the Gokobiru River, Northern Ishikari, Hokkaido Japan.

Kazutaka Shimoda, Miyuki Nakajima and Tomiko Ito

Freshwater-fish fauna of the Gokibiru River, Hokkaido, Japan, was investigated in 2000, 2001 and 2002. Nine species belonging to 4 families were collected. The common species in the Gokibiru river were masu salmon (*Oncorhynchus masou*), Japanese dace (*Tribolodon hakonensis*), tyuman river sculpin (*Cottus hangiongensis*), wrinklehead sculpin (*Cottus nozawae*) and floating goby (*Gymnogobius* sp. 2). Three diadromous species (*Tribolodon hakonensis*, *Cottus hangiongensis* and *Gymnogobius* sp. 2) were not distributed in the upper stations because of the erosion control dam with fishway, indicating that they could not move through the fishway.

7, (短報) 降海後のサクラマス幼魚の鱗における中間帯の形成 (予測) (59-66)

安藤大成 (北海道立水産孵化場) ・宮腰靖之 (北海道立水産孵化場) ・永田光博 (北海道立水産孵化場)

Estimation of intermediate band formation in the scale patterns of masu salmon juveniles migrated into the sea

Daisei Ando, Yasuyuki Miyakoshi and Mitsuhiro Nagata

Scale patterns of nine masu salmon, *Oncorhynchus masou* juveniles just after migrating into the sea were investigated. The scales had wide spaced circuli outside the freshwater zone, and this band estimated 2-10 (mean 6.8) circuli, while some fish had narrow spaced circuli at the end part of the band (*intermediate* band). We thought that the difference in the patterns of the band could be used for a "entry check" to determine entry timing into coastal waters because it agreed with the downstream time of masu salmon smolts. More detailed investigation is required to understand the formation process of the scale pattern in the *intermediate* band.

著者索引 (1946~2004)

著者名 (アルファベット順)	卷-巻別番号					
阿部 春三	19-5	21-2				
安藤 大成	56-2	56-9	56-10	57-6	57-7	58-3
	58-7					
青海 昭紀	21-3					
Tomoya Aoyama	52-3	53-10				
青山 智哉	51-7	51-8	51-9	53-3	53-9	56-5
新谷 康二	36-2	44-5	45-7	46-3		
有末 二郎	49-6					
浅見 大樹	47-2	49-3	51-2	51-4	51-5	51-6
	52-8	55-4				
浅野 俊威	24-2	24-7				
阿刀田光紹	23-4	24-1	24-7	26-1	27-4	27-5
	27-6	28-1	29-2	31-2		
粟倉 輝彦	17-5	17-6	18-1	18-2	19-1	20-1
	20-5	21-1	21-3	22-5	23-1	24-1
	24-2	24-5	24-7	26-5	27-1	27-2
	28-1	29-1	31-4	31-6	31-7	32-1
	32-2	32-3	33-8	35-3	35-7	36-5
	36-6	37-5	37-6	38-3	38-4	38-6
	39-9	40-2	40-3	41-3	44-1	47-1
	48-3	48-5	48-8	48-11		
東谷 隆幸	39-6					
伴 真俊	38-8	39-3	42-3	42-4	43-8	
千葉 善昭	24-1					
江口 弘	1-4	2-2	3-2	4-2	4-10	5-2
	5-5	6-7	7-4	8-5	8-7	9-9
	9-10	10-9	10-10	10-18	11-8	11-10
	11-11	12-1	12-3	12-9	12-10	12-11
	13-2	13-8	13-9	13-10	13-11	14-1
	14-3	14-11	14-13	15-1	15-2	15-9
	15-10	15-12	16-1	16-7	16-10	17-1
	18-7	19-8	19-9	20-6	20-7	21-7
	22-1					
布田 博敏	44-2					
藤田 忠	8-13	9-3	10-13			
Makoto Fujiwara	52-1					
藤原 真	50-1	51-3	53-3			
麓 龍司	11-13	12-5	14-4			
船岡 輝幸	57-5					
羽田 良禾	21-6					
原 彰彦	39-6					
原 茂	2-2	5-5	10-6			
原 武	40-3					
橋本武三郎	4-5					
Makoto Hatakeyama	55-5	56-6	56-7			
畑山 誠	44-6	46-2				
蜂谷 俊雄	6-3					

Hirofumi Hayano	52-1					
隼野 寛史	49-2	50-1	51-2	51-3	53-4	53-5
	53-7					
早坂 誠一	20-3					
林 和明	30-4	31-8				
林中 信男	13-8	15-10	16-6			
林 成治	10-13					
疋田 豊治	7-6	7-8	11-7	13-6		
疋田 豊彦	5-6	6-10	7-4	8-2	9-7	9-9
	14-8	16-12	17-7	18-4	19-3	20-10
	22-6	28-7	34-6			
疋田 裕雍 (旧名 豊彦)	10-7	11-4	11-15			
日野 修次	49-6					
平井 尚志	42-2					
平野 和夫	47-2	51-2				
広部 武男	9-3	10-12				
本間 馨	17-6	18-2				
本間 正男	37-3	38-1	39-6	41-6	41-7	
細川 澄夫	18-6					
市川美代枝	6-3					
五十嵐聖貴	56-8					
五十嵐真一	1-2					
五十嵐孝夫	21-8					
今田 和史	26-1	27-5	27-6	28-4	29-4	31-2
	31-3	31-6	31-7	33-6	34-5	35-3
	36-3	38-6	39-7	39-10	41-11	43-6
	43-7	45-2	49-3	49-4	49-5	49-6
	56-4	58-5				
今井 輝	14-7	15-8	18-9			
井上 勝弘	24-1					
犬飼 哲夫	4-8					
James R. Irvine	50-1	51-3	52-1	52-5		
石田 昭夫	3-1	4-1	4-7	5-3	5-4	6-9
	7-7	7-9				
石田 力一	2-5	3-3	4-9	5-7		
石井 清士	27-2					
石川 博	4-5					
石川 靖	56-8					
石川 嘉郎	11-2	14-9	16-8			
伊藤 和雄	30-5					
伊藤小四郎	8-15	10-13	10-14	10-15	12-7	12-8
	13-7	14-5	14-6	15-2	15-4	15-5
	15-6	16-4	17-4	18-3	19-2	25-2
	31-1					
伊藤 繁	6-3					
伊藤 哲司	10-3	16-4				
Tomiko Ito	57-3	58-1				
伊藤 富子	24-2	24-7	26-1	26-2	27-4	28-5
	29-3	30-2	31-4	31-6	31-7	33-1
	35-2	35-3	36-3	38-6	43-6	54-4

		55-6	55-7	56-8	57-2	58-2	58-6
伊藤	安男	18-6					
伊藤	嘉郎	11-1					
岩見	俊則	43-4	43-5	45-8	46-4		
岩田	宗彦	41-4	42-7	46-3			
伊沢	敏穂	39-7	41-3	41-11	43-6	49-3	49-4
		49-6	55-6				
泉	孝行	38-8	39-3	40-5	41-8	42-2	
甲斐	哲夫	8-7	8-14	9-12	10-17	11-8	12-9
		12-10	12-11				
兼子	樹広	21-3					
金子	豊二	53-7					
笠原	昇	36-2	38-8	39-3	42-3	42-4	43-8
		45-7	45-9	47-4	56-2	56-10	
春日井	潔	51-7	53-8	57-4			
片桐	浩司	55-7	56-8				
川尻	敏文	49-4	49-5	51-4	51-6		
Hiloshi Kawamura		52-3					
河村	博	32-2	33-3	34-3	35-6	37-1	37-2
		38-2	39-4	39-11	41-9	57-6	
川村	洋司	35-1	38-5	42-2	49-6	53-2	53-3
		53-9	55-6	55-7	57-2		
香山	勳	5-8	6-6	7-12			
菊地	資郎	19-5					
木村	鎚郎	5-2					
木村	喬久	26-5	48-2				
木村	義一	11-2	18-11				
喜多	正広	39-12					
北村	隆也	41-7	41-10	43-3	43-7	45-2	45-5
		53-1	55-6	56-2	56-10		
帰山	雅秀	38-2					
小林	明弘	21-4					
小林	耕一	49-4	49-5				
小林	美樹	40-7	43-4	43-5	45-8	47-5	52-5
		55-2	57-5	57-8			
小林	哲夫	7-1	8-1	8-9	8-10	10-4	11-1
		18-2					
小出	展久	41-8	45-7	52-7			
小島	博	33-4	34-2	34-4	34-6	35-4	35-5
		36-5	36-6	36-7	37-5	38-3	38-7
		39-2	39-3	39-9	39-12	40-5	40-6
		41-4	41-5	42-6	42-7	46-3	46-4
		53-7	57-8				
小松志知子		41-4					
近藤	賢蔵	9-1	10-16	12-2			
小山	達也	49-1	52-7	56-5			
久保	達郎	1-1	1-7	2-3	2-8	3-5	3-8
		4-12	11-3				
工藤	智	30-4	31-8	36-1	41-12	45-6	45-9
		51-7	57-5	57-8			
倉橋	澄雄	10-14	13-8	15-10	18-5	19-5	19-7

	20-2	21-1	21-2	22-4	22-5	23-2
	26-2					
黒田久仁男	10-16	12-2	12-5			
黒萩 尚	9-10	10-17	11-14	12-4	13-9	14-13
	14-14	14-15	14-16	15-2	16-11	18-10
	19-10	19-11	20-6	20-8	20-9	21-7
	22-6	22-7				
黒川 忠英	40-6	41-4	41-5	42-6	42-7	46-3
楠田 聡	56-4					
李 培翼	47-4					
馬淵 正裕	38-5					
真野 修一	50-2	54-3				
Leo Margolis	48-1					
増田 政司	52-4					
松原 貞夫	41-4	46-3				
松原 孝博	39-6					
松原 敏幸	41-6	45-2				
松本 春義	18-5	19-5	20-2	21-1	21-2	22-4
	23-2	28-3	30-3	30-7	32-2	
三原 健夫	1-6	2-9	6-3	7-2	10-9	12-1
	13-1	16-11				
三上 英敏	49-6	56-8				
三木 伸一	32-1					
皆川 久	11-16	12-3	13-4	13-8		
源 雅子	23-3					
三坂 尚行	49-9	51-7	54-3	56-2	56-10	
三浦 猛	42-2					
Yasuyuki Miyakoshi	52-1	52-9				
宮腰 靖之	49-8	50-1	53-4	53-5	53-6	56-9
	57-7	58-3	58-7			
Mahito Miyamoto	52-3					
宮本 真人	37-2	39-1	39-4	40-6	41-1	41-2
	41-4	41-5	42-7	46-3	50-1	52-5
	52-6	53-2				
水野 伸也	56-2	56-10				
森 稔	50-4					
諸住 高	7-12					
元田 茂	3-1	4-1	5-1	5-3		
村上 豊	45-8	48-13	50-4	53-7	55-6	56-10
	58-2					
永洞真一郎	56-8					
長坂 有	52-6					
長澤 和也	44-1	48-12	48-13	50-5		
Mitsuhiro Nagata	52-3	56-1				
永田 光博	39-1	39-4	39-5	41-1	41-2	41-9
	43-5	49-1	50-1	50-3	51-1	52-5
	52-6	53-2	53-4	53-5	54-2	56-9
	58-7					
Kazuaki Naito	53-10					
内藤 一明	46-5	48-14	49-7	49-9	51-7	56-2
中島 幹二	42-6	47-3				

Miyuki Nakajima	58-1						
中島美由紀	54-2	54-4	55-6	58-6			
中野 広	47-4						
忍関 素子	42-2						
西田 秀夫	8-4	8-8	9-8	9-9	10-5		
西村 明	41-6	41-7	43-3	43-7	44-6	45-2	
	46-2						
西野 一彦	3-4	4-13	8-6	11-6			
野村 哲一	38-3	38-4	48-7				
小川 和夫	48-9						
小川 俊文	37-5	39-8					
Hideki Ohhama	58-4						
大東 信一	3-5	4-11	8-13	9-1	10-12	10-15	
	10-16	11-17	14-5	14-17	17-8	19-10	
	19-11	20-8	20-9	22-6	22-7		
Shin-ichi Ohkubo	52-3						
大久保進一	41-12	42-5	44-4	45-6	46-7	47-5	
	49-8	52-5	52-6				
大森 始	46-4	52-7	54-2	56-11			
太田 博巳	39-6	41-3	41-6	41-7	42-1	43-7	
	44-5	44-6	45-2	45-7	46-6		
岡田 鳳二	24-3	26-4	28-2	28-3	30-3	30-4	
	30-7	31-1	31-8	32-3	33-7	36-1	
	40-1	40-7	43-4	43-5	45-7	45-8	
岡田 雋	9-2	9-5	10-3	11-2	14-9	15-4	
	15-5	15-6	16-4	21-8			
岡本 眞美	31-6	31-7					
岡本 剛	5-8	6-6	7-12				
大久保正一	3-5	4-2	4-4	4-11	5-2	6-2	
	6-5	7-5	7-11	8-3	8-12	9-3	
	20-3						
奥野 敦	21-2						
大藏 翠	5-8	6-6					
大藏 武	5-8	6-6	7-12				
小野 威	21-3						
長内 稔	11-11	11-12	12-4	14-16	15-7	16-5	
	17-1	17-3	18-8	18-10	19-8	19-9	
	19-11	20-6	20-7	21-5	22-3	23-4	
	24-4	26-3	28-6	29-4			
太田 亨	24-3						
大竹 好美	5-8	6-6	7-12				
大塚三津男	21-5	22-3	24-4				
大屋 善延	9-4	10-10	10-11				
小山田 博	6-2						
尾崎 豈志	11-1	11-6	16-2	22-2			
斉藤 讓二	39-13						
斎藤 清造	28-3						
坂口 清次	40-3						
D. K. Sakai	43-1	55-5	56-6	56-7	57-1		
坂井 勝信	32-4	33-5	33-7	34-1	35-8	36-4	
	37-4	43-2	44-2	44-3	45-1	45-3	

	46-1	48-5					
坂本 博幸	30-6	39-11	41-9	45-2	52-8		
坂野 栄市	6-4	7-10	8-11	9-6	9-11	10-6	
	11-5						
坂崎 繁樹	49-4	49-5					
櫻庭 弘文	22-1						
柵田 昭二	28-1						
佐野 誠三	1-1	1-5	2-6	2-8	3-6	3-9	
	6-1	7-1	7-3	8-1	8-9	10-1	
佐々木正三	9-10						
佐々木トキ子	41-3						
佐々木義隆	43-7	46-3	47-3	47-4	52-7	56-2	
	56-10	56-11					
佐藤 長蔵	41-6						
Hirokazu Sato	52-10						
佐藤 弘和	52-6						
佐藤 孝弘	56-9						
柴田 尚志	17-6	17-8	19-3	26-2			
島津 武	47-1	48-10					
Kazutaka Shimoda	58-1						
下田 和孝	54-1	54-5	55-1	55-2	55-3	56-2	
	56-3	56-5	56-11	57-5	57-8	58-6	
進藤 宏	8-5						
神力 義仁	39-6	41-6	41-7	41-8	44-5	45-7	
	46-6	49-8	56-10				
成 基百	57-4						
末武 敏夫	2-7	10-8					
Kei-ichi Sugiwaka	52-1						
杉若 圭一	33-7	34-2	34-4	35-4	35-5	36-1	
	36-2	36-5	36-6	37-5	38-3	39-2	
	39-13	40-2	40-4	40-7	41-3	45-4	
	50-1	51-3	53-2				
鈴木 研一	49-8	53-2	54-2				
Kunio Suzuki	57-1						
鈴木 邦夫	44-2	44-3	45-3	46-1	48-5	48-6	
田島 則善	58-2						
高橋 嘉夫	4-5						
Tatsuya Takami	52-2	52-3	52-10	53-10			
鷹見 達也	48-13	50-4	50-5	51-8	53-3	53-9	
	56-5						
高野 和則	27-2						
高野 敬志	56-8						
高安 三次	9-1	10-16	10-20	11-9	11-10	12-2	
	12-5	14-4	16-3	18-11			
武田 典子	56-4						
竹内 勝巳	53-2	54-1	56-9				
民谷 嘉治	43-7	45-2					
田村 正	6-2	7-5	8-3	8-12	9-3	10-12	
	18-2	21-8					
田中 真	37-6						
田中 道敏	2-4						

田中 寿雄	22-6	23-4	24-6	25-3	26-3	27-3
	28-6	29-4	30-1	31-1	31-5	36-2
	39-9	39-11	41-9			
TetsuoTeranishi	58-4					
寺西 哲夫	40-2	41-3	52-4	56-4		
寺尾 俊郎	13-5	13-10	13-11	14-7	14-8	14-11
	14-12	15-8	15-10	15-11	15-12	16-6
	16-7	16-9	16-10	17-9	17-10	18-5
	18-9	19-4	19-5	19-7	20-2	20-4
	21-2	22-4	23-2	24-3	25-1	26-4
	28-3	28-7	30-3	30-7	31-1	32-3
	33-2	38-9	39-8			
故 富田光政	21-6					
外崎 久	14-10	15-9	20-6	21-5	26-2	31-4
	32-3	33-8	39-1	39-4	41-1	
津田 要	38-8					
内山 正昭	11-17	13-4	14-17	18-5	19-5	20-2
	21-2	22-4	23-2	24-3		
上野 康弘	49-7					
宇野 勉	35-2					
浦和 茂彦	44-1	48-8				
渡辺 寛	43-8					
渡辺 克彦	32-2	37-2	39-4			
渡辺 宗重	10-2					
渡辺 智治	58-5					
亘理 信一	9-1					
山田 英明	42-1					
山本喜一郎	1-3	2-1	2-5	3-7	4-3	4-6
	6-8					
山下 和則	52-4					
山下 幸悦	46-3	47-3	54-1	55-2		
山内 皓平	38-8	39-3	39-6	42-1	42-2	42-3
	42-4	43-8				
山崎 文雄	28-1					
柳井 清治	52-6	56-9				
柳瀬 雅子	21-4	22-2				
安川 雅夫	10-13					
安富 亮平	49-3	49-4	49-6	56-8	58-2	58-5
米川 年三	27-4	31-1	35-1	35-3	36-3	38-5
吉田 徳市	54-1					
吉水 守	37-6	48-4				
吉崎 勲	21-2					
吉住 喜好	9-10	10-17	10-18	10-19	11-13	12-6
	13-3	14-2	15-3	16-2	17-2	18-6
	19-6	20-3	21-4	22-2	23-3	24-2
	24-7	26-1	27-4	28-4	31-6	31-7
	35-3	36-3	38-6			

各位

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