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GROWTH AND REPRODUCTIVE DIFFERENCES
OBSERVED BETWEEN FAMILIES OF BROODSTOCK
SELECTED FROM ONE STRAIN OF RAINBOW TROUT SALMO GAIRDNERI

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SUMMARY

The progeny of ten male-female matings selected from one strain of rainbow trout Salmo gairdneri were identified and reared to maturity.

Growth and reproduction data was recorded to determine the magnitude and significance of family differences.

Significant differences were demonstrated indicating that the families were genetically different sub-populations.

The value and advantages of maintaining identifiable families is discussed briefly.

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INTRODUCTION

In 1972, the Harrietta Brood Stock Hatchery implemented an experimental broodstock selection program involving the maintenance of separate family identities with a strain of a species.

The program being tested was proposed by Graham A.E. Gall (1) in his article entitled Rainbow Trout Broodstock Selection. His program was structured to maintain the heterozygosity of a strain of broodstock by; identifying families, selecting for chosen criteria via the families performing the best in that criteria, and perpetuating future broodstock via inter-family matings.

This particular sub-study was undertaken to determine the magnitude, significance, and implications of the differences between the resulting families.

METHODS

Rainbow trout of strain "W" were spawned by mating one hundred females to one hundred different males. The resulting one hundred matings or families were identified and incubated individually. As development progressed, the families were selected on the basis of; eggs per parent female, egg size, percent hatch, percent fingerling mortality, and fingerling growth rates.

By the time the fish were 2 inches in length, the number of families had been reduced to ten. The ten families were identified by ten different fin clip combinations and an equal number of fish from each family were combined for rearing. They matured as three year olds during the fall of 1975.

During the first three spawnings of 1975, each ripe female was identified by her family clip, measured, weighed, and given a number. Each female was individually spawned in to a rubber pan and her eggs were identified with her number. Each females eggs were fertilized and incubated individually. When her eggs reached the eyed stage, production was recorded by number and size of eggs.

During the spawning operations, it was observed that several fish displayed an abnormal growth characteristic. Therefore, six hundred fish were randomly identified by clip and examined for abnormalities.

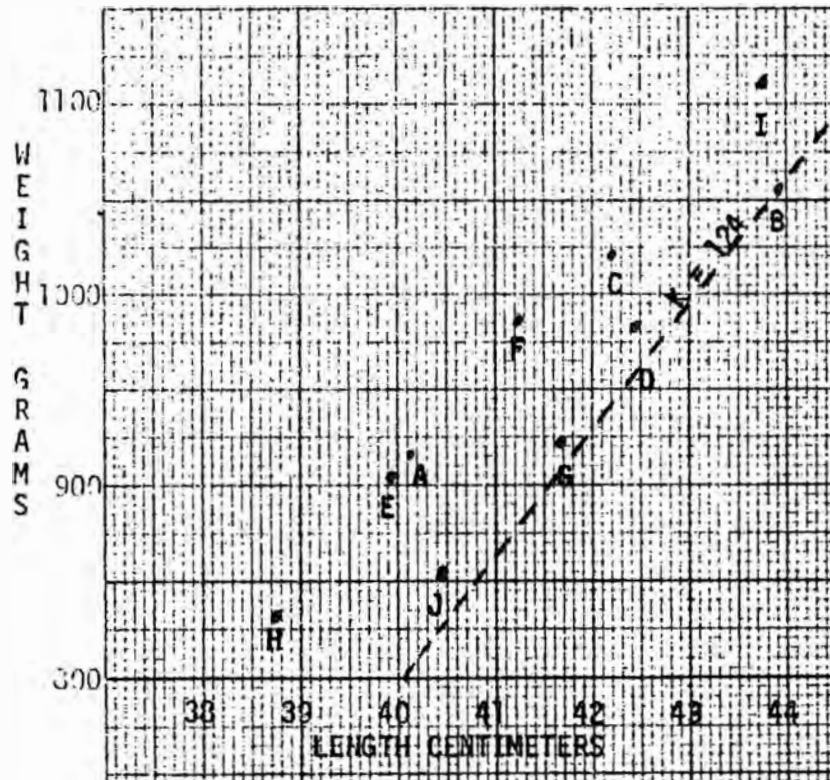
All data was recorded by identifying family clips. Tables were prepared using arithmetical means and regression was determined by the method of least squares. Significance was determined by the "T" test.

RESULTS

Average female length and weight are given by family in Table I. The data shown is the arithmetical mean of the length and weight of all females sampled from each family.

The average family length varied from 38.7 centimeters for family H to 43.9 centimeters for family B. Average female weight varied from 833 grams for family H to 1111 grams for family I. Differences between the respective family means for average length and average weight were significant at the .01 level.

TABLE I AVERAGE FAMILY LENGTH
WEIGHT COMPARISON

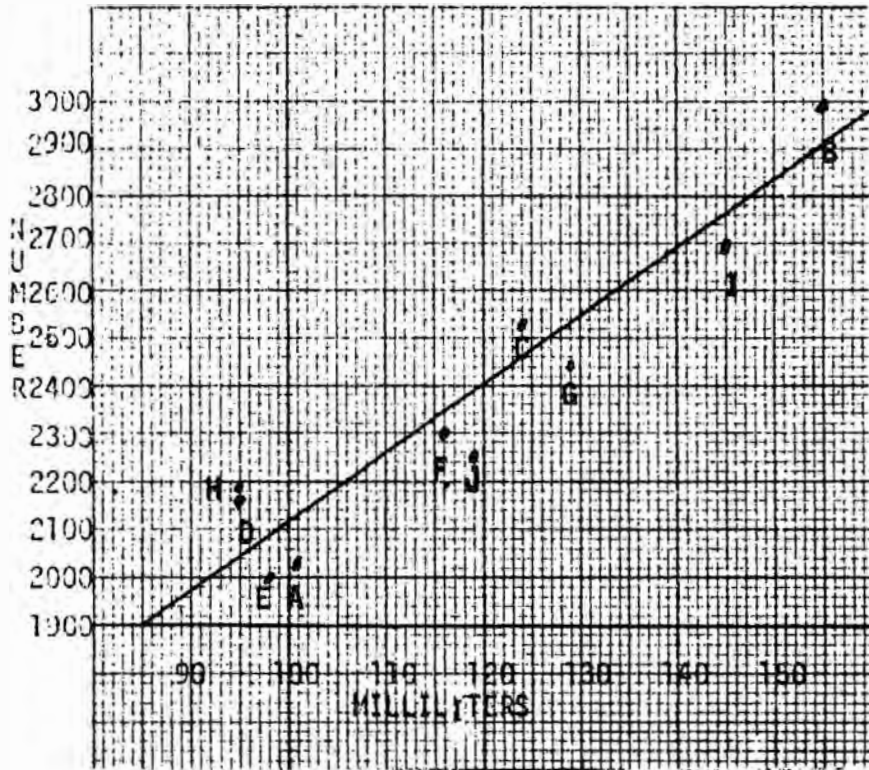


Differences in growth characteristics can be observed further by comparing the length weight ratios of the families to the normal adult rainbow condition factor of $K=124$; represented by dotted line. Family H for example is to the left of the line ($K=143$) while family B is almost exactly on the line ($K=124.5$). This indicates that the females in family H were much heavier in relationship to their length than were females from family B.

Reproductive Capabilities

The average number and volume of eggs produced per female is given by family in Table II. The average number of eggs varied from 1998 for family E to 2984 for family B while the volume of eggs produced varied from 95 milliliters for families D & H to 155 milliliters for family B.

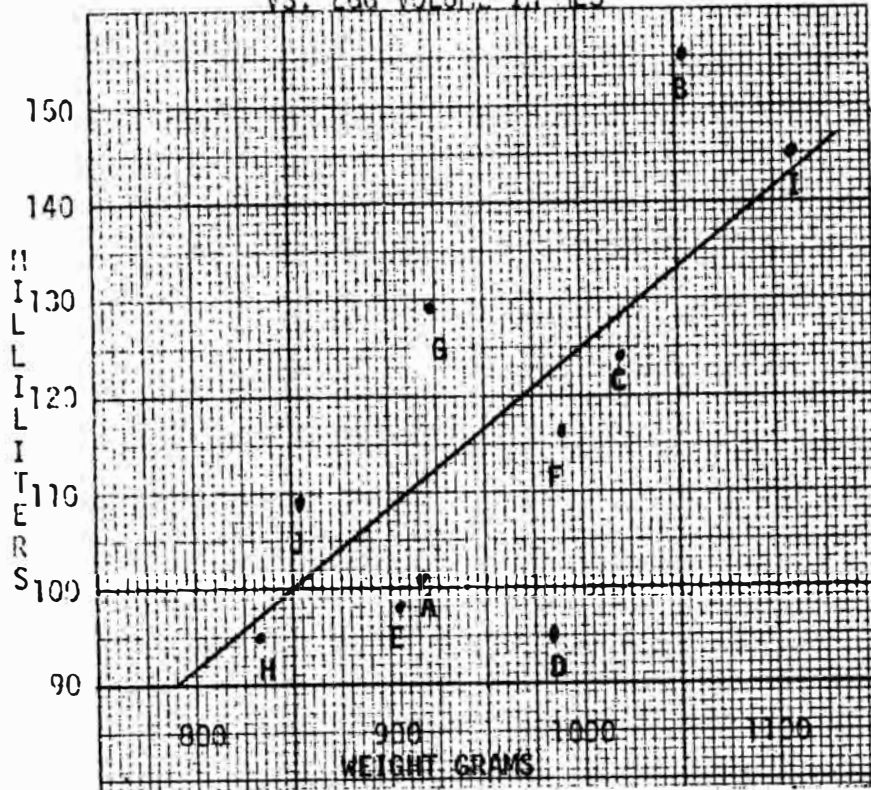
TABLE II FAMILY REPRODUCTIVE POTENTIAL
IN EGG NUMBER AND VOLUME



Differences between the respective family means for average egg number and average egg volume were also significant at the .01 level.

Graham A.E. Gall (2) has indicated a strong genetic relationship between the weight of a female and the volume of eggs she produces. Average female weight and average volume of eggs produced are compared in Table III.

TABLE III AVERAGE WEIGHT PER FEMALE
VS. EGG VOLUME IN MILS



Families B, G, J, and I, fall above the regression line suggesting that their production may be above normal for fish of their weight. Application of Gall's data would therefore indicate that they could have greater genetic reproductive potential than the other families.

Another measurement of reproductive potential, time of spawning, is summarized in Table IV.

Percent of Females Ready to Spawn by Family

	A	B	C	D	E	F	G	H	I	J
9-22-75	7.1	3.7	13.2	50.0	10.7	10.4	8.9	21.8	2.0	0
10-7-75	10.7	15.9	21.9	35.7	30.0	17.8	8.9	20.2	8.0	9.1
10-20-75	*	12.2	*	*	*	*	31.1	*	20.0	36.4

* Ripe females from these families were not spawned on this date.

At the first egg take (September 22, 1975) fifty percent of the females in family D yielded eggs while females from family J did not yield eggs. By the end of the second egg take (October 7, 1975) eighty six percent of the females from family D had spawned while only 9.1 percent of family J had spawned. The probability of this great a difference occurring by chance is only 7.7 percent.

Abnormal Characteristics

The most obvious abnormality was a retardation in development which resulted in a shortened football-shaped fish, recorded in photos I and II.

Photo I

Normal Female

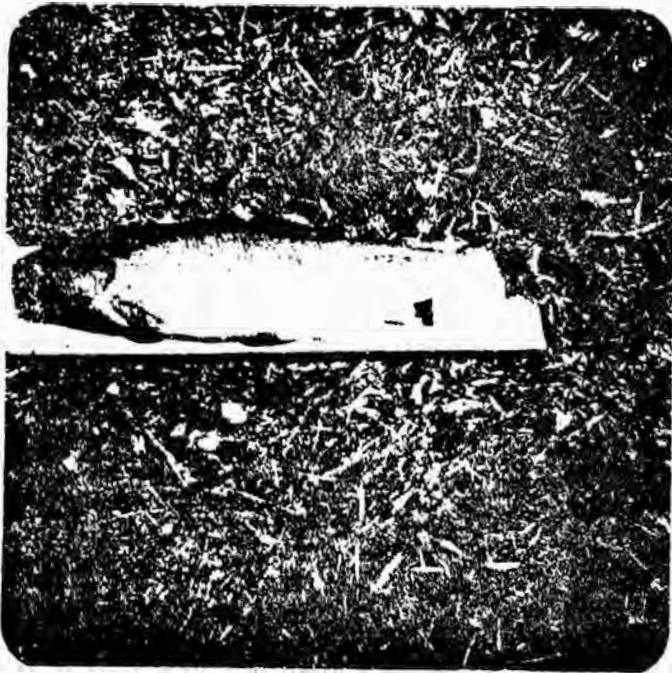
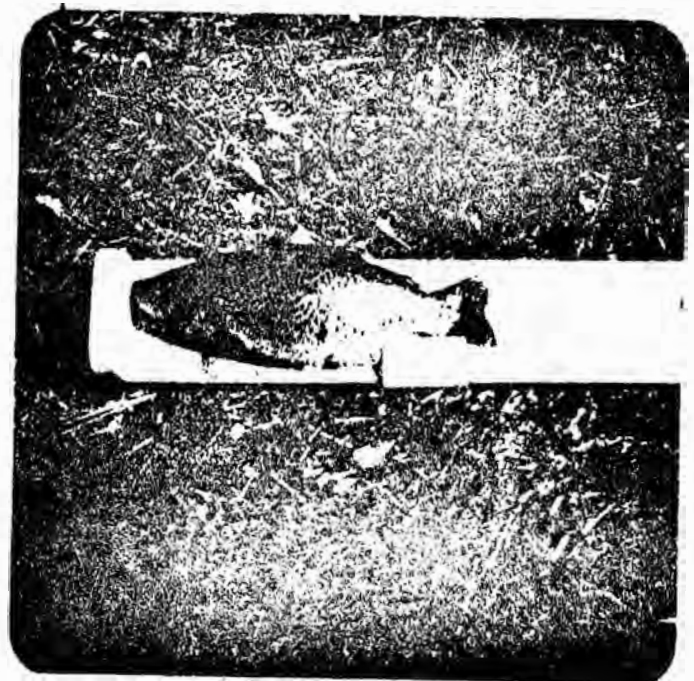


Photo II

Abnormal Female

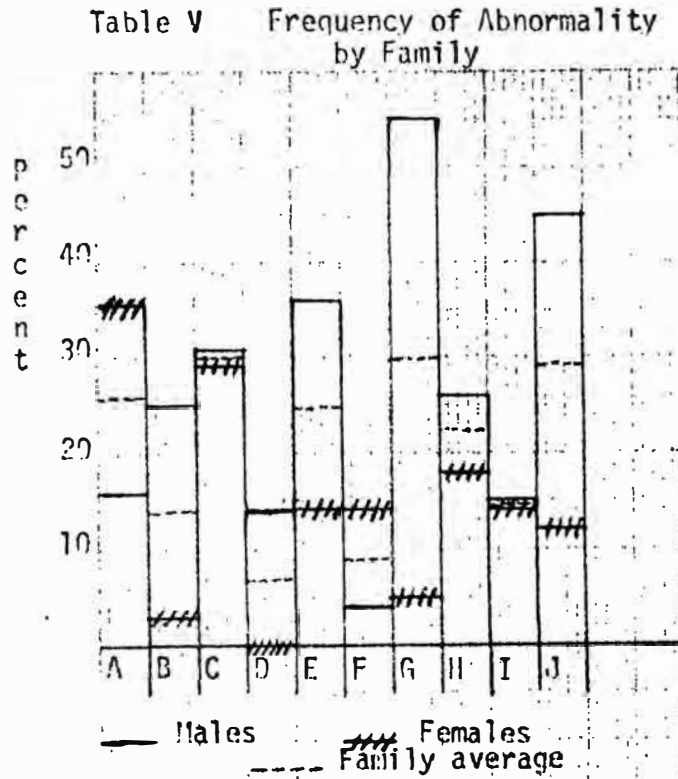


All abnormal fish were excluded from the data used for the length weight growth relationships shown in Table I.

Measurements of the abnormal fish revealed their average length to range from 30 to 36 centimeters as compared to the apparently normal fish which ranged from 39 to 44 centimeters. As is visible in the photographs, the abnormal fish were much heavier in relationship to their length (Avg. $K=245$) than were normal fish.

Dissection of abnormal fish revealed a normal number of vertebrae with each vertebra appearing equally shortened.

Abnormality data from the six hundred fish sample is given by sex in Table V.

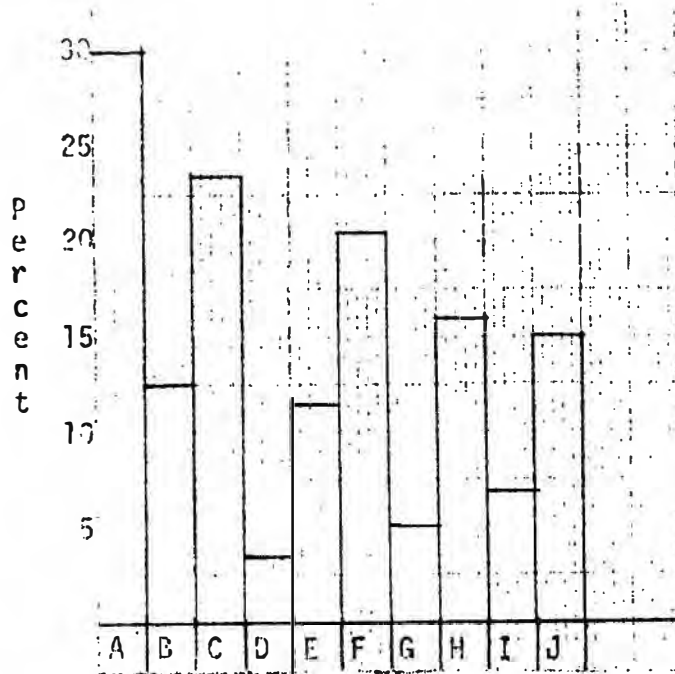


The population average revealed 26.6% of the males to be affected while only 14.4% of the females were affected. Individual families varied from 7% for family D to 30% for family G.

Estimated Survival

The survival rates given in Table VI were calculated using the frequency of family occurrence data obtained from the combined sample of nine hundred fish.

Table VI Survival to Spawning by Family



An estimated 30 percent of family A survived to first spawning as compared to only 7 percent of family D. Family A could therefore be projected to yield four times the number of producing females or approximately four times the number of eggs as could be expected from family D. Since both families started from an equal number of fingerlings, the cost per unit of egg production from family D would be four times as great as the cost per unit of egg production from family A.

DISCUSSIONS AND CONCLUSIONS

Significant differences were observed between the families for all factors measured. It is evident, therefore, that different characteristics were inherited from the respective parents and were passed on to all the offspring of the mating, thus creating identifiable sub-populations. These sub-populations were the result of differing family gene pools.

The ability to identify these sub-populations or differing gene pools within a strain of broodstock can be demonstrated to be of major importance to a broodstock program. For example, consider if future broodstock were to be selected solely on the basis of greatest length from non-identifiable progeny of the ten matings. Table I indicates that most of the fish chosen would come from families I and B. Thus the gene pool of all future broodstock would be limited to the gene pool created in the original two matings. This, in effect, would be line breeding and would be accompanied by increased homozygosity. This consequence is avoided in the proposed program by maintaining a minimum number of identifiable families which are inter-bred for propagation of the strain.

This study therefore substantiated the proposed program by illustrating both the magnitude of family differences and the advantages of maintaining family identities.

REFERENCES

1. Gall, Graham A.E. Rainbow Trout Broodstock Selection. Inland Fisheries Administrative Report No. 71-10. California Department of Fish and Game.
2. Gall, Graham A.E. Genetics of Reproduction in Domesticated Rainbow Trout. Department of Animal Science, University of California.