



Brigham Young University
BYU ScholarsArchive

Theses and Dissertations

1951-06-01

A taxonomic study of the catostomidae of Utah Lake with notes on the fish population

Lyle Junior Lowder
Brigham Young University - Provo

Follow this and additional works at: <https://scholarsarchive.byu.edu/etd>

BYU ScholarsArchive Citation

Lowder, Lyle Junior, "A taxonomic study of the catostomidae of Utah Lake with notes on the fish population" (1951). *Theses and Dissertations*. 7812.
<https://scholarsarchive.byu.edu/etd/7812>

This Thesis is brought to you for free and open access by BYU ScholarsArchive. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of BYU ScholarsArchive. For more information, please contact ellen_amatangelo@byu.edu.

A TAXONOMIC STUDY OF THE CATOSTOMIDAE OF UTAH LAKE
WITH NOTES ON THE FISH POPULATION

Abstract of
A Thesis submitted to the
Department of Zoology and Entomology
of
Brigham Young University

In partial fulfillment
of the requirements for the degree of
Master of Science

By
Lyle J. Lowder

June 1951

During the period from October 1950 to March 1951 a study of the taxonomy of the Catostomidae of Utah Lake was undertaken. Throughout this study information was collected on the numbers of suckers taken by some of the fisherman.

From the data gathered it appears that the three species of Catostomidae originally named from Utah Lake are still there. The external morphological features of these fish are not recognizable unless they are observed very carefully. The most outstanding external characteristics used to differentiate the species are the mouth, lips, papillae on the lips and the general shape of the head. The three species that occur in the lake are Chasmistes liorus, Catostomus fecundus and Catostomus ardens.

The population counts on these fish showed that the suckers have increased in numbers since the drought of 1934-5 but by no means have reached the point that they held previous to that time. Utah Lake was known during pioneer days as a great sucker pond. The carp, Cyprinus carpio, is the dominant fish in Utah Lake today.

This thesis was written in an effort to stabilize the classification of the Catostomidae in Utah Lake, and also to provide data as to the population of the suckers at the present time.

A TAXONOMIC STUDY
OF THE CATOSTOMIDAE OF UTAH
LAKE WITH NOTES ON THE FISH POPULATION

A THESIS
SUBMITTED TO THE
DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY
OF
BRIGHAM YOUNG UNIVERSITY
IN PARTIAL FULFILIMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

BY

LYLE J. LOWDER

JUNE 1951

This thesis, by Lyle J. Lowder, is accepted
in its present form by the Department of Zoology
and Entomology as satisfying the thesis requirements
for the Degree of Master of Science.

ACKNOWLEDGMENT

The writer is deeply obligated to Dr. Vasco M. Tanner, head of the Department of Zoology and Entomology at the Brigham Young University, for his valuable assistance and encouragement throughout the progress of this problem. His library has been of great value to me and I was allowed to draw freely from it.

The writer also wishes to thank Dr. D. Elden Beck and Dr. Wilmer W. Tanner for their encouragement from time to time.

My sincere thanks go to Henry Loy, a commercial fisherman on Utah Lake, who allowed me to take from his seines, without cost, the fish I needed. He was instrumental in assisting me with population counts, and for his assistance I am most appreciative.

TABLE OF CONTENTS

TITLE PAGE	i
CERTIFICATE OF ACCEPTANCE	ii
ACKNOWLEDGMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	v
Chapters	
I INTRODUCTION	1
II HISTORY OF THE PROBLEM	3
III PROCEDURE	6
IV ESTABLISHMENT OF GENERIC NAMES OF CATOSTOMIDAE OF UTAH LAKE	11
V ESTABLISHING THE SPECIFIC NAMES OF CATOSTOMIDAE IN UTAH LAKE	17
VI ADDITIONAL NOTES ON OTHER ANATOMICAL DIFFERENCES	23
<u>Chasmistes licorus</u> Jordan	
<u>Catostomus ardens</u> Jordan	
<u>Catostomus fecundus</u> Cope and Yarrow	
Plate I	
VII NOTES ON POPULATION	33
VIII SUMMARY	41
IX BIBLIOGRAPHY	44

LIST OF TABLES

Measurements of <u>Chasmistes liorus</u> Jordan . . .	24
Measurements of <u>Catostomus ardens</u> Jordan . . .	26
Measurements of <u>Catostomus fecundus</u>	29
Cope and Yarrow	
Population Tables	41

CHAPTER I

INTRODUCTION

The purpose of this thesis is to establish the generic and specific names of the species of fish belonging to the family Catostomidae found in Utah Lake.

To do this it was necessary for the writer to collect a series of suckers from the lake, and make a careful anatomical and morphological study of them. These characteristics were then compared with the original descriptions of the genera and species they were thought to belong in. A total of 6,782 suckers were examined. Complete measurements were made on about 100 specimens.

It was not recognized until the latter part of this investigation that these fish represented three separate and distinct species of Catostomidae. For this reason complete measurements were taken on the last remaining 100 specimens. They have been placed with the consent of the curator, in the Ichthyology Museum at the Brigham Young University.

Some data was taken on specimens which have not been placed in the museum. This information has been used in reaching the conclusions in this study.

In addition to the above, notes have been taken on the population of the Catostomidae as compared to species of

other fish taken in the lake. Comments will be made in another section of this paper concerning the undesirable ecological factors effecting the fish population.

Utah Lake, situated in the heart of Utah County, Utah, is one of the largest fresh water lakes in the west. It covers between 75,000 and 90,000 acres of land. It is bordered on the east by Provo and Springville, on the south by Spanish Fork and Payson, on the west by Genola, and on the north by Lehi, American Fork, Pleasant Grove and Orem. It has a depth of from 6 inches to 13 feet and an average depth of about 6 feet. The lake is used as a storage reservoir for irrigation water which is used in Salt Lake County, and therefore, its depth varies greatly throughout the year. The lake lies at the western slopes of the Wasatch Mountains, and is on the eastern edge of the Great Basin, the largest desert area in North America. Father Escalante (1776) and Captain Fremont (1843) were probably the first white men to see the waters of Utah Lake and to record notes as to their findings.

CHAPTER II

HISTORY OF THE PROBLEM

The classification of the suckers of Utah Lake has always been a difficult problem. The principle difficulties lie in the many nomenclatural changes introduced by previous workers.

Yarrow and Henshaw, the collectors of the vertebrates with the Wheeler Survey in 1872, collected specimens of one of the suckers from Utah Lake. Professor E. D. Cope and H. C. Yarrow studied these specimens and decided they represented a new species. The authors also decided it was a true Catostomus, having the parietal fontanelle well marked and widely opened. They gave to it the specific name of fecundus¹ because it occurred in such great numbers.

David Starr Jordan, one of America's leading Ichthyologists, examined the type specimen of Catostomus fecundus in 1878. The specimen at that time, was in poor condition as stated by Jordan, "The original type of the species is in very bad condition, the mouth being shrunken and distorted, and the bones of the head protruding through the skin so that the peculiarities are hardly recognized."² From this specimen Jordan introduced a new genus, Chasmistes. In his description he used as the type, the specimen collected by Yarrow and

Henshaw.

In the same year, 1878, Jordan described a new species of sucker from Utah Lake which he placed in the genus Chasmistes, and gave it the specific name of licorus.³ Because sufficient specimens were not available a comparison of Chasmistes licorus and Catostomus fecundus was not made and the status of Chasmistes fecundus was not given.

In 1881, Jordan named another species of sucker from Utah Lake. This species was placed in the genus Catostomus and given the specific name of ardens, because of the bright red band which occurs along the lateral line at the breeding season. It was characterised by very thick, heavy lips with numerous papillae on each lip. The naming of this new species Catostomus ardens, made Utah Lake the type locality of one genus, Chasmistes, and three species of suckers, Catostomus fecundus, Catostomus ardens and Chasmistes licorus.⁴

The most confused situation in the history of these suckers occurred in 1896, when Jordan and Evermann (after Jordan had listed fecundus as the type specimen for the genus Chasmistes) listed fecundus in the genus Catostomus.⁵ Then he confused the issue further in 1930, by placing fecundus in the genus Chasmistes again.⁶ No reason is given by Jordan for his listing (in 1896) of fecundus in the genus Catostomus. In view of his 1930 listing, we may assume that his final conclusion was to place fecundus in the genus Chasmistes.

Of the literature reviewed since 1896, there has been only one report made concerning the suckers of Utah Lake.

This paper was published by Tanner in 1936; a man who has been in contact with this problem more than any other worker. His study covers a critical time as far as the suckers of the lake are concerned, for it was in the 1930's that a severe drought reduced the level of the lake and seriously upset its biotic balance. So far reaching were the effects of this drought that Dr. Tanner was unable to collect any suckers other than Catostomus ardens. This lead him to suggest that Catostomus ardens and Catostomus fecundus are synonymous, mainly because he was at that time, unable to distinguish any difference between the specimens obtained from the lake. Tanner received correspondence from Dr. Carl G. Hubbs stating that he was in favor of this change.⁷ The presence of these fish now indicates that they must have been there at that time but in such small numbers that they were not taken. It is my experience that one species of these fish can be very numerous in the fishing area at one time during the year and not present in these same waters at other times. Catostomus ardens seemed to be the species occurring in the smallest numbers with Catostomus fecundus occurring in the largest numbers at the times of this study.

CHAPTER III

PROCEDURE

Field work.--The majority of specimens used in this study were taken while in company with Mr. Henry Loy, a commercial fisherman on the lake. He was very cooperative in permitting me to examine any and all the fish caught. At first I accompanied him in the setting of the seine, but later the Brigham Young University motor boat was used to reach the seine as it was taken up. This saved time and made possible the observation of thousands of specimens.

The seining took place mainly on the east side of the lake from 1,000 yards north of the mouth of Provo River and extended to an area south, to near the mouth of Spanish Fork River. Some seining was done in the Goshen Bay area which is in the extreme southern end of the lake.

The seine which was used, is 500 yards long and 6-8 feet deep; this was cast out around an area in the lake. The top of the net is held up by cork bouys and the bottom of the net is allowed to sink. Ropes that are about 100 yards long are tied to each side of the net. The ropes are then drawn in by gasoline engines until the end of the net reaches the

engine; the rest of the net is then pulled in by hand. As the net is being pulled in by hand the fish are forced to the back of the net where there is a large bag. The rest of the net is then pulled into the boat with the exception of the bag. The fish in the bag are dipped into the boats with small dip-nets.

While we were pulling in the nets, if we had a large net full of fish, the water around the bag of the net would be churned nearly to the foaming point by the action of the fish. To see this and to see the tons of carp and suckers as they are dipped into the waiting boats is worth a day of anyones time.

Probably the most interesting part of the field work was the seining through the ice. A large hole was cut in the ice to allow the net to slide into the water under the ice. To the ropes on each end of the net, are tied one inch by two inch pieces of lumber, 20 feet long. About 100 feet from the shore another large hole is cut in the ice to bring the net and fish from under the ice. These 20 foot boards are shoved along under the ice through small holes, which have been cut 200 feet apart, towards the large hole near the shore. When they reach the large hole near the shore, the ropes are taken off the boards and the net is drawn in, in the same manner as in the open water. This is another method of collecting well worth anyones time to see.

In order to get a comparative population index taken from the lake, each filled dip-net of fish taken in the seine

was counted. An average of the number of fish in each dip-net was multiplied by the number of dip-nets taken from the bag. In this manner I could arrive at the number of fish taken in a single seine.

The fish that occurred in small numbers and that had to be thrown back because of fish and game laws, were easily counted. The carp and the suckers, that occurred in large numbers and were taken by the fishermen for marketing purposes, were counted at the shore as they were separated and weighed by the fishermen. Enroute from the fishing area to the shore, specimens were examined by the hundreds in order to discover some characteristics that would enable the identification of the three species of Catostomidae. The scale count was made of hundreds of suckers. Arriving at the shore several specimens of each species were placed in five gallon cans filled with water and brought to the B.Y.U. laboratory for further study.

Laboratory technique.--In the laboratory the fish were either preserved or used for the making of skulls. Those that were preserved were injected with a five per-cent solution of formaldehyde. Those that were to be made into skulls were treated in the following manner. A small bucket partially filled with water was placed on an electric plate and the water was allowed to reach a temperature just below the boiling point. Before the fish were placed in the hot water, scale counts and measurements thought to be of value, were taken and recorded. The posterior end from approximately the insertion

of the dorsal fin of the fish, was then cut off and the internal organs removed from the anterior part. This anterior part containing the head, the Weberian apparatus and the upper half of the back bone was placed in the hot water and allowed to remain for about 2 minutes, depending on the size of the fish. The larger the fish the longer the heating time. After sufficient cooking, enough to loosen the muscle and other tissue from the skeleton, the fish was removed from the water. By use of forceps and the end of an eye-dropper, attached to a water faucet by a rubber hose, the meat was gradually picked and washed away. One must be careful in picking the muscles from around the first second vertebrae so that the weberian apparatus will not be destroyed. The use of the eye-dropper is very helpful in saving the Weberian apparatus. This eye-dropper method was also very useful in removing the brain from its cavity. In washing, care was taken not to allow a direct stream of water to strike the ligament and tripius bone, since this would loosen and wash them away. It was found that if the fish were cooked too long or were not cooked when they were fresh, the tissue holding the bones together was weakened and the rib bones with several of the skull bones, along with the ligament of the weberian apparatus could not possibly be kept intact.

Method of external examination.--The main method of external examination was done by careful observation of a large series of fish. By this method we were able to recognize the three species of suckers. For approximately 6 months,

from October to the last of March 1950-51, a careful study of the external differences were observed in hundreds of suckers as they came from the net. Special attention was paid to the Catostomidae. Fortunately the large numbers available made it possible for me to examine such important parts as the lips, mouth, shape of head, and to make measurements of those parts which would aid in separating morphologically similar species.

Method internal examination.--The part of the internal anatomy examined by this writer was the skeletal system with emphasis on the cranium and the Weberian apparatus. It was hoped that some very prominent characteristics could be found. A careful study revealed no outstanding characteristics, however there were some minor differences in the skull and Weberian apparatus. They could be worked out very satisfactorily but it would involve a detailed comparative anatomical study.

CHAPTER IV

ESTABLISHMENT OF GENERIC NAMES OF CATOSTOMIDAE OF UTAH LAKE

The existence of the three suckers originally named from Utah Lake, has been in doubt for the past 25 years. During this period workers were unable to collect specimens representing the three original species. Observation, by the writer, of the morphology of some 6,000 specimens does show distinct differences. The differences are of such magnitude it appears that the original descriptions are valid. From a series of each of the three species of suckers, a specimen typical of the group was selected for descriptive and illustrative purposes. (Fig. 1-9.)

The genera of the three original suckers seem to be in controversy, as shown by the history of this problem. Therefore, it seems advisable to attempt to stabilize the genera of these suckers. One sucker, used as a type specimen, shows characteristics of the genus Chasmistes. However, in comparing it with the original description of Chasmistes it does not agree with several of the characteristics. (These characteristics are given later.) In order to establish the validity of the description of Chasmistes, two specimens of Chasmistes cujus were obtained from Nevada. Chasmistes cujus and the Utah Lake specimens were compared with the original

description. The results are discussed below. The following is the original description of the genus Chasmistes.

CHASMISTES - Jordan

Fishes related with Catostomus having the teeth, scales and air-bladder as in that genus, but distinguished by the size and position of the mouth, the great development of the mandible, and by the small, smooth lips.

Head disproportionately large, forming more than one-fourth the length, broad and flattish above; sides of head vertical, slightly directed inwards, the breadth through the checks less than the breadth through the eyes; eyes small, high up, rather posterior; mouth exceedingly large, terminal; the lower jaw in the closed mouth being very oblique, placed on an angle of about 45° ; the lower jaw very long and strong, its length more than one-third the length of the head, nearly half the length of the head in the adult, its tip when the mouth is closed about on the level with the eye; upper jaw very protractile; upper lip very thin (for a sucker), and nearly smooth; snout elevated above the rest of the head, notably so when the mouth is closed; lower lip moderate, consisting of a broad flap on each side of the mandible, in front, reduced to a narrow rim, the surface of the lip nearly smooth, without evident papillae; nostrils large, suborbital bones narrow, but rather broader than in Catostomus; preorbital unusually large; mucus channels moderately developed; fontanelle very large; isthmus rather narrow, pharyngeal bones and teeth essentially as in Catostomus.

Body rather slender, tapering quite regularly from the shoulders to the tail, but little compressed; caudal peduncle rather stout. Fins moderate, the dorsals rays about 12, the anals 7; pectorals rather long, not quite reaching ventrals, ventrals reaching vent; anal fin high reaching caudal; caudal fins rather long, its lobes equal. Scales moderate, large on the caudal peduncle, much smaller and crowded anteriorly, 60-65 in lateral line, about 18 in transverse series from dorsal to ventral. Sexual peculiarities unknown. Coloration usual. Air-bladder in two parts. Size moderate or rather large. The single species now included in this genus is known only from Utah Lake.

GENERIC CHARACTERISTICS

CHASMISTES Jordan, 1878. "This genus is distinguished from Catostomus by the very large, terminal mouth, the lower jaw being very strong, its length about one-third that of the head. The lips are little developed and are very nearly smooth. The type of the genus is C. fecundus, Cope and Yarrow."²

COMPARISONS

The description states that the head should comprise more than one-fourth the length of the body. The head of the Utah Lake specimen measures 79 mms and the body length is 326 mms. C. cujus has a body length of 436 mms and a head length of 129 mms. Although the typical specimen from Utah Lake does not agree with the original description there are several other specimens taken from the lake that do. Those specimens that do not agree are within a few mms.

The description of the type calls for a greater width through the eyes than through the cheeks. The breadth through the eyes of the Utah Lake specimen measures 37 mms and the cheek measures 44 mms. The C. cujus has a width through the eyes of 57 mms and through the cheeks of 59 mms. In both specimens these measurements disagree with the original description. The snout is not elevated above the rest of the head, as indicated in the original description, on either specimen.

The original description calls for 12 rays in the dorsal, 7 in the anal, and the ventrals to reach the vent. The specimen from Utah Lake has 13 dorsal fin rays and 7 anal, the ventrals do not reach the vent. The C. cujus has 10 rays in the dorsal and 7 in the anal; and the ventrals do not reach the vent.

The Utah Lake specimen and Chasmistes cujus agree and disagree with the original description on the same characters.

Therefore, I am sure that the Utah Lake specimen belongs to the genus Chasmistes. If the genus is Chasmistes the species is licorus. It is the only species in the genus Chasmistes described from Utah Lake, with the exception of fecundus, which is not a true Chasmistes, as will be shown later in this paper. Utah Lake is the type locality of G. licorus and this species is not known to inhabit any other waters.

The second genus found in Utah Lake is Catostomus. The species fecundus has been changed from the genus Catostomus to Chasmistes and visa versa many times and was finally left in the genus Chasmistes. The data indicates that fecundus as well as ardens show definite characteristics of the genus Catostomus. The species fecundus does not agree with the original description of Chasmistes because, the mouth is not large nor terminal; the lower jaw is not long nor strong and its length enters the head more than three times. The lips are well developed and are not smooth. Because of these disagreements with the description of Chasmistes, I have decided to compare fecundus as well as ardens and Catostomus tahoensis, with the original description of the genus Catostomus.

CATOSTOMUS LeSuer

Head more or less elongate, its length ranging from three and one half to five times that of the body, its form varying considerably in the subgenera. Eye usually rather small, high up and medium, more or less posterior in position; suborbital bones narrow, longer than broad, much as in Myxostoma; fontanelle always present, usually widely opened, in two species reduced to a narrow slit, but never wholly obliterated.

Mouth rather large, always inferior, and sometimes notably so; the upper lip thick, protractable, papillose; the lower lip greatly developed, with a broad, free margin, deeply incised behind so that it forms two lobes, which are often more or less separated, mandible horizontal, short, not one-third the length of the head and not reaching to opposite the eye; lower jaw usually without distinct cartiliginous sheath, not rugose, pharyngeal bones moderately strong, the teeth shortish, vertically compressed, rapidly diminishing in size upward, the upper surface of the teeth nearly even, or somewhat cuspidate.

Body elongate, more or less fusiform, subterete, more or less compressed.

Scales comparatively small, typically much smaller and crowded anteriorly, the number in the lateral line ranging from about 50-115, the number in the transverse series between the dorsals and ventrals, from 15-40; lateral line well developed, straightish, somewhat decurved anteriorly.

Fins variously developed, dorsal with its first rays midway of the body with from 8-14 developed rays; anal fin short and high with probably 7 developed rays; ventrals inserted under the middle of the posterior part of the dorsal, typically with 10 rays, in one subgenus usually 9, the number often subject to variation by one; caudal fin usually deeply forked, the lobes nearly equal.

Sexual peculiarities not very well marked, the fins higher in the male and the anal is somewhat swollen and tuberculate in the spring; breeding males in some species with rosy or orange lateral band.

COMPARISON

The species from Utah Lake, fecundus and ardens as well as C. tahoensis from Nevada, agree with the original description of Catostomus with one exception. The lower jaw of the specimen considered to be C. fecundus is not completely horizontal. It lies at a 30° angle with the top of the head when the mouth is closed.

My typical specimen of fecundus does show some tendencies towards the genus Chasmistes. The mouth is placed on a 30° angle with the upper lip slightly overhanging the lower lip. However, the moderately heavy lips, with fine, sponge-

like papillae covering them, the short jaw bone, the inferior mouth, and the general appearance of the body and head, very easily place it in the genus Catostomus.

This study has shown that fecundus belongs to the genus Catostomus and that ardens is also a Catostomus, a point which to my knowledge, has never been disputed. (Figs. 3-9.)

CHAPTER V

ESTABLISHING THE SPECIFIC NAMES OF CATOSTOMIDAE IN UTAH LAKE

Now that the generic names of the Catostomidae of Utah Lake have been dealt with it becomes necessary to discuss the specific names.

The acceptance of the genus Chasmistes established the species liorus as explained previously. Is Catostomus fecundus an extreme end of a series of Catostomus ardens making it synonymous with C. ardens or is it a separate and distinct species? In approaching this problem it is necessary to compare specimens of both species with the original descriptions. Below is the original description of Catostomus fecundus.

CATOSTOMUS FECUNDUS Cope and Yarrow

At the first examination of this species, it was supposed to be identical with Girard's Acomus generosous; but a comparison with his type in the National Museum at the Smithsonian Institution proves it to be a new species. It is a true Catostomus, having the parietal fontanelle well marked and widely opened. The head enters the entire length of the body 5 times, the diameter of the orbit 6 times in greatest length of the side of the head. The insertion of the dorsal fin anteriorly, is nearer the end of the muzzle than the caudal; the ventral originating below the middle of the dorsal. The width of the dorsal to the ventral enters the entire length to insertion of caudal, 6 times.

Radii: D.-12-13; A. 1-8; P.-17; V.-11. Scales are in 20 longitudinal rows, from the insertion of the dorsal ray to the pectoral and in 60 transverse rows from the branchiae to insertion of caudal. They are elongate and octagonal, smaller

on dorsal region, and larger on ventral. Body elongate, subfusiform.

COMPARISON

The length of the head will enter the length of the body 5 times or more*. On C. fecundus the entire length is 392 mms and the head measures 69 mms. On C. ardens the body length is 396 mms and the head measures 71 mms. The diameter of the eye enters the length of the side of head 6 times. On C. fecundus the eye measures 11 mms and the side of the head measures 85 mms. In C. ardens the eye measures 10 mms and the side of the head measures 83 mms. The insertion of the dorsal is nearer the snout than the insertion of the caudal. On C. ardens the insertion of the dorsal fin is 179 mms from the snout and the fish measures 392 mms. On C. fecundus the dorsal fin is inserted 172 mms from the snout and the fish measures 396 mms. Both fish have the ventral inserted below the middle of the dorsal, as called for in the description. The description says the width from the dorsal to ventrals will enter the body length 6 times. The width between the insertion of the dorsal and the insertion of the ventrals on C. fecundus is 65 mms. On C. ardens it is 66 mms. The radii of the fins on both fish are C. fecundus D:-11; C. ardens, D:-12; A:-7; V:-11; both agree with the description

*This assumption is made on the basis of from point of snout to occiput not from the snout to operculum. I base this assumption on the next statement in the original description in which it distinguishes between the side of the head and the length of the head.

with the exception of one dorsal ray on C. fecundus. Scales are as follows:

C. fecundus - 13-67-11

C. ardens --- 11-70-10

Neither fish conforms to the scale counts. All other characters of both fish agree with the description. It is evident from the preceding data that both fish which are considered to be two species could very easily be classified as fecundus. There are a few other characteristics, however, which will be recognized in the following comparison of the two fishes with the original description of C. ardens which separate them as two different species. The description of C. ardens is as follows:

CATOSTOMUS ARDENSI Jordan

Body rather elongate, subfusiform, little compressed, the back broad and somewhat elevated. Head broad and convexed above, the front regularly sloping from the nape to the snout. Mouth entirely inferior. The mandible quite horizontal, the premaxillaries scarcely raised above the level of the base of the mandible. Upper lip very wide, full, pendent with about 8 rows of coarse, irregular papillae; of which the second and third rows from the inside are much larger than the others; upper lip continuous with the lower lip at the angle of the mouth. The lower lip cut to the base in the middle, by a deep, abrupt incision. Front of eye midway in head. Eye very small, 7 mms in head. $3\frac{1}{2}$ the convex interorbital space. Isthmus broad, half broader than the eye. Fontanelle large, as is noticed in the other species in this paper. Scales crowded anteriorly, 9-65-9; breast with evident imbedded scale. Dorsal fin inserted a little behind the middle of the body, low and long, its anterior rays but three-fourths the length of the fin, one and a half the length of the last ray; the free edge of the fin straight. Caudal fin short and broad, about equally forked, its upper lobe but two-thirds the length of the head. Ventrals short, not quite reaching the vent. Anal very high, reaching caudal. Dorsal rays 13, anal 7. Length of head three and two-thirds in body to the base of caudal; greatest depth four and one half. Teeth essentially

as in the others.

Color blackish above, blotched with darker, the whole back and sides obscurely spotted; belly white, a narrow, bright, rosy, lateral band on the anterior part of the body, overlying the blackish; fins mostly dusky mottled; top and sides of head rendered dusky by the presence of many dark spots.

COMPARISON

The two specimens agree with the original description down to the curvature of the head. C. ardens has a much greater curvature of the head from occiput to snout than does C. fecundus (Refer to plate 1). C. ardens has an upper lip 6 mm wide and C. fecundus has an upper lip 3 mm wide. C. ardens has 7 rows of coarse papillae on upper lip, with the second and third rows from the inside noticeably larger than the others. C. fecundus has 5 rows of fine papillae on upper lip, with the papillae rather uniform over the lip. In C. fecundus the third row of papillae may be slightly larger than the rest. In C. ardens the eye will enter the head 7 times, the eye being 10 mm and the head being 71 mm. The width of the eye will not enter the head 7 times in C. fecundus. In this species the eye measures 11 mm and the head 69 mm. On C. fecundus the width of the orbit does not enter the width of the interorbital space three and one half times since the eye is 11 mm and the interorbital space is 31 mm. In C. ardens the width of the eye enter the interorbital space three and one half times. The scale count of either fish does not agree with this description. The description calls for 9-65-9. The scale counts are on C. ardens, 11-70-10 and on C. fecundus,

13-67-11.

The dorsal fins on these specimens are not located behind the center of the body as called for in the description. C. fecundus being 173 mm from snout and C. ardens being 179 mm from snout. The anterior rays in the dorsal fins of these suckers are more than three fourths the length of the base of the dorsal. The anterior ray of C. fecundus is 52 mm and the base of the dorsal is 52 mm. The anterior ray of C. ardens is 55 mm and the base of the dorsal is 57 mm. The head of C. ardens is 81 mm while the body length without the head is 315 mm. C. fecundus has a body length, without the head, of 306 mm and the head is 86 mm. The head will go into the body of C. ardens three and two-thirds times but not in C. fecundus.*

Both fish agree with the remainder of the description with the exception of these fish that were not taken during the breeding season, therefore they are not colored as in the original description.

Although both fishes could very easily be classified as C. fecundus using the original description as the basis, the specimen I consider to be C. fecundus does not agree with the description of C. ardens. On this basis it is the writers decision that these suckers represent the two species named C. fecundus and C. ardens.

*I used the length of the head, the distance from the snout to the operculum because this fish was described by Jordan and he always used, as measurement of the head, the distance from snout to operculum. (From Dr. V. M. Tanner's personal relationship with David Starr Jordan).

The description of C. fecundus given by Professor E. D. Cope and H. C. Barlow is too general for a species description. It resembles a generic more than a species description. The fact that both C. ardens and C. fecundus agree with the description, illustrates this point. This has been one of the most confusing parts of this problem.

CHAPTER VI

ADDITIONAL NOTES ON OTHER ANATOMICAL DIFFERENCES

The most valuable characteristics used in this study to classify the Catostomidae of Utah Lake are the head and the lips. These characteristics along with others are listed below and may be observed in the drawings.

CHASMISTES licorus Jordan

Nose very blunt, top of head flat; bottom of head runs at a 45° angle from snout; mouth on 45° angle. Upper lip very thin, with few or no papillae; papillae when present, not arranged in rows. Lower lip deeply lobed, with very wide notch between lobes; long, strong mandibles. Head enters body length slightly more than four times. Mouth terminal, when mouth is closed upper lip is overhanging and the lower lip is underslung. Base of dorsal enter entire length of body $5\frac{1}{2}$ -6 times, seldom more. Base of anal usually longer than in C. fecundus but shorter than in C. ardens. Interorbital width enters the entire length of the body from $9\frac{1}{2}$ - $10\frac{1}{2}$ times. Snout usually short. Some of these characteristics on the measurements of fins may overlap with the other species but never over a few mm.

*Measurements on the length of head are from the operculum to the snout in this description.

TABLE I
Measurements and Characteristics
of Chasmistes liorus Jordan

Locality	Utah Lake							
	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU
Number	10389	10374	10372	10385	10386	10390	5242	5251
Length of body	308	335	331	328	308	298	343	307
Length of head	71	82	84	62	76	72	78	73
Depth of body	75	82	82	81	76	72	81	66
Danthal of dorsal peduncle	29	31	31	30	23	30	32	27
Length of ventral peduncle	57	57	56	56	57	57	59	50
Length of snout	32	39	39	35	32	34	39	38
Diameter of eye	8	10	10	10	10	9	9	8
Interorbital width	24	27	39	34	33	35	34	30
Depth of head	59	58	60	58	55	53	56	51
Snout to occiput	57	65	67	65	60	63	63	62
Snout to dorsal	143	165	168	160	149	142	153	142
Snout to ventral	168	203	195	194	173	170	178	169
Length base of dorsal	57	60	56	62	54	53	55	61
Length base of anal	23	30	31	34	28	27	27	30
Height of dorsal								
Length of anal								
Length of ventral	45	48	45	46	45	41	40	42
Length of caudal	68	63	63	64	62	61	57	57
Dorsal rays	13	13	13	13	13	12	13	12
Scales lateral series	62	63	66	69	68	62	66	66
Scales above lateral line	10	11	12	13	11	12	13	11
Scales below lateral line	11	9	10	11	10	9	12	10
Scales before dorsal	30	27	34	33	32	26	35	31
Anal rays	8	8	8	8	8	8	8	7
Length of pectoral	63	61	67	61	65	60	57	56

CATOSTOMUS ardens Jordan

Head not so noticeably broad at posterior edge because of the very blunt nose. Top of head tapers a great deal from occiput to snout and anterior end of snout is usually tapered downward. Mouth when closed, nearly horizontal; upper lip does not overhang lower lip. Short mandible with entirely inferior mouth, upper lip very wide with 7-9 rows of very coarse papillae; upper lip twice as wide as C. fecundus with second and third rows of papillae enlarged. C. ardens usually has the longest base of the dorsal of the three species and has a greater distance from the snout to the occiput than C. fecundus. Interorbital width enters body length from 10-12 times.

CATOSTOMUS fecundus Cope and Yarrow

Head broad at posterior edge and tapers gradually forward to a pointed snout. Top of head tapering slightly downward from occiput to anterior snout. Anterior end of snout does not taper downward. Mouth when closed lies on a 30° angles; Upper lip slightly overhanging lower lip; sides of head vertical. Snout to occiput enters length of body 5 times, (may lack 2-3 mm). Short mandibles, mouth inferior; upper lip with very fine papillae, width of upper lip about half as wide as in C. ardens, papillae arranged in 4-6 rows, third row slightly larger than the others.

Interorbital width enters the length of body 11 times,

TABLE II
Measurements and Characteristics
of Catostomus ardens Jordan

Locality	Utah Lake									
	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU
Number	3812	3815	4750	4781	4782	4783	4733	5293	10409	
Length of body	170	213	127	152	145	85	151	300	102	
Length of head	39	48	29	36	34	23	34	67	25	
Depth of body	38	53	29	36	35	21	33	67	23	
Depth of caudal peduncle	14	19	10	12	12	8	11	28	9	
Length of caudal peduncle	29	33	19	23	23	13	22	58	17	
Length of snout	17	21	13	16	15	9	15	33	10	
Diameter of eye	6	8	5	5	6	4	6	9	4	
Interorbital width	16	19	10	16	15	9	14	30	10	
Depth of head	26	33	19	24	25	15	23	51	17	
Snout to occiput	33	41	24	31	30	18	30	54	21	
Snout to dorsal	83	102	62	73	69	43	77	139	47	
Snout to ventral	95	118	72	80	80	47	87	171	51	
Length base of dorsal	31	41	23	27	26	16	28	53	18	
Length base of anal	13	17	10	12	7	7	11	23	8	
Height of dorsal	32	39	24	27	29	19	30	45	21	
Length of anal	30	40	20	24	14	24	47	47	18	
Length of ventral	24	32	17	19	19	12	31	40	14	
Length of caudal	29	45	22	28	22			56	25	
Dorsal rays	12	13		12	12	12	13	13	12	
Scales lateral series	61	69	62	77	68		72	62	62	
Scales above lateral line	12	13	12	12	12		11	14	10	
Scales below lateral line	10	12	11	10	9		10	12	11	
Scales before dorsal	34	35	30	29	33		35	36		
Anal rays	8	7	7	7	7	7	7	8	7	
Length of pectoral	34	49	23	27	25	18	29	58	20	

TABLE III
Measurements and Characteristics
of Catostomus ardens Jordan

Locality	Utah Lake									
Number	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU
	10357	10358	10368	10395	10396	10397	10398	10399	10400	10401
Length of body	370	310	345	200	400	258	295	316	354	333
Length of head	87	70	76	45	87	65	66	76	80	77
Depth of body	34	69	76	42	79	61	70	84	83	77
Depth of caudal peduncle	32	36	28	18	32	25	26	30	32	30
Length of caudal peduncle	62	57	55	36	64	45	54	55	59	56
Length of snout	43	33	35	22	37	30	31	34	38	36
Diameter of eye	12	9	9	6	12	9	9	9	10	9
Interorbital width	31	28	29	20	37	28	29	33	32	30
Depth of head	60	48	50	33	60	44	44	55	58	54
Snout to occiput	74	58	60	38	72	57	58	63	66	65
Snout to dorsal	174	148	157	93	179	131	137	160	157	161
Snout to ventral	200	168	189	106	206	150	151	167	170	183
Length base of dorsal	65	51	62	40	65	52	61	58	64	60
Length base of anal	31	24	29	15	32	26	27	29	29	29
Height of dorsal	51	46	46	39	59	50	51	55	58	49
Length of anal	82	60	61	40	76	65	62	55	65	55
Length of ventral	52	35	41	30	52	43	46	46	45	40
Length of caudal	70	59	58	42	65	59	50	63	58	57
Dorsal rays	13	12	13	13	12	12	12	13	12	13
Scales lateral series	66	69	72	65	63	62	63	68	72	79
Scales above lateral line	14	12	12	11	10	11	12	13	12	11
Scales below lateral line	14	10	12	10	8	9	11	13	13	12
Scales before dorsal	36	32	35	29	29	30	30	29	31	32
Anal rays	7	7	7	7	7	7	7	7	7	8
Length of pectoral	77	60	57	39	72	57	59	63	62	57

(may vary from $10\frac{1}{2}$ - $11\frac{1}{2}$). Base of dorsal enters entire length of body 6 times or more. Base of anal shorter than in G. ardens and Chasmistes licorus. The distance from the snout to occiput is less than in G. ardens.

TABLE IV
Measurements and Characteristics
of Catostomus fecundus Cope and Yarrow

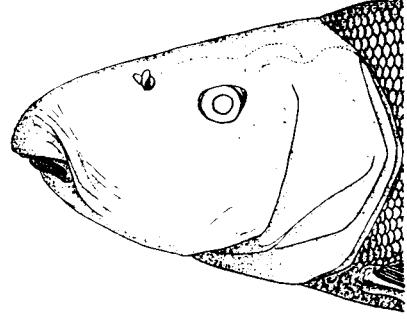
Locality	Utah Lake									
	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU
Number	10359	10360	10362	10365	10364	10384		10391	10369	10392
Length of body	295	317	351	353	316	331	372	342	319	272
Length of head	65	77	81	81	75	83	80	85	75	63
Depth of body	61	71	79	76	71	75	84	69	78	62
Depth of caudal peduncle	25	28	28	29	28	31	32	31	29	24
Length of caudal peduncle	52	52	56	59	52	54	62	54	61	51
Length of snout	30	37	42	47	36	37	36	40	38	32
Diameter of eye	9	9	9	10	10	10	11	9	9	9
Interorbital width	24	32	32	31	29	32	32	32	32	27
Depth of head	45	53	52	54	50	58	58	56	57	43
Snout to occiput	55	64	69	66	61	65	66	69	65	54
Snout to dorsal	142	156	170	169	153	158	173	156	161	126
Snout to ventral	159	174	192	195	184	182	197	200	183	152
Length base of dorsal	50	55	51	59	58	49	57	53	56	46
Length base of anal	24	28	29	25	27	22	29	25	24	20
Height of dorsal	47	54	52	53	53	56	54	56	53	46
Length of anal	50	65	61	57	63	61	60	65	65	50
Length of ventral	39	42	40	43	46	46	43	49	45	47
Length of caudal	61	64	63	71	63	60	69	70	63	51
Dorsal rays	12	13	12	13	13	12	12	13	13	13
Scales lateral series	66	65	70	65	72	72	72	62	66	70
Scales above lateral line	13	13	14	12	11	14	13	12	12	11
Scales below lateral line	14	11	12	10	11	12	12	10	10	10
Scales before dorsal	37	41	46	31	29	39	32	31	44	29
Anal rays	8	8	8	8	8	8	8	8	8	8
Length of pectoral	50	64	57	60	58	62	60	64	64	54

TABLE V

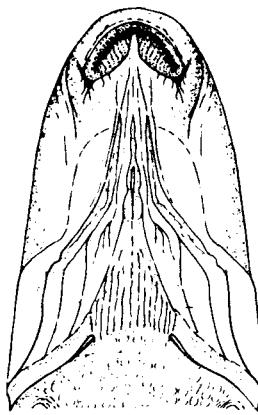
Measurements and Characteristics
of Catostomus fecundus Cope and Yarrow

Locality	Utah Lake								
Number	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU	BYU
	10293	4731	9581	10410	3813	3814	4748	4749	
Length of body	392	149	342	191	160	215	142	139	
Length of head	89	37	78	45	43	49	30	33	
Depth of body	77	36	75	65	44	49	32	31	
Depth of caudal peduncle	34	15	30	17	15	15	10	10	
Length of caudal peduncle	67	28	62	30	29	36	21	23	
Length of snout	43	15	36	30	19	20	12	14	
Diameter of eye	10	6	9	7	7	7	5	5	
Interorbital width	35	15	34	18	17	21	12	13	
Depth of head	58	25	57	31	29	33	21	22	
Snout to occiput	74	29	64	36	35	37	24	29	
Snout to dorsal	172	70	164	90	80	103	69	67	
Snout to ventral	205	81	167	107	100	119	83	78	
Length base of dorsal	55	25	52	30	27	35	24	24	
Length base of anal	30	10	30	13	11	15	9	9	
Height of dorsal	59	28	54	35	33	41	26	26	
Length of anal	67	27	72	33	34	44	24	23	
Length of ventral	49	20	47	27	26	32	20	20	
Length of caudal	67	61	61	41	37	41	25	30	
Dorsal rays	12	12	12	12	12	12	12	12	
Scales lateral series	72	70	70	70	65	67	72	65	
Scales above lateral line	12	13	12	11	11	12	13	12	
Scales below lateral line	12	12	12	10	10	12	12	12	
Scales before dorsal	37	33	42	29	37	35	37	33	
Anal rays	8	8	7	7	7	7	8	7	
Length of pectoral	66	30	68	38	37	47	26	29	

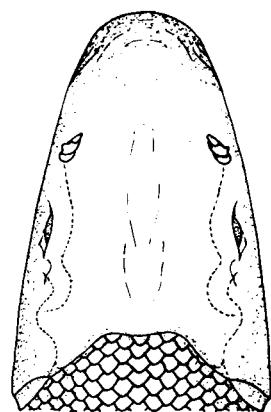
PLATE I



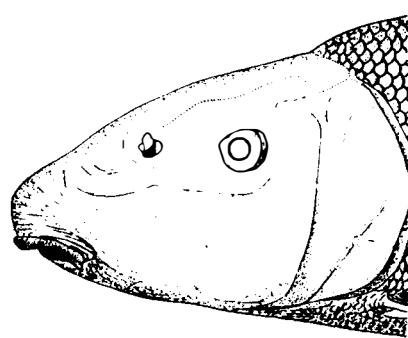
1



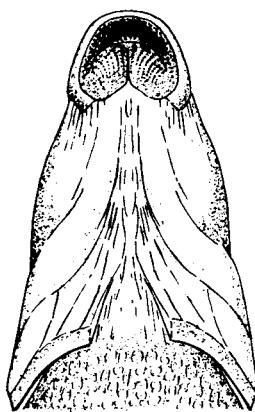
2



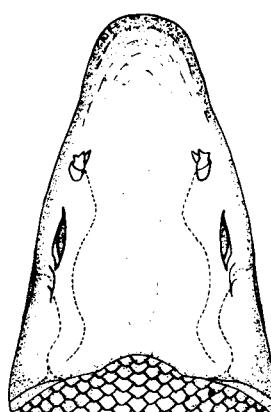
3



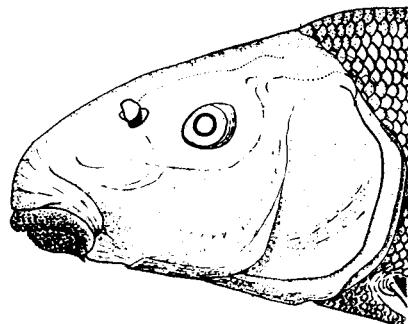
4



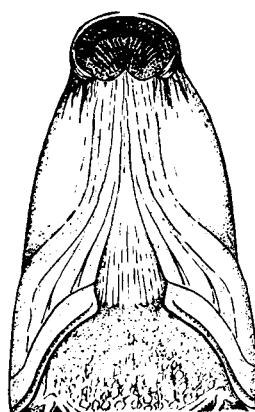
5



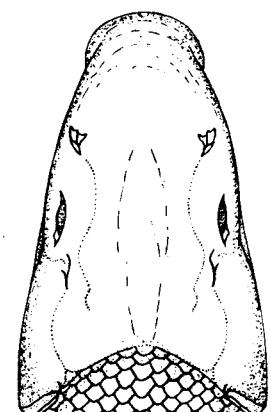
6



7



8



9

CHAPTER VII

NOTES ON POPULATION

Before white men came to this country, Utah Lake was a large fish "pond", and according to information which is available, it was much larger. Beautiful streams flowed from the mountains keeping the lake supplied with clean fresh water. The Indians camped on the shores of this great lake and took from it their subsistence for the long, hard winters. The main part of the subsistence taken consisted of large, native trout and suckers, which existed in great abundance.

The story of the disappearance of these trout from Utah Lake is very unfortunate. The fact that there are no native trout in Utah Lake is common knowledge to present day fishermen.

The first permanent white settlers came to this area in 1849 when the Mormon pioneers settled at the site now known as Salt Lake City, 40 miles north of Utah Lake. They found Utah Lake teeming with large, native trout. As far as is known the trout were the most prominent fish with reference to population. The Mormon pioneers and other people present caught tons of trout from the lake and took them to Salt Lake City where they sold them in the fish markets. The stories

told by many pioneers reveal the tastiness and excellence of this fish food. It seemed at this time that the supply of trout from Utah Lake could never be exhausted. Little did they know that their acts and the acts of those to follow them would entirely eliminate the trout from this lake.

The trout were river spawners and would run up the rivers and streams emptying into the lake, each spring to spawn. With the coming of the white men, irrigation projects were built without any thoughts of preserving the fish life of the lake. No screens were placed across the mouths of the irrigation canals and ditches and as the trout went up stream to spawn or came down stream after spawning, many of them were carried off into these small canals and ditches. After the day's irrigation was completed and the irrigation gates were closed, many trout were trapped and died when the ditches dried up. The settlers knew the time of the year the trout spawned and waited at the mouth of the river and caught them as they came up to spawn. These destructive acts, along with others, were carried to such extremes that in 1891 the trout were no longer the prominent fish in the lake. According to David Starr Jordan, in the year 1891, the trout ranked third in population of Utah Lake. The suckers were the most prominent while the chubs were second in population.

The population of the trout was continuously reduced until the drought of 1932. During the succeeding three years of drought, it was a rare privilege to see a trout in Utah Lake.

In 1881, Jordan and Gilbert confirmed the assumption by Mr. Madsen that Utah Lake was the greatest sucker pond in the universe. The suckers did not go as far up the streams to spawn as did the trout, and therefore their spawning was less hazardless. They rapidly increased in numbers until the drought of 1932-35 which was very disastrous to the fish life of the lake. Tanner states, "The surface area of the lake was reduced from 90,000 acres to 50,000 acres. In 1934-35 hundreds of tons of suckers were killed due to freezing and crowding into shallow holes.⁷ It is easily seen that under these conditions the population of the suckers of Utah Lake was greatly reduced and the title given the lake by Jordan and Gilbert was soon changed.

The last trout from Utah Lake was taken in 1936. It weighed approximately one pound and is now in the Ichthyology Museum at the Brigham Young University.

In 1871, carp were accidentally introduced into Utah Lake and in 1875 they were purposely planted there by the government. At the present time the carp have replaced the trout as the most prominent fish of the lake. The sucker which was the prominent fish in 1891 has been reduced in number and now has only the second largest population in the lake. Of the fish introduced other than the carp, the catfish have managed to survive with the best results and rank third in population. The populations of the larger fish of the lake are shown on the tables within this thesis. These population counts were made over a period of time extending from October 1950

to February 1951.

At the present time the ecological situations occurring in Utah Lake are very undesirable. It is difficult to understand how any fish could live under these conditions. The Geneva Steel Company eliminates its wastes into the lake. This waste is emptied at a rate of thousands of gallons per minute. The ^{bulrush, saltgrass, etc.?} grass and the cat-tails for miles along the lake shore are a dirty black as a result of this pollution. The cities around the edges of the lake empty raw sewage into it. Not only the fish are effected by the sewage but the water fowls as well. The sewage effects the fish by using the dissolved oxygen of the water during its decomposition. Many suckers are loosing their eyesight and becoming deformed in body structure. In addition to this, the fish and game laws of Utah do not protect the suckers as they spawn, and thousands of them are taken during the spawning season. It is not necessary to protect the carp during their breeding season in as much as they spawn in the lake.

If it were not for the carp and suckers, there would be no commercial fishing in Utah Lake. The commercial fishing provides winter jobs for about 20 men. The suckers are sold for chicken feed for approximately $2\frac{1}{2}$ cents a pound and the carp are sent to California for sale as food in the resturants.

There is a parasite in Utah Lake that is causing considerable damage to the suckers. It also attacks the chubs and catfish, but not as readily as it does the suckers.

According to the commercial fishermen, in the last 5

years, the numbers and individual size of the fish caught in their nets have been decreasing. In as much as the carp are the fish most commonly caught this may indicate that the carp are decreasing in numbers also.

The following charts show the results of the population counts. The number in each column represents the number of fish of each species of fish caught in one haul of the seine. The date the catch was made is given at the top of the column. The weather of the day the catch was made and the area of the lake from which it was taken is listed at the bottom of each column. The seining for these counts covered a period of time extending from October 31, 1950 to February 9, 1951. Previous statements may be clarified by the use of these charts.

	10/31/50	11/1/50	11/1/50	11/1/50	11/15/50
TROUT	0	0	0	0	0
PERCH	0	5	2	0	2
BASS	0	0	0	1	0
CATFISH	0	9	100	20	55
CRAPPIE	0	0	0	0	0
SUCKERS	16	- 33	60	50	150
CARP	500	1000	250	15000	17000
CHUBS	0	0	0	0	0
WEATHER	fair	fair	slightly windy	fair	fair
LOCATION	Goshen Bay	Goshen Bay	North P. River	South P. River	North P. River
	11/29/50	11/20/50	11/22/50	11/29/50	11/29/50
TROUT	0	0	0	0	0
PERCH	8	2	3	0	3
BASS	0	0	0	1	0
CATFISH	3	180	105	500	5
CRAPPIE	0	0	0	0	0
SUCKERS	1350	106	154	50	300
CARP	3000	14000	20000	2000	150
CHUBS	0	0	0	1	4
WEATHER	windy	fair	fair	fair	windy
LOCATION	South P. River	South P. River	South P. River	South P. River	North P. River

	<u>12/1/50</u>	<u>12/2/50</u>	<u>12/6/50</u>	<u>12/6/50</u>	<u>12/9/50</u>
<u>TROUT</u>	0	0	0	0	0
<u>PERCH</u>	3	5	7	1	0
<u>BASS</u>	1	0	0	0	0
<u>CATFISH</u>	475	225	350	300	100
<u>CRAPPIE</u>	0	0	0	0	0
<u>SUCKERS</u>	400	425	475	475	350
<u>CARP</u>	2050	1250	1500	1000	200
<u>CHUBS</u>	0	3	2	0	0
<u>WEATHER</u>	windy	fair	fair	fair	windy
<u>LOCATION</u>	South P. River	South P. River	South P. River	North P. River	North P. River
	<u>12/11/50</u>	<u>12/11/50</u>	<u>1/14/51</u>	<u>1/14/51</u>	<u>1/15/51</u>
<u>TROUT</u>	0	0	0	0	0
<u>PERCH</u>	6	10	0	0	0
<u>BASS</u>	0	0	0	3	0
<u>CATFISH</u>	250	300	25	50	3
<u>CRAPPIE</u>	0	0	0	0	0
<u>SUCKERS</u>	600	700	200	200	6
<u>CARP</u>	1500	2000	3000	2000	1000
<u>CHUBS</u>	0	0	1	0	0
<u>WEATHER</u>	windy	windy	underice	underice	underice
<u>LOCATION</u>	Goshen Bay	Goshen Bay	South P. River	South P. River	Goshen Bay

	<u>1/15/51</u>	<u>1/15/51</u>	<u>1/23/51</u>	<u>2/8/51</u>	<u>2/9/51</u>
<u>TROUT</u>	0	0	0	0	0
<u>PERCH</u>	4	6	1	10	0
<u>BASS</u>	0	0	0	0	0
<u>CATFISH</u>	10	15	100	5	0
<u>CRAPPIE</u>	0	0	0	0	0
<u>SUCKERS</u>	25	20	150	25	2
<u>CARP</u>	2000	2000	7750	950	200
<u>CHUBS</u>	0	6	0	10	0
<u>WEATHER</u>	under ice	under ice	windy	fair	windy
<u>LOCATION</u>	Goshen Bay	Goshen Bay	South P. River	North P. River	North P. River

CHAPTER VIII

SUMMARY

By carefully observing the charts and drawings herein included, it will be observed that very few external morphological characteristics can be used to separate the species.

The scale counts in most fish are very stable and seem to be in these species. However, the scale counts of these species lie within the same range making it impossible to use them to separate the species with certainty. During my studies of the fish of Utah Lake. The scales were counted on 500 specimens of C. litorus and C. fecundus and 250 specimens of C. ardens. In each species the scales on the lateral line ranged from 62-72, with the majority falling between 63-67. The scales above and below the lateral line range from 9-14 above and below.

The dorsal and anal rays are not dependable characteristics in this problem. The dorsal rays of each species are 12-13 and the anal rays from 7-8. The measurements of these fins seem to be of no value, such as the length of the anal fin and the height of the dorsal, since they are dependent upon the sex and the breeding season. The length of the other fins vary considerably in each species making them of little value in classification.

The other characteristics that were not thought to be outstanding for the separation of the species, seem to be in the same category in each species as the scale counts.

The data indicates that the three species originally named in Utah Lake are still present. Their validity may be questioned by some. However, one willing to spend the necessary time in a study of this kind, will agree that there are three distinct species of Utah Lake Catostomidae. Some workers have suggested the possibility of C. fecundus being an extreme end of a series of C. ardens. This is a possibility, but if this is assumed, it must also be assumed that Chasmistes liorus is a part of this same series. My observations have shown that there is a sucker in Utah Lake for every step of a continuous series with reference to lips, papillae and head, from Chasmistes liorus to Catostomus ardens with C. fecundus in the center of the series. In view of this, it can be said that there is either two genera and three species or one genus and one species of suckers in Utah Lake. Chasmistes liorus spawns in April and C. ardens and C. fecundus spawn in June. Therefore, Chasmistes liorus is a separate and distinct species. This eliminates the possibility of one genus and one species.

It can not be said that C. fecundus and C. ardens do not interbreed, as this is yet to be varified. Even though they breed at nearly the same time, I do not believe they interbreed.

The reasoning in this is as follows:

In morphological characteristics, Catostomus fecundus shows as

many differences when compared to Catostomus ardens as does Chasmistes liorus when it is compared to Catostomus ardens. As far as my research is concerned Catostomus ardens and Catostomus fecundus are as distinct from each other as Chasmistes liorus and Catostomus ardens are distinct from each other. The final decision as to the speciation of Catostomus fecundus and Catostomus ardens will be made when the breeding — habits are investigated.

The population counts taken indicate that the suckers have decreased in numbers since the discovery of Utah Lake. These counts also reveal that the suckers have increased in numbers since the drought of 1934-5 but have not increased to the numbers held previously. The information given in the Chapter 7 shows how the suckers decreased in numbers and were replaced as the most dominant fish of the lake, with reference to population, by the trout. Still later and at the present the trout have been replaced by the Cyprinus carpio as the most dominant fish of the lake with reference to population.

CHAPTER IX

BIBLIOGRAPHY

1. Cope, E. D. and Yarrow, H. C.
Report on the collection of fishes made in
portions of Nevada, Utah, California, Colorado,
New Mexico and Arizona, during the years 1871-
2-3 and 4. Rept. Geog. and Geol. Expl. and Surr.
West of the 100 th Meridian. Vol. V. Zoology
pp. 685-693.
2. Jordan, David Starr, 1878; Bull. Hayden Geol.
Surr. Terr.; pp. 417.
3. Jordan, David Starr, 1878; Bull. U. S. Nat.
^{P. 150.}
Mus.; No. 12; pp. 219.
4. Jordan, David Starr; 1881; notes on collection
of fishes from Utah Lake; Proc. U. S. Nat. Mus.
Feb. 16.
5. Jordan, David Starr and Evermann, Barton W.
1896; the fishes of North and Middle America;
part 1 A; pp 178;.
6. Jordan, David Starr, 1930; Genera of Fishes.
7. Tanner, Vasco M.; 1936; A Study of the Fishes
of Utah; Utah Acad. of Sci.; Arts and Letters;
Vol. XIII, pp. 155-184. pls. 1-III.

8. Jordan, David Starr; 1891; Bull. U. S. Fish
Commission, Vol. 9; pp. 34.