

**FOOD AND FEEDING HABITS OF *CYPRINUS CARPIO* L.
AT SEROW FISH FARM, EGYPT**

By

H.M. BISHAI

Zoology Department, Faculty of Science, Cairo University.

AND

S.A. ABDEL-MALEK

W. LABIB

Institute of Inland Waters and Fish Culture, Barrage Fish Farm.

INTRODUCTION

The food and feeding habits of the mirror carp was studied by different investigators working at different localities (Seeley, 1886, Bean 1892 ; Cole, 1905 ; Forbes and Richardson, 1909 ; Greeley, 1928 ; Clemens, 1939 ; Gerking, 1950 ; Sigler, 1958 ; Hora and Pillay, 1962 ; Walburg and Nelson, 1966 etc.).

The study of the food of carp in Egyptian waters was not carried out since the introduction and successful acclimatization of carp in Egypt in 1949. The knowledge of the main food items of carp at different stages is of utmost importance. Although in carp culture artificial food is usually given, yet, natural food is necessary for good growth and healthy carp as it provides certain substances which are not included in artificial food. Wunder (1949) has shown that the natural food taken by carp in ponds consists chiefly of chironomid larvae, other insects larvae and zooplankton, all these are rich in protein. Brown (1957) indicated that 5 species of insect larvae *Gammarus* and *Heladulus* contained 82% water and not less than 11.5% protein. All these authors emphasised the importance of natural food for carp as a source of protein.

Hence the study of natural food of carp is needed especially during the early larval tages, which are considered as the most critical stages in the life of fish. The exact information of the main food items of carp fry from the stage at which they commence feeding to the early fingerling stage is of utmost value to provide optimum nursery requirements for their successful rearing. Such food items could be made abundant at the suitable time either by providing the necessary requirmental conditions or by artificial fertilization of fish ponds.

MATERIAL AND METHODS

In the present work, the gut contents of 400 carp were analysed. The total length was recorded for each fish to the nearest millimeter. The fish were taken from the spawning and rearing ponds and they ranged from the newly hatched to the adults (6 mm. — 420 mm. length). Most of these fish were examined fresh and the other fish were preserved in 5% formalin for gut examination at a later date. Each food organism was identified, then counted and the results were analysed by the following methods :

The occurrence method : the number of fish which each food item occurs is listed as percentage of the total number of fish examined. The number of occurrences of all items is summed and scaled down to a percentage basic to show the percentage composition of the diet. This method was used by many investigators (Allen, 1935 ; Frost, 1939 ; Hynes, 1950 ; Sigler, 1958 ; Bishai and Abu-Gideri, 1962 ; Abdel-Malek, 1968, Alkholy & Abdel-Malek, 1971, Walburg and Nelson, 1966, etc.).

The dominance method : the number of fish in which each food item occurs as a dominant food stuff is expressed in the ways used in the occurrence method. This method was tried by Frost, 1939 ; Hynes, 1950 ; etc.

RESULTS

All carp examined for food were left in the ponds to feed on natural food, artificial food was not added. After complete examination of 400 carp of various lengths and according to the present data, three major groups were selected :—

- a) Group I : 6 mm. — 109 mm. long.
- b) Group II : 110 mm. — 179 mm. long.
- c) Group III : 180 mm. — 420 mm. long.

The percentage occurrence and the percentage composition of diet by using the occurrence and the dominance methods were calculated as shown in tables I and II respectively.

Group I (6mm. — 109mm. long)

The results are based on the examination of the gut contents of 274 carp. By using both the percentage occurrence and the percentage composition of the food items, it was found that copepods, chironomids, rotifers and diatoms were the main food components while the other food items were less frequent (Table I and Fig. I).

Copepods mainly *Cyclops* spp. and *Eutropina* sp. formed the most important food organisms in this group as shown in tables I and II. All copepods occurred in 68.8% and the percentage composition was 23.7. The average number of copepods eaten per fish in this group was 35 which increased with increase of fish length.

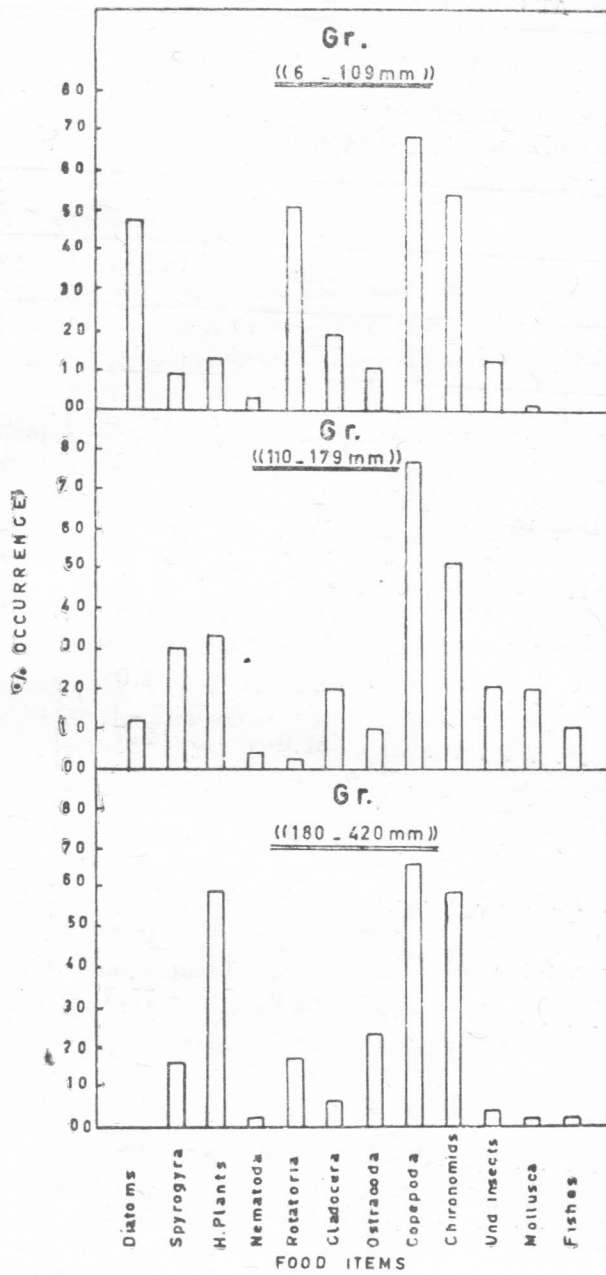


FIG. 1.) HISTOGRAM SHOWING PERCENTAGE OCCURRENCE OF THE DIFFERENT FOOD ITEMS TAKEN BY MIRROR CARP *CYPRINUS CARPIO* L. AT DIFFERENT STAGES

Fig. 1.— Histogram Showing Percentage Occurrence of the Different Food Items Taken by Mirror Carp *Cyprinus carpio* L. at Different Stages

TABLE 1.—Percentage occurrence of various food items eaten by *Cyprinus carpio* L. at Serow Fish Farm.

Group	I	II	III
Length of fish (mm)	6-109	110-179	180-420
Number of fish examined	274	74	44
<i>Food items :</i>	% Occurrence		
Chrysophyceae Diatoms	47.4	12.1	—
Chlorophyceae Spyrogyra	9.1	10.0	16.0
Higher plant tissue	13.1	33.8	59.0
Nematoda	3.0	4.0	2.3
Rotatoria	51.0	2.7	17.0
<i>Crustacea :</i>			
Cladocera	19.3	20.0	6.8
Ostracoda	11.0	10.0	23.0
Copepoda	68.6	77.0	66.0
<i>Insecta :</i>			
Chironomids	54.0	51.3	59.0
Other Insects	12.4	20.3	4.6
Mollusca	0.4	20.0	2.3
Fish fry	—	10.8	2.3

Chironomid larvae and pupae were abundant in the alimentary tracts, and they formed the second important food item. The maximum occurrence of chironomids was 90%, while the minimum was 37%, and the average was 54%. By using the occurrence and dominance methods it was found that the percentage composition of chironomid larvae and pupa was 18.6 and 22.1 respectively. The average number of chironomids eaten per fish was 6.2 individuals.

Rotifers of various species were found in almost 50% of the fish examined and they were eaten in fair quantities, so their percentage occurrence was 51, while their percentage composition was 17.6.

Diatoms formed a fair proportion of the food eaten by this group of fish. Their average percentage occurrence was 47.4, which reached its maximum (78%) in case of fish of lengths 30 — 39 mm. The percentage composition of diatoms by occurrence method was 16.4%.

Cladocera mainly *Daphnia* sp. and *Bosmina* spp. occurred with average percentage 19.3% and the percentage composition by using the occurrence method was 6.9%. It is of interest to mention that Cladocera were found in nearly half the number of guts of carp of lengths 6 — 19 mm.

Higher plants including aquatic and terrestrial forms and their parts as bark, stems and leaves had a percentage occurrence 13.1%, which increased with the increase of the length of fish. These higher plants were not found in the guts of smallest fish lengths ranging from 6 — 19 mm.

As seen from table I, unidentified aquatic insects, insect larvae and pupae occurred with an average percentage of 12.4%. This percentage increased with the increase of the length of fish.

The average percentage occurrence of ostracods in this group was found to be 11, while the percentage composition (by using the occurrence method) was very low (3.8%). This indicates that ostracods are not important food items for this group of fish.

Green algae mainly *Spyrogyra* were found in 75% of the total guts examined. They formed 40% of the food taken by carp ranging from 6 — 9 mm. in length. The importance of green algae as food for carp decreases with the increase of length.

Carp rarely eats free nematodes, which are found in very small quantities as seen from tables 1 and 2 and fig. 1. Molluscs were rarely taken by this group of fish. Only one gastropod was found in the gut of a carp fry of length 45 mm. It is clearly seen that carp fry did not use fish as a food component in this group of fish.

Group II (110 — 179 mm. long)

This group includes 74 specimens and the results are shown in tables I and II. It is observed that copepods mainly *Cyclops spp.* and *Eutropina spp.* chironomid larvae and higher plant tissue mainly cork, stems and leaves of *Typha* and some terrestrial plants, formed the most important food items of this group of carp (Table 2).

The percentage occurrence of copepods, chironomids and higher plant tissue was 77 ; 51.3 and 33.8 while their percentage composition was 26.3 ; 17.6 and 11.6 respectively.

As in the first group, it was noticed that carp fed chiefly on copepods which made up more than one-quarter of the food contents. It was of interest to mention that a 175 mm. long carp ate 640 copepods. The average number of copepods eaten per fish was 110.8 individuals.

Chironomids constitute an important food item for this group of fish. In most cases its percentage occurrence was more than 25% and reached its maximum, 83% in fish of lengths 160 — 169 mm. The average number of chironomids in the alimentary canal was found to be 25 individuals.

Cladocera (mainly *Daphnia* sp. and *Bosmina* spp.), unidentified aquatic insects (insect larvae and pupae, and *Mollusca* mainly *Gastropoda*), were found to have nearly the same percentage occurrence (20%) and the same percentage composition (6.9%).

Chlorophyta mainly *Spyrogyra* formed 10% of the food contents of carp in this group, although its occurrence ranged from 22 to 38%.

In rare cases, carp ate its fry. Six carp fry ranging in lengths from 15 to 25 mm. were found in the gut of a carp 130 mm. long and 25 mm. weight. In another case a young carp 160 mm. and 61 gm. weight ate only one carp fry 30 mm. long. Two carp fry of lengths 18 and 35 mm. were found in the gut of 175 millimeter long carp.

In this group of fish it was noticed that the percentage occurrence of diatoms decreased and reached 12%, also the percentage composition was found to be 4.2%.

Other food components as nematodes, rotifers and ocracods were rarely represented, and were eaten in small quantities. (Fig. 1 and Tables 1 and 2).

Group III (180 — 420mm. long).

Examination of 44 carp of this group showed thta the most important food items were copepods and chironomids where their percentage occurrence was 66 and 59 and the percentage composition was 25.6 and 22.8 respectively. (Tables 1 and 2). Higher plant tissue occurred in 59% of the guts and composed 22.8% of the total food.

Copepods were the main food items eaten by carp of this group. 600. copepods were found in the gut of a fish 320 mm. long. The average number of copepods eaten per fish was 176.2 individuals.

Chironomids were very important food organisms for carp. When examining the gut contents of a carp 320 mm. long and 400 gm. weight, 136 chironomids were found in the gut. The average number of chironomids eaten per fish in this group was found to be 42.5 individuals.

Ostracods mainly *Cypris spp.* were found in nearly one-quarter of all the fish examined, and the percentage composition was 8.9%.

Spyrogyra occurred with 6.2%, while diatoms completely disappeared from the guts of this group of fish.

Other food items of animal origin as nematodes, rotifers ... etc., were rarely eaten and were found in small quantitie. in guts of carp.

FEEDING BEHAVIOUR

The feeding behaviour of carp has been described by many authors. Black (1946) showed that carp are bottom feeders, they typically suck up mud and other material from the bottom, eject it and select food, when it is suspended in the water. Sigler (1958), Miller *et al* (1959), Jessen and Kuhan (1960), showed that the area where carp are found extensively are characterised by uprooted aquatic vegetation and soiled water. Hora and Pillay (1962) stated that carp collects food by taking bottom mud into the mouth, sifting out digestible particles and rejecting the rest. They pointed out that in searching for worms and insect larvae carp burrows holes into the embankments. This habit of feeding destroys benthic vegetation and makes the water turbid.

TABLE—2. Percentage composition of food items eaten by *Cyprinus carpio* L. at Serow Fish Farm.

Group	I		II		III	
	6—109		110—179		180—420	
Length of fish (mm)						
Number of fish examined	247		74		44	
Food items :	% composition					
	Oec. method	Dom. method	Oec. method	Dom. method	Oec. method	Dom. method
<i>Chrysophyceae :</i>						
Diatoms	16.4	12.3	4.2	4.2	—	—
<i>Chlorophyceae :</i>						
Spyrogyra	3.2	1.8	10.3	10.3	6.2	6.2
Higher plant tissue	4.5	4.8	11.6	11.3	22.8	22.8
Nematoda	1.1	1.2	1.5	1.4	0.9	0.9
Rotatoria	17.6	13.7	0.9	0.9	6.6	6.6
<i>Crustacea :</i>						
Cladocera	6.7	7.4	6.9	6.9	2.6	2.6
Ostracoda	3.8	4.5	3.4	3.4	8.9	8.9
Copepoda	23.7	27.1	26.3	26.4	25.6	25.6
<i>Insects :</i>						
Chironomids	18.6	22.1	17.6	17.6	22.8	22.6
Other Insects	4.3	5.0	6.9	7.0	1.8	1.8
Mollusca	0.1	0.1	6.9	6.9	0.9	0.9
Fish fry	—	—	3.6	3.7	0.9	0.9

Surface feeding by carp is a common occurrence at which time the fish may feed on aquatic organisms or may graze directly on the vegetation (Cole, 1905).

In the present study we observed that mirror carp is a bottom feeder, taking up mud and other material from the bottom and then ejecting it after selecting the suitable food. This feeding behaviour agrees with the observation of Black (1946). It is noteworthy to mention that the ponds where carp lives are usually turbid because of this bottom feeding habit. It is noticed that carp in the fish ponds may come occasionally to the surface probably to feed on aquatic organisms and vegetation.

DISCUSSION

The present data suggest that carp (6—420 mm) tend to eat more animal food than plant material. This agrees with the findings of previous investigators working at various localities, who found that animal material is the main food for carp (Pearse, 1918 ; Gennerich, 1922 ; Greely, 1928 ; Ewers and Boesel, 1935 ; Clemens, 1939 ; Lindquist et alii, 1943 ; Wunder, 1949, Nakamura, 1956 ; Vass, 1957 ; Sigler, 1958 ... etc. However, other workers believe that plant material is more important food item than animal material (Seeley, 1886 ; Bean, 1892 ; Hunt, 1911 ; Mottley, 1938 ; Dill, 1944 etc.).

At Serow Fish Farm, the percentage composition of food of animal origin is 73.9% 73.9% and 71.9% for carp 6 — 109 mm. ; 110 — 179 mm. and 180 — 420 mm. long respectively. Copepods and chironomids are the most important items in the diet of carps as they formed 42.3%, 43.9% and 48.4% of the total food in the three size groups.

The present results show that food items for larval carp (Group 1 : 6 — 109 mm. long) are copepods, chironomids, rotifers and diatoms which occurred in 68.5%, 45.0% and 51.0% respectively of all fish examined, and composed 23.7%, 16.6% 17.6% and 16.4% of the total food eaten respectively (Tables I and II and Fig 1). Cladocera and remains of higher plants occurred at a lower percentage. However, Cladocera were more frequent in the guts of early larval stages (6 — 19 mm.). Algae in the form of *Spyrogyra* were found in a high percentage in case of 6 — 9 mm. long carp and their importance decreased with the increase of fish length. These findings are in close agreement with those of previous investigators (Gill, 1905 ; Pearse, 1918 ; Sigler, 1958 ; Hora and Pillay, 1962 ; Saadi, 1965 ... etc.), who pointed out that rotifers, entomostracans and algae are principal food items of early larval stages of carp.

The food of the young — of — the — year constituted mainly copepods (77%), chironomid larvae and pupae (51%), higher plants (33%) and algae (30%). Rotifers, ostracods, molluscs and nematodes are less important. This agrees with the observations of Pearse (1918) who showed that food of young German carp contained larvae and pupae of chironomids, caddis flies and other hexapods, small molluscs, ostracods and crustaceans. Sigler (1958) found that young carp feeds mainly on small crustaceans, chironomids ; plant debris is a minor item when the diet consists primarily of entomostracans. However, Hora and Pillay (1962) found that the food of carp when reaching 10 cm. long consisted of bottom dwelling aquatic animals together with considerable amounts of more or less decayed vegetable matter and epiphytic plankton. Walburg and Nelson (1966) pointed out that young carp feed on phytoplankton, copepods and chironomid larvae to a great degree than adults.

Food material taken by adult carp (180—420 mm. long ; 1—3 years old), consisted of copepods chironomids and remains of higher plants which are the most important food items with a percentage occurrence 66, 59 and of all the guts examined respectively. Diatoms are not consumed by large fish. It is noticed that with the increase of length of fish the importance of diatoms decreases while that of higher plants increases. These results confirm the observations of Wunder (1949), Vass (1957), Sigler (1958), Walburg and Nelson (1966), who showed that chironomid larvae, microcrustaceans, copepods and zooplankton are the main food items of adult carp.

From the present study it is concluded that copepods and chironomids are the major food items of carp. The average number of copepod individuals eaten per fish is 35 ; 110.8 and 176.2, for the three size groups respectively ; while for chironomids it is 6, 25 and 42 for three size groups respectively, thus showing an increase in the number of copepods and chironomids eaten with the increase of fish size.

Although the present results suggest that carp is not a fish eater yet in about 6 cases out of 400 carp fry were found in the gut of the fish examined Sigler (1958).

SUMMARY

1.—Analysis of the gut contents of 400 mirror carp ranging from 6—400 mm. long at Serow Fish Farm, shows that carp feeds mainly on animal food; plant material is less important.

2.—Copepods and chironomids form the most important food items of carp during all stages of their life.

3.—Using the occurrence and dominance methods it was found that larval carp (6—109 mm. long) feed mainly on copepods, chironomids, rotifers and diatoms. Algae in the form of *Spyrogyra* occurred in high percentage in 6—9 mm. long, and decreased with increase of length of fish.

4.—Young carp (110—175) mm. long) feeds mainly on copepods, chironomids, molluscs and nematodes are less important as food item.

5.—Adult carp (180—420 mm. long) consumes copepods, chironomids and higher plants. Diatoms are not taken by adult fish.

REFERENCES

- ABDEL-MALEK S.A., 1968.—Feeding of young three spines stickleback (*Gasterosteus aculeatus* L.) in the Kandalaksha Bay of the white Sea. Problems of Ichthyology. Vol. III. No. 2 (49).
- ALKHOLY A.A. and ABDEL-MALEK S.A., 1972.—Food and Feeding Habits of some Egyptian Fishes in Lake Quarun. Part I. *Tilapia zillii* (Gerv.). A. According to different localities. Bull. Inst. Ocean. Fish., 2 : 185-201.
- ALLEN K.R., 1935.—The food and migration of the perch (*Perca flaviatilia*) in Windermere. Jour. of Anim., Ecol., 4.
- BEAN T.H., 1892.—The fishes of Pennsylvania. Rept. Pennsylvania State Comm. Fish. (1889-1891), 1-49.
- BLACK J.D., 1946.—Nature's own weed kiler, the German carp. Wisconsin Conserv. Bull. II, No. 4.
- BISHAI H.M. and ABU-GIDERI Y.B., 1965.—Studies on the biology of genus *Synodontis* at Khartoum. II. Food and feeding habits. Hydrobiologia ; 26 : 98-113.
- BROWN M.E., 1957.—Experimental studies on growth. In "Physiology of fishes" (Edited by M.E. Brown), Vol. I, Chapter IX : 361-364. Acad. Press Inc., New York.
- CLEMENS W.A., 1939.—The fishes of Okanogon Lake and near by waters. Bull. Fish. Res. Bd. Canada, No. LVI : 27-34.
- COLE L.J., 1905.—The German Carp in the United States. Rept. U.S. Bur. Fish., Vol. 525-641.
- DILL W.A., 1944.—The fishery of lower Colorado River. Calif. Fish and Game, 30 : 109-211.
- EWERS L.A. and BOESEL M.W., 1935.—The food of some Backeye Lake fishes. Trans. Am. Fish. Soc., 65 : 57-70.
- FORBES S.A. and RICHARDSON R.E., 1909.—The fishes of Illinois. 357 pp.
- FROST W.E., 1939.—River Liffey Survey. II. The food consumed by the brown trout (*Salmo trutta* Linn.) in acid and alkaline waters. Proc. R. Irish Acad. Vol. XLI. B.
- GENNERICH H., 1922.—Was frisst die Karpfenbrut in Teichen. Z.F. fisherei, 21 : 368 p.

- GERKING S.D., 1950.—A carp removal experiment at Oliver Lake Indiana. Invest. Indiana Lakes Streams, 3, (10) : 373-388.
- GILL T., 1905.—The family of cyprinids and the carp as its type. Smithsonian Inst. Misc. Collections ; 45 : 295-305.
- GREELEY J.R., 1928.—Fishes of Oswego Watershed - Suppl. 17th. Ann. Rept. Conserv. Dept. 1927 : 84-107.
- HARIAN J.R. and SPEAKER E.B. 1956.—Iowa fish and fishing. Iowa State Conserv. Comm : 85-87.
- HORA S.L. and PILLAY T.V.R., 1962.—Handbook on fish culture in the Indo-Pacific region. FAO. Fisheries Division Biology Branch-No. 14.
- HUNT W.T., 1911.—As to the carp. Trans. Am. Fish. Soc., 41 : 189-193
- HYNES M.B.N., 1950.—The food of freshwater sticklebacks (*Gasteroseus aculeatus* and *Pygosteus pungitius*), with review of methods used in studies of the food of fishes., J. Anim. Ecol. 19 : 36-59.
- JESSEN R.L. and KUHN J.H., 1960.—When the carp are eliminated. Minnesota Dept. conserv. Official Bull., 23 (134) : 46-50.
- LINDQUIST A.W. ; CHEISTIAN D. and HANCY J.E., 1943.—The relationship of fish to the clear lake gnat in Clear Lake, California. Calif. Fish & Game, 29 (4) : 196-202.
- MILLER H.J. ; BRYDNILDSON C.L. and THEINEN C.W., 1959.—Rough Fish control. Wisconsin Conserv. Dept. No. 225 : 15.
- MOTTLEY C. Mc C., 1938.—Carp control studies with special reference to Chautargua Lake. Suppl. 27, N.Y. Conserv. Dept. Ann. Rept., 226-235.
- NAKAMURA K., 1956.—Possibility of carp fingerling production in farm pond, Nagano prefecture. Bull. Freshwater Fish. Res. Lab., 6, (2).
- PEARSE A.S., 1918.—The food of the shore fishes in waters near Madison, Wisconsin. Bull. Wisconsin Nat. Hist. Soc. 35 : 249-292.
- SAADI A., 1965.—Ernahrung und Wachstum des Karpfens in ersten lebensjahr aus der Untersuchungsstelle fur Teichwirtschaft om Zoologischen Institut. Arch. Hydrobiol. 61. page.
- SEELEY H.G., 1886.—Freshwater fishes of Europe. Cassel, London, 444 pp.
- SIGLER W.F., 1958.—The ecology and use of carp in Utah. Utah State University. Logan Agricultural Experiment Station. Bulletin. No. 405, Decembre, 1958.
- VAAAS K.F., 1957.—Studies on the food and feeding habits of the common carp in Indonesia (I) Changes in diet during growth. Indo-Pacific. Fish council 7th Session Bandung-Indonesia (I.P.F.C./C. 57/Tech 1361) 25 P (Mimeographed).
- WALBURG C.H. and NELSON W.R., 1966.—Carp, River carpsucker, Small mouth Buffalo & Big mouth Buffalo in Lewis & Clark Lake Missouri River. Fish. Res. Biologists Research Report, 69 : 1-30.
- WUNDER W., 1949.—Fortschrittliche Karpfensichwirtschaft, Erwin Nagele, Stuttgart.