THE FOOD OF ILLINOIS FISHES.

By S. A. FORBES.

But little has been written on the food of the fresh water fishes of this country, and nothing whatever, so far as I can learn, on the food of the fishes of of this state. I have not found anything more elaborate than a short paper* by Prof. S. I. Smith, of Yale College, on the food of a few specimens of White Fish, Red Horse (*Myxostoma aureolum*), Yellow Perch and Sturgeon (*Acipenser rubicundus*), from Lakes Superior and Erie. An item † relating to the food of the White Fish was published by Dr. Stimpson, of the Chicago Academy of Sciences, in 1870, and a few scattered notes of single observations occur in various papers on classification. ‡

The importance of the subject, both to the scientific student and to the practical fish breeder, seems to warrant more systematic work; and a methodical investigation has therefore been begun at the State Laboratory, the first results of which are given in the following memoranda.

PURPOSES OF THE INVESTIGATION.

A thorough knowledge of this subject should contribute something to our theories of distribution, since the food of those forms having appetites at all discriminating must have much to do with their range. Light might even be thrown upon past distribution, and the causes be suggested of extensive migrations. The chosen *haunts* of different groups within their habitat, are probably determined largely by their gastronomic needs and preferences. Do the wide-spread species eat similar articles throughout their range, or are they wide-spread because they are omnivorous, or because their food habits are more *flexible* than those of other fishes? On the other hand, are the narrowly limited species ever restricted by the local character of their food?

* Report of U. S. Commissioner of Fish and Fisheries, Pt. II, p. 690.

† American Naturalist, Sept. 1870, p. 403.

‡ A paper by Dr. C. C. Abbot in the Report of the U. S. Fish Commissioner for 1875-6 will also repay examination.

We ought also to gain, by this means, some addition to our knowledge of the causes of variation, of the origin and increase, the decline and extinction of species, and of the remarkable persistence of such forms as the river gar. What groups crowd upon each other in the struggle for subsistence? Do closely allied species, living side by side, ever compete for food? What relation, if any, do specific and generic differences bear to differences of food? These, and many similar questions, may not improbably be helped toward a solution.

Several *structures* not now fully understood, ought to receive their explanation. The variously developed grinding surfaces on the pharyngeal teeth of some cyprinoids, the differences in the structure of the gill-rakers among sun-fishes and of the lips among suckers, are cases in point.

It seems likely, however, that the food habits of fishes will be found, like their structure, much less highly differentiated than those of birds. This is what we should expect *a priori*, and it is indicated by the observations I have made upon both classes.* Prominent peculiarities, having apparently an important bearing upon the taking of food, will probably be found merely to extend a little the capacities of the species, or to enable it to take those slight advantages of its competitors when the struggle for existence comes to the death grapple, which after all are sufficient to decide the contest. To bring out such facts as this, a great number of observations will be necessary, covering all varieties of circumstance, and made with reference to the relative proportions of the different elements in the food of each species. The Top Minnows, for example, will probably be found to take the surface-swimming insects *more frequently* than the *Cyprinidae* do, but not by any means to depend on them *chiefly*.

Really *intelligent fish-culture*, on any large scale, implies a full acquaintance with the food of the native species. It is a matter of especial importance that the predaceous fishes should all be known, as well as the kinds of fishes on which each chiefly preys. A knowledge of the food of all species worth saving is, of course, indispensable, in order that proper measures may be taken to preserve their food supplies. It will also be of interest to know what fishes there are at once worthless for human food and harmless in their habits, and therefore worth encouraging, or perhaps even hatching, as food for the more valuable "game fishes." The gizzard shad (*Dorosoma cepedianum*), seems to be a fish of this character, as it lives chiefly on vegetable food and minute crustacea, and contributes largely to the food of the marketable fishes. Apparently ignorant of this fact, the fishermen often leave long lines of this species to rot on the bank where the seines are hauled.

* See "The Food of Birds," in Trans. Ill. Hort. Soc., Vol. X, p. 37, 1876.

Some valuable fishes may be found dependent on food too liable to injury or destruction by man or nature, to make it worth while to cultivate them, while others, equally valuable, may be proven to subsist on food practically indestructible.

Such species as eat *mixed food*, so that, in case of scarcity of one kind, another may be drawn upon, are evidently more promising, other things being equal, than those of a more limited diet.

That a full understanding of the *competitions* among the fishes of a stream or lake is necessary to anything better than guess-work in fish-culture, or an expensive and improvident trusting to luck, is evident at once.*

The *scavenger* fishes, which, by devouring the filth of streams, help to purify them, are doubtless worthy of recognition. Whether a filth-eating fish is better or healthier food than a bird or a mammal of similar habits, may, perhaps, be profitably discussed.

An acquaintance with the subject sufficient for the purposes above mentioned must, of course, include the whole life of the fish, at all ages and in all seasons. It is not impossible, for example, that the draining of stagnant waters connected with a stream may unfavorably affect some of its fishes, by lessening the supply of *Entomostraca*, especially *Cludocera*, for the food of the fry.

So much may properly be said concerning the purpose and promise of the research, to justify the labor given to it,—especially since the general neglect it has received may seem to indicate that it is not worth elaborate study.

METHODS.

The stomachs and intestines were taken out of the fishes just as these came from the seine; were labeled with specific name, place and date, and preserved in strong alcohol. They were afterward opened and the contents examined (usually with the microscope). Notes were made upon the objects found in each, as far as they were recognizable—the species being determined, if possible, otherwise the genus, family, order, or even only the class. The contents of each stomach were then bottled separately in alcohol, labeled and preserved for future verification and further study. The emptied stomachs have also been kept for anatomical purposes, and as a means of verifying the species. It was found unnecessary to remove the stomachs of the minnows, as these were well enough preserved in the bodies of the fishes themselves.

* That fishes and land birds should ever come into competition, seems at first sight remarkable; nevertheless some of the former eat large numbers of land insects which fall into the water. The supply of these would, of course, be limited by the depredations of birds.

In summing up, all the notes on the food of each species were collated, and an attempt was made to arrange the essential facts in a compact and simple form. The classification of fishes used is that of the preceding paper on the fishes of Illinois.

RESULTS.

Only a mere beginning has as yet been made. One hundred and forty-nine specimens have been examined, representing fifty-four species—taken chiefly (except the minnows) from the Illinois River, near Peoria and Henry, in June and November, 1877, and April and May, 1878. The specimens were all of a fair average size. In this preliminary report upon so small a number of specimens, it has not been deemed worth while to specify dates and places.

When the facts relating to any species are numerous and varied enough to make systematic condensation desirable, the articles of food have been arranged according to the natural classification of plants and animals, in such a way that one wishing to know only the general conclusions reached can readily learn them, without being embarrassed by unessential details.

The importance of a knowledge of the *proportions* of the different elements of the food has been kept in mind, and an attempt made to indicate these rudely by placing after each the number of specimens of the species in which the given element was found. Thus, under *Lepiopomus pallidus* (No. 18), of which two specimens were examined, "Chrysomelidæ 2" indicates that *one or more beetles* of this family were found in the stomachs of each of *two specimens* of that species. The figures in parentheses placed after the family and specific names of *fishes* indicate the number of specimens examined.

DETAILS OF FOOD.

DARTERS. ETHEOSTOMATIDAE. (9.)

Entomostraca and larvae of diptera and neuroptera.

1. *Sand Darter.* *Pleurolepis pellucidus*, Ag. (2.) Larvae of small diptera.

2. *Black-sided Darter.* *Alvordius maculatus*, Grd. (1.) Small diptera (gnats), larvae of May-flies (Ephemeridae), and many unknown minute eggs?, oval, tuberculated, with tubercles in longitudinal rows.

3. *Johnny Darter.* *Boleosoma maculata*, Ag. (1.) Several Cyclops and many larvae of gnats.

4. *Banded Darter.* *Nanostoma zonalis*, Put. (1.) Larvae of gnats, including some with antennae similar to those of *Corethra pictipennis*.

5. *Rough-cheeked Darter*. *Poecilichthys asprigenis*, Forbes, (2.) Larvae of *Chironymus* (diptera), and other aquatic larvae; also pupae of a small Ephemerid approaching *Baetisca*.

6. *Striped Darter*. *Etheostoma lineolata*, Ag. (1.) Many larvae of *Chironymus* (diptera).

7. ——— ——— *Boleichthys elegans*, Gir. (1.) Larvae of gnats and of May-flies, with a few copepoda.

PERCHES. PERCIDAE. (7.)

Chiefly fishes, including perch, bass, sun-fish, gizzard shad, minnows, (Cyprinidae) and cat-fish; also water-bugs (*Corixa*).

8. *Ringed Perch*. *Perca americana*, Schrank, (1.) A cyprinoid fish.

9. *Black "Salmon." Wall-eyed Pike*. *Stizostethium vitreum*, Mitch. (1.) A bony fish with sub-globular stomach; probably one of the suckers.

10. *White "Salmon." Wall-eyed Pike*. *Stizostethium canadense*, Smith, (4.) A common perch (*Perca*), a sun-fish (*lethelidae*), a black bass (*Micropterus salmoides*), a gizzard shad (*Dorosoma*), a cat-fish (*Siluridae*), and an undetermined bony fish with cycloid scales.

11. *Wall-eyed Pike*. *Stizostethium*, (species undetermined) (1.) An unrecognizable bony fish and several water-bugs (*Corixa alternata*, Say).

WHITE BASS. LABRACIDAE. (4.)

Sun-fish, larvae of neuroptera and diptera, and other insects.

12. *White Bass*. *Roccus chrysops*, Raf. (3.) Chiefly larvae of May-flies (Ephemeridae); also a sun-fish, (Centrarchidae) and another spiny-finned fish, and a few larvae of *Chironymus* and other diptera.

13. *Yellow Bass*. *Morone interrupta*, Gill. (1.) Chiefly larvae of Ephemeridae (May-flies). An amphipod crustacean (*Allorchestes dentata*, Sm.), some larvae of dragon flies (*Agrion*) and a few young grasshoppers.

BLACK BASS AND SUN FISHES. CENTRARCHIDAE. (31.)

Food mixed, animal and vegetable, the former largely predominating. A few fishes (a darter, another percoid fish, and two or three cyprinoid minnows), a multitude of insects, land and water, representing all orders but hymenoptera; arachnida (spiders and water mites), amphipod and isopod crustacea (*Allorchestes* and *Asellus*), hosts of entomostraca (cladocera and copepoda, chiefly the former), a few mollusks, bivalve and univalve, an earth worm, and masses of *Plumatella*-like polyzoa; also a good deal of *Potamogeton*, *Ceratophyllum* and other water weeds, and algae, together with miscellaneous floating vegetable trash.

14. *Black Bass*. *Micropterus pallidus*, Raf. (3). A large mouse, a percoid fish, a small stone roller (*Campostoma anomalum*), pupae of dragon flies, a water bug (*Zaitha fluminea*) and a few confervoid algae.

15. *Black Croppie*. *Pomoxys nigro-maculatus* LeS. (10). Chiefly larvae of May-flies (Ephemeridae). Many larvae of small diptera (various species of gnats), and occasionally a small percoid fish. The following is a detailed exhibit of the food of these ten specimens :

FISHES (Ctenoid.) 2.

INSECTS 10.

COLEOPTERA 3 (Larvae of Gyrinidae 2.)

DIPTERA 6 (Gnats and their larvae.)

HEMIPTERA 2 (*Corixa alternata*, Say.)

NEUROPTERA 9 (Larva of Ephemeridae 8, pupae of Agrioninae 1).

CRUSTACEA 3 (Entomostraca.)

CLADOCERA 2 (**Ceriodaphnia angulata* (Say) Forbes 2). **Bosmina* (Sp. ? 1).

COPEPODA 1 (Diaptomus).

POLYZOA Sp ? 1.

A few seeds and blossoms of trees in 2.

16. *White Croppie*. *Pomoxys annularis*, Raf. (9). Specimens taken in midsummer were feeding chiefly on the larvae of May flies. A number collected in March were distended with *Ceriodaphnia angulata* and larvae of may flies and dragon flies (Agrioninae). A small fish was found occasionally, and a few water bugs.

FISHES 4.

Etheostomatidae 1, Cyprinidae 1 (*Luxilus analostanus*), undetermined cycloid fish 1.

INSECTS 8.

COLEOPTERA 1 (larvae of Gyrinidae).

HEMIPTERA 1 (*Corixa alternata*, Say).

NEUROPTERA 8 (Larvae of Ephemeridae 5, of Agrioninae 5).

CRUSTACEA 5 (Entomostraca.)

Ceriodaphnia angulata, Say, 5.

17. *Croppies*. *Pomoxys*, Sp. undet. (2). A cyprinoid minnow, a few spiders, a hemipter, and larvae of May flies.

18. *Common Sun Fish*. *Blue Sun Fish*. *Lepiopomus pallidus*, Mit. (5). Almost wholly insects (many of them terrestrial.) A few mollusks and a little pond weed (*Potamogeton*).

* See appendix.

INSECTS 4.

LEPIDOPTERA 2 (Caterpillars).

COLEOPTERA 3.—Carabidae 1 (*Agonoderus pallipes*), Gyrinidae 1 (larva), Scarabaeidae 1 (*Aphodius inquinatus*), Chrysomelidae 2 (*Diabrotica* 12—*guttata* and a *Haltica* ?).

DIPTERA 2 (larvae of gnats).

ORTHOPTERA 1 (*Phaneroptera curvicauda*, a *Tettix* and a cricket.)

HEMIPTERA 3 (*Corixa alternata* 2, *Arma* ? 1).

NEUROPTERA 2 (Larvae of *Ephemeridae*.)

ARACHNIDA 3.

Spiders 2, *Hydrachnidae* (water mites) 1.

MOLLUSKS, 2.

Gasteropoda 2 (*Physa*, *Planorbis*).

Also an earthworm, some *Potamogeton*, and a number of unrecognized small seeds.

19. *Bluc-cheeked Sun-fish*. *Lepiopomus ischyryus*, Nels. (1). Full of hornwort (*Ceratophyllum demersum*) and a polyzoan (*Plumatella* ?); also fragments of small bivalve shells, some small crustacea (*Asellus*, * *Allorchestes dentata*, Sm., and *Cypris*, sp.) and a little mixed vegetable matter.

20. *Bream. Pumpkin Seed*. *Eupomotis aureus*, Walb. (1). Several *Aselli*, univalve mollusks, and some unrecognized vegetable matter.

PIRATE PERCHES. *APHODODERIDAE*.

21. *Western Pirate Perch*. †*Aphododerus isolepis*, Nels. (3). The largest specimen (3 in. long) had eaten several *Aselli*, some larvae of diptera, a *Corixa* and another water-bug—apparently a *Galgulus*. The second in size (2½ in.) contained only a small eyeloid fish and several larvae of neuroptera. In the stomach of the smallest were several ostracoda (*Cypris*,) a larval *Corixa* and a few gnats.

MAIGRES. *SCIAENIDAE*.

22. *Sheepshead*. *Haploidonotus grunniens*, Raf. (7). Mollusks and larvae of May flies, with a few larvae of gnats.

Unios 2, *Planorbis* 2, *Limnea* 1, *Ephemeridae* 6, diptera 2.

* See appendix.

† An observation of the intestines shows that one effect of the remarkable change in the position of the vent in this species is the lengthening of the alimentary canal and a consequent increase of the digestive surface. The intestine passes from its origin at the stomach first upward, then backward, then downward, reaching the ventral wall at a point about half way from the bases to the tips of the ventrals. In the smallest specimens, it opens at this point. In the others, it turns forward along the middle line of the belly, and opens at a point more or less to the front, according to the size of the fish, leaving a seam of naked skin behind.

STICKLEBACKS. *GASTEROSTEIDAE*.

23. *Brook Stickleback*. *Eucalia inconstans*, Kirt. (1). Entomotraca (Cyclopidae and Eurycerus), and many mulberry-like masses of eggs (mollusks?)

SILVERSIDES, *ATHERINIDAE*.

24. *River Silverside*. *Labidesthes sicculus*; Cope. (5). Chiefly minute crustacea (copepoda and cladocera). A few small diptera and larvae of small dragon flies.

Cyclopidae 3, Daphniadae 3, (Bosmina, * Daphnia *), Lynceidae 1, (Eurycerus *), small diptera 3, larvae of Agrioninae 1.

TOOTHED MINNOWS. *CYPRINODONTIDAE*. (7).

Chiefly insects, aquatic and terrestrial; crustacea (amphipoda and cladocera), and gasteropod mollusks.

25. *Barred Killifish*. *Fundulus diaphanus*, Le S. (2). Planorbis and Pisidium, larvae of small diptera, Allorchestes, and cladocera of the family Lynceidae.

26. *Top Minnows*. *Zygonectes notatus*, Raf. (3). Bones of a small fish. Several small winged hymenoptera, small wingless ants, a spring beetle (Elateridae), a few hemiptera, several diptera and diptera larvae and pupae, a small spider, Crangonyx gracilis, and a number of Daphniidae and Lynceidae (Eurycerus, &c.)

27. *Striped Top Minnow*. *Zygonectes dispar*, Ag. (2). Physa and Planorbis, hemiptera and small diptera, and a few Lynceidae.

MUD MINNOWS. *UMBRIDAE*.

28. *Mud Minnow*. *Melanura limi*, Kirt. (2). Many water mites (Hydrachnidae), diptera larvae, Cypris, Planorbis, and fragments of unrecognizable insects.

PIKES. *ESOCIDAE*. (8.)

Fishes of several families, and tadpoles.

29. *Northern Pike*. *Esox lucius*, L. (8.) Only fishes. The eight specimens contained remains of 12 fishes, among which were a black bass (*Ambloplites rupestris*), and another ctenoid fish, a gizzard shad (*Dorosoma*), a toothed herring (*Hyodon*), 3 cyprinoids (1 *Campostoma anomalum* and 1 *Alburnops*?), an *Ichthyobus* and another large cycloid fish.

* See appendix.

30. *Little Pickerel*. *Esox salmoneus*, Raf. (2.) A small fish and two tadpoles of frogs.

MOON EYES. *HYODONTIDAE*.

31. *Toothed Herring*. *Hyodon tergisus*, Le S. (3). Numerous insects, including a bee, carabid beetle, some aquatic hemiptera, numerous larvae of Ephemeridae; a remarkable crustacean of which but a single specimen has hitherto been found in this country (*Leptodora hyalina*,* Lillj.); some rotten wood, elm seeds and other vegetable trash, evidently gathered from the drift-wood where one of the specimens had found its food.

HERRINGS. *CLUPEIDAE*. (6.)

32. *Ohio Golden Shad*. *Pomolobus chrysochloris*, Raf. (1.) A small bony fish and a few fragments of insects.

33. *Gizzard Shad*. *Hickory Shad*. *Dorosoma cepedianum*, Le S., var. *heterurum*, Raf. (5.) Extremely dirty. Every stomach examined was at least half full of mud. The food was chiefly vegetable, consisting largely of algae and a few crustacea, such as would naturally be entangled in the vegetation eaten. The objects recognized were a few diptera larvae, *Lepidodora hyalina*, Cypris, Cyclops, masses of *Chara*, confervoid algae, desmids, and vast numbers of diatoms.

MINNOWS. *CYPRINIDAE*. (15.)

Time has failed for the examination of any sufficient number of this family, some of the most important genera having been omitted entirely. Enough has been learned, however, to show that these fishes live, some chiefly on aquatic vegetation (especially algae) and others on insects, of which small diptera and their larvae seem to constitute the greater part. The section whose teeth are not hooked probably eat vegetable food more largely than those with raptatorial teeth, no insects at all having been found in the intestines of the five specimens of that section examined.—I found a surprising amount of dirt in the intestines of these herbivorous minnows,—too much, I think, to have been taken incidentally.

34. *Stone Roller*. *Campostoma anomalum*, Raf. (1.) Full of dirt and confervoid algae.

35. *Blunt-nosed Minnow*. *Hyborhynchus notatus*, Raf. (3.) Full of dirt, with fragments of endogenous vegetation, confervoid algae, and many diatoms.

36. *Silvery Minnow*. *Hybognathus argyritis*, Grd. (1.) Full of sand and an immense number of diatoms, with a few filaments of confervoid algae and fragments of other vegetable matter.

* See appendix.

37. *Red-finned Shiner*. *Luxilus cornutus*, Mit. (2.) Chiefly vegetable. Fragments of unrecognizable insects, a mass of confervoid algae and parts of a netted-veined leaf.

38. *Silver Fin*. *Luxilus analostanus*, Gir. (3.) Insects of several orders and a few algae.

39. *Red Fin*. *Lythrurus diplaemius*, Raf. (1.) A few small diptera.

40. *Emerald Minnow*. *Notropis atherinoides*, Raf. (2.) Several small gnats, an unknown hemipter and a little vegetable matter.

41. *Silver-mouthed Dace*. *Ericymba buccata*, Cope. (1.) A few small larvae of diptera, much sand and indeterminable matter, partly vegetable.

42. *Common Chub*. *Semotilus corporalis*, Mit. (1.) Many Ephemera larvae and a larva apparently belonging to the Dytiscidae.

SUCKERS. CATOSTOMIDAE. (24.)

My observations on this family indicate that its food is chiefly animal, consisting principally of mollusks, insect larvae and entomostraca. It is not impossible that in this, as in some other cases, the proportion of vegetable food is under-estimated, owing to the rapidity with which it is digested, as compared with the chitinous and calcareous coverings of arthropods and mollusks. The intestines of the family contain usually large quantities of mud.

There seems to be a well defined difference between the food of the Catostominae (Red Horse) and that of the Bubalichthyinae (Buffaloes), the former group feeding much more freely on mollusks than the latter, and less generally on entomostraca. Of the eight *Myxostomas* examined, the principal food of each was small, thin-shelled Unionidae (Anodonta), while no entomostraca at all were observed in them, and annulate worms (Naididae) were found in but two specimens. On the other hand, mollusks were found in only four out of fourteen carp and buffaloes (gasteropods 2, bivalves 2), and in these insignificant in quantity, while large numbers of entomostraca were noticed in twelve of the specimens. The intestines of many of the buffaloes were filled with a yellowish, shreddy, corpuscular fluid which I could only interpret as altered intestinal mucus and broken down membrane. The fishermen at Peoria report, however, that these fishes frequent the mouths of the gutters from the still-houses of which the river front is redolent, apparently feeding upon the distillery slops.

43. *Red Horse*. *Myxostoma macrolepidotum*, Le S. (3.) Chiefly mollusks, (Unionidae, Physa, Planorbis.) A number of ringed worms (Naididae), fragments of Chara and endogenous vegetation, and much mud.

44. *Golden Red Horse*. *Myxostoma aureolum*, Le S. (2.) Chiefly mollusks, (Anodonta, Paludina), a few slender ringed worms (Naididae), much dirt and a little unrecognized vegetation.

45. *Myxostoma*, sp. undet. (3.) Only mud and Unionidae.

46. *Chub Sucker*. *Eremyzon sucetta*, Lac. (2.) Confervoid algae, diatoms, mud.

47. *Carp Suckers*. *Carpiodes*, sp. (6.) I have found it quite impossible to recognize the species of this genus with certainty by the descriptions extant, and until they have been revised prefer not to attempt to separate them.

Mollusca 1 (gasteropoda).

Insecta 3 (Chironomus larvae).

Crustacea 4; Cladocera 3 (Bosmina 1, Ceriodaphnia 1, Lynceidae 1), Ostracoda 2 (Cypris), Copepoda 3 (Cyclops 2, Canthocamptus 2.) Also nematoid worms 1, and various algae 2.

48. *Red-mouth Buffalo*. *Ichthyobus bubalus*, Raf. (6.) Chiefly entomostraca.

Mollusca 1 (Limnea ?).

Insecta 4 (larvae of diptera.)

Crustacea 6, Cladocera 5, (Bosmina 4, Daphnia 2, Ceriodaphnia angulata 4, Lynceidae 2) Ostracoda 2 (Cypris), Copepoda 5 (Cyclops 5, Canthocamptus 1). Also diatoms 1, and seeds and glumes of grasses 1.

49. *Black Buffalo*. *Bubalichthys niger*, Raf. (2.) Larvae of gnats and May flies, Unionidae, Ceriodaphnia, Cyclops, a Lumbricus, diatoms, mud.

CAT FISHES. SILURIDAE, (8.)

Very miscellaneous feeders, eating both animal and vegetable food, the former the more freely. Bones and pieces of fish were found, evidently from too large animals to have been swallowed alive. Aquatic larvae of all kinds, worms, water bugs, mollusks (rarely), algae, stems and leaves of both exogens and endogens, masses of fine roots, with an occasional craw-fish make up the bill of fare.

50. *Common Channel Cat*. *Ichthaelurus punctatus*, Raf. (6.) Bones and pieces of large fishes 3, fragments of bivalve mollusks (no shells) 1, land insects 1 (bees, plant bugs), aquatic larvae 6 (Dytiscidae, Agrioninae

and other dragon flies, May flies, caddis flies), water bugs, 1 (*Corixa* and *Notonecta*), vegetable matter 4, (algae, *Naiadaceae*, roots stems and leaves of various plants).

51. *Black Cat Fish*. *Amiurus melas*, Raf. (2). Taken in small prairie creeks, McLean Co. Stomach of one was full of purely vegetable food, consisting chiefly of a mass of confervoid algae; that of the other contained no vegetation, but exhibited fragments of various insects, some of them terrestrial, and remains of young craw-fishes and aquatic larvae.

DOG FISHES. AMIIDAE.

52. *Dog Fish*. *Grinnel*. *Amia calva*, L. (1.) A single small specimen, 5 in. long, from S. Ill., had eaten some *Ephemera* larvae, a few ostracoda (*Cypris*) and some confervoid algae, with numerous diatoms.

GAR PIKES. LEPIDOSTEIDAE.

53. *Broad-nosed Gar*. *Lepidosteus platystomus*, Raf. Seven or eight specimens were opened, but the stomachs of all but one were entirely empty. This one contained a common river craw-fish, (*Cambarus immunis*, Hagen.) Is the gar a nocturnal feeder?

SPOON-BILLED CATS. POLYODONTIDAE.

54. *Shovel Fish*. *Bill Fish*. *Polyodon folium*, Lac. (5.) This is by far the most remarkable fish in our rivers, and is not less remarkable in its food than its structure. By the fishermen it is supposed to live on the slime and mud of the river bottom. The alimentary canal of each of the five specimens examined was found full of a brownish, half fluid mass, which, when placed under the microscope, was seen to be made up chiefly (in one case almost wholly) of countless myriads of entomostraca, of nearly every form known to occur in our waters, including many that have been seen as yet nowhere but in the stomachs of these fishes. Mixed with these, in varying proportion, were several undetermined and probably undescribed species of water worms (*Annulata*), most of them belonging to the family *Naididae*. Sometimes as much as a fourth of the mass was composed of vegetable matter,—largely algae, but including fragments of all the aquatic plants known by me to occur in the waters of the Illinois, except *Ceratophyllum*. Occasional leeches (*Clepsine*), water beetles (*Coptotomus interrogatus* &c.), a few larvae of diptera and *Ephemerae* and water bugs (*Corixa*) were noticed. Among the crustacea several specimens of the remarkable *Leptodora hyalina* already referred to were found.

I have not had time for anything more than a general examination of the mass of matter presented,—sometimes more than a pint from a single fish,—and cannot, therefore, give a list of the species. Curiously, very little mud was mixed with the food.

The remarkably developed gill-rakers of this species thus receive their explanation. These are very numerous and fine, arranged in a double row on each gill arch, and are twice as long as the filaments of the gill. By their interlacing they form a strainer scarcely less effective than the fringes of the baleen plates of the whale, and probably allow the passage of the fine silt of the river bed when this is thrown into the water by the shovel of the fish, but arrest everything as large as a Cylops. The fish is said by the fishermen to plow up the mud in feeding, with its spatula-like snout, and then to swim slowly backward through the muddy water. Its mouth, it may be noticed, is very large, even for a fish.

It is possible that this wholesale destruction of entomostraca may affect the food supply of other and more valuable fishes, especially of the very young of the predaceous species. We cannot yet say, however, where the *stress* of the struggle comes in the life of any given species, and consequently are unable either to relieve or heighten it at will, or to perceive the full effect of the forces already at work. Fuller knowledge must precede any but the most cautious and conservative recommendations.

RECAPITULATION.

A summary of the leading facts presented in this paper is given in the following table. The figures taken from left to right give, in a general way, the food of each family and species, and taken vertically show the fishes which eat any given kind of food. The line of totals will show something of the relative importance to fishes as a class of the different food elements. The figures in the table have the same use as those in the preceding list, showing the *number of specimens* of the given species found to eat the food mentioned at the head of the column.

It will be seen that, estimated in this way, the most important kinds of food are insects, crustacea, plants, fishes and mollusks, in the order named. These data apply entirely to adult fishes, however; if the young were also taken into account, crustacean food would doubtless be found more important.

The best food fishes ("fine fish" of the markets—Percidae, Labracidae, Centrarchidae, Esocidae) are chiefly piscivorous, except the Centrarchidae, which are nearly omnivorous, but prefer insects. Scarcely any fishes examined, except some Cyprinidae, can be called strictly herbivorous, although the gizzard shad (*Dorosoma*) is chiefly so, the animal food taken being probably incidental.

That the sheepshead, with its enormous crushing pharyngeals, should eat fewer mollusks than the red-horse, was scarcely to be expected, and may yet prove untrue.

Cat-fishes are the only ones shown to be scavengers. The fishermen, however, attribute similar habits to sheepshead and buffalo-fish.

Cyprinidae seem to be divided into two sections, corresponding to the shapes of the pharyngeal teeth, those without raptatorial hooks being herbivorous.

All these general statements ought, perhaps, to be put in the form of questions for future solution, since the number of specimens is too small and the space and time represented too limited to justify settled conclusions.

No. on List.	Names of Fishes.	No. examined.	Fishes.	Ctenoid.	Cycloid.	Silurid.	Mollusks.	Univalve.	Bivalve.	INSECTS.	<i>Terrestrial.</i>	Hymenoptera.	Lepidoptera.	Diptera.	Coleoptera.	Orthoptera.	Hemiptera.	Neuroptera.	Arachnida.	Araneidae.	Hydrachnidae.	MYRIAPODA.	CRUSTACEA.	Decapoda.	Tetradeapoda.	Entomostotra.	Worms.	POLYZOA.	PLANTS.	Phaeogam.	Cryptogam.	GARBAE.				
	<i>Etheostomidae</i>	9								9									4				2													
1	Pleuralepis pellucidus	2								2																										
2	Alvordius maculatus	1								1									1																	
3	Boleosoma maculatum	1								1																										
4	Nanostoma zonale	1								1																										
5	Poecilichthys asprigenis	2								2									2																	
6	Etheostoma lineolatum	1								1																										
7	Boleichthys elegans	1								1									1																	
	<i>Percidae</i>	7		3	4	1													1																	
8	Perca americana	1		1	1																															
9	Stizostethium vitreum	1		1	1																															
10	S. canadense	4		3	2	1																														
11	Stizostethium, sp.	1		1															1																	
	<i>Labridae</i>	4		2						4									3																	
12	Roccus chrysops	3		2						3									3																	
13	Morone interrupta	1								1									1																	
	<i>Centrarchidae</i>	31		8	4	5				25									24																	
14	Micropterus pallidus	8		2	1	1				1									5																	
15	Pomoxys nigro-maculatus	10		2	2					10									1																	
16	P. annularis	9		3	1	2				8									1																	
17	Pomoxys, sp.	2		1						2									1																	
18	Lepidopomus pallidus	5								5									1																	
19	L. ischyruis	1								1									1																	
20	Eupomotis aureus	1								1																										
	<i>Aphododeridae</i>																																			
21	Aphododerus sayanus *	3		1	1					3									1																	
	<i>Sciænidæ</i>																																			
22	Haplodonotus grunniens	7								6									6																	

* While these pages are being printed, I learn from Dr. Jordan that he finds no constant differences between the eastern and western forms of Aphododerus.

No. on List.	Names of Fishes.	No. examined.	Fishes.	Otenoid.	Cycloid.	Siluroid.	MOLLUSKS.	Univalve.	Bivalve.	INSECTS.	<i>Terrestrial.</i>	Hymenoptera.	Lepidoptera.	Diptera.	Coleoptera.	Hemiptera.	Neuroptera.	ARACHNIDA.	Araneidae.	Hydrachnidae.	MYRIAPODA.	CRUSTACEA.	Decapoda.	Tetradecapoda.	Entomostotra.	WORMS.	POLYPOA.	PLANTS.	Phaenogams.	Cryptogams.	GARBAGE.		
	<i>Catostomidae</i>	24	..	..	..	..	11	5	9	11	..	..	..	..	9	9	1	..	..	..	..	11	5	10	..	..	10	..	7	..	..		
43	<i>Myxostoma aureolum</i>	2	..	..	..	..	2	1	2	1	..	..	..	..	1	1	..	..	..	..	..	..	..	1	..	..	1	..	..	..	..		
44	<i>M. macrolepidotum</i>	3	..	..	..	..	2	2	2	1	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
45	<i>Myxostoma</i> , sp.....	3	..	..	..	..	3	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
46	<i>Erimyzon sucetta</i>	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
47	<i>Carpionides</i> , sp.....	6	..	..	..	..	1	..	1	3	..	..	..	1	1	..	..	..	..	..	..	..	..	..	1	..	..	2	..	2	..	..	
48	<i>Ichthyobius bubalus</i>	6	..	..	..	..	1	..	1	4	..	..	..	4	4	..	..	..	..	..	..	..	4	4	6	..	..	3	1	2	..	..	
49	<i>Bubalichthys niger</i>	2	..	..	..	..	2	2	..	2	..	..	..	2	2	..	1	..	..	..	..	1	1	1	1	..	..	1	..	1	..	..	
	<i>Siluridae</i>	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
50	<i>Ichthaelurus punctatus</i> ...	6	..	..	..	..	1	..	6	1	1	..	..	6	1	1	6	..	..	..	..	..	1	..	..	1	..	..	4	1	3	3	..
51	<i>Amiurus melas</i>	2	..	..	..	..	..	..	1	1	..	..	..	1	1	..	..	..	..	..	..	1	1	..	..	..	..	1	1	1	..	..	..
	<i>Amiidae</i>	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
52	<i>Amia calva</i>	1	..	..	..	..	..	..	1	1	..	..	..	1	..	..	1	..	..	..	..	1	1	1	1	..	..	1	..	1	..	..	..
	<i>Lepidosteidae</i>	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
53	<i>Lepidosteus platystomus</i> ..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	1	..	..	..	..	..	..	..	..	..
	<i>Polyodontidae</i>	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
54	<i>Polyodon folium</i>	5	..	..	..	..	..	..	..	..	..	..	..	5	5	2	3	..	..	..	..	..	5	..	..	5	..	..	5	3	5	..	..
	TOTAL	149	30	12	17	1	22	14	12	95	22	5	2	9	8	2	5	7	4	3	1	46	2	16	37	7	2	35	14	25	3	..	..

NOTE.—I have just succeeded in obtaining, too late for previous notice, a copy of an elaborate paper on the Fisheries of the Great Lakes, by Mr. J. W. Milner, Asst. U. S. Fish Commissioner, published in the first report of the commissioner, 1872-3. It contains full notes on the food of the White Fish, Lake Trout, Lake Herring and Sturgeon. An article by Prof. A. E. Verrill in the same report contains interesting matter for a comparison of the food of allied marine and fresh water species.