	China.	India.	Philippines.	Malacca.	Borneo.	Singapore.	Gilolo.	Ternate.	Sumatra.	Java.	Waigou.	Bachian.	Dory.	Mysol.	Celebes.	Ceram.	Amboyna.	Martabello.	Bouru.	Key.	Aru.	Timor.	Kaisaa.	Australia.	New Hebrides.	Madagascar.	Africa.	Europe.
Oryssus maculipennis . . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xyphidria rufipes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
laevipes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tremex insignis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
insularis	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.
Cladomacra macropus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.
Tenthredo coxalis	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
purpurata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.
Cynips insignis	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Notes on the Food and Parasites of the *Salmo salar* of the Tay.

By W. CARMICHAEL M'INTOSH, M.D., F.L.S. Communicated
by T. S. COBBOLD, M.D., F.L.S.

[Read Dec. 4, 1862.]

THE nature of the food of the *Salmo salar* has been variously estimated. Dr. Knox read a paper to the Linnean Society "On the Food of certain gregarious Fishes," including the Salmon, in which it is stated*, "From the time the salmon enters the fresh water, it ceases to feed, properly speaking, although it may occasionally rise to a fly, or be tempted to attack a worm or minnow, in accordance seemingly with its original habits as a smolt. But after first descending to the ocean and tasting its marine food, it never again resorts to its infantile food as a constant source of nourishment." He goes on to state that nothing whatever is found in the stomach or intestines of the fresh sea-salmon but a little reddish substance, which he found to be the ova of some species of Echinodermata, and affirms that such is the sole food of the salmon in the sea. He combats the views of M. Valenciennes, who describes the salmon as voracious and a devourer of fishes, and

* In abstract of paper, Annals of Nat. Hist., 2nd series, vol. xvi. p. 60.

maintains that there is not a single fact in the history of British salmon to support this opinion, and concluding thus :—"As to their feeding regularly in rivers, Mr. Young's experiments have negatived the assertion beyond all doubt." Yarrell gives the authority of Faber to support the assertion that it feeds on small fishes and various small marine animals; and Dr. Fleming says, "their favourite food in the sea is the sand-eel." Others confirm the latter statement, and add that within flood-mark some salmon have been taken with two, and some with three full-sized herrings in their stomachs.

In order to test the accuracy of the above conclusions with regard to the Tay, I examined the stomachs and intestines of upwards of a hundred salmon and grilse caught in the river from the commencement of the season in February to its ending in September of this year. The salmon in its young condition feeds freely enough; for the stomachs and intestines of the parr from Stormontfield ponds are gorged to an extreme degree with beetles, flies, larvæ, larvæ-tubes, and minute crustacea, while those of the smolts are also well filled. Indeed the voracity of young parr has cost them their lives in instances where they have been too freely fed with small flies. Such being the nature of the fish from its earliest age, one is sceptical at first sight in regard to the statement that the grilse and salmon do not feed in fresh water at all. Professor Owen* observes that the salmon, in common with many other fishes, when hooked or netted, empties its stomach by an instinctive act of fear, or to facilitate escape by lightening its load; so that the stomach, thus cleared of its contents, exhibits subsequently, for reward to the investigator, only the tiny animalcules, which, having been swallowed with more substantial fare, escaped ejection by lurking in the gastric mucus. Were such the case, an explanation would be readily given to the fact that the stomach of a fish which possesses so powerful a circulatory apparatus, and whose mucular tissues undergo a continual waste, should thus frequently be found empty. But if the salmon so fared, we should expect to find the intestines at least well filled with the débris of such food, since it cannot very easily vomit it after it has passed the pylorus; and the very terror which impels it to disgorge in one case may entirely paralyse its efforts to do so in another.

In its usual condition, the stomach is coated internally with a consistent white mucus of great tenacity, well calculated to hold

* Lect. on Comp. Anat.: Fishes, p. 237.

any "animalcules" introduced from without; yet in few or none did such occur, cellulo-granular matter and oil-globules alone appearing. In ten instances only did remnants of fishes occur, and in all these nothing remained but vertebral columns, cranial and other bones, with the denser tissues, as the lens, &c. The number of bones in several cases showed that the animals had enjoyed a most ample repast, since they belonged to fishes from 8 to 10 inches in length—of what species I have not been as yet able to determine. Some pieces of cartilage, skin, and pigment-cells seemed to belong to smelts, but most of the vertebrae belonged to larger fishes. The other kinds of food found in the stomach consisted of fragments of small freshwater crustacea with a portion of a shrimp in one or two fishes, and an occasional piece of insect-cuticle.

The duodenum is generally supplied in abundance with a less cohesive mucus of an orange tinge, and which is continued along the intestine. A constant accompaniment of this mucus in almost all fishes is a number of whitish or yellowish masses, extending far down the gut as a fragile knotted cord surrounded by the mucus—in some instances nearly to the anus. When a small portion of the white substance is put between glasses, it is gritty, and is found to consist of a vast number of calcareous crystals like those of the triple phosphate. They are quite unaffected by ether, but effervesce much and disappear on the addition of hydrochloric acid. Some of the larger crystals showed roughnesses on their surfaces, as if smaller crystals adhered or had adhered to form compound masses; others had a somewhat radiate arrangement of the constituent crystals. They occurred in all portions of the intestine from the pylorus downwards, but not in the pyloric cæca, and appeared in the fasting as well as in the full-fed fish. The mucus which more immediately surrounded them had a fibro-granular aspect. The exact origin of these crystals is an interesting question. So constantly were they present under all conditions as regards food, that they could not have been much influenced by the varying state of the latter. The intestinal surface being an eliminating as well as a secreting surface, we may conclude that these crystals had their origin in fluids produced by the mucous membrane. The skeleton of this fish being of small specific gravity and deficient in earthy matter, it may be that the excessive elimination of salts keeps down the specific gravity; or again, the circulating fluid by this means may so adapt the bones to the varying density of the salt and fresh water that their specific

gravity is in accordance with the medium. At any rate, and whatever be the explanation, the presence of these crystals is an interesting physiological fact. In a greater number of instances than in the case of the stomach, bones, lenses, and other dense textures occurred in the intestines; for they were present in several instances where no trace occurred in the former, and vertebræ could readily be detected as far down as the anus. In addition to those in which the débris of ascertained food in the stomach was found in the intestines, I met with crustacean hairs in several instances, Diatomaceæ, sand-particles, fragments of an insect, masses of solid fat, and portions of liver belonging to a fish like the Sparling. In every other instance there was nothing in the intestinal tract but parasites, mucus, crystals, and an abundant supply of fatty globules and particles of all sizes. The rapidity and power of digestion in this fish is extraordinary; but there is no doubt that, if the fish had fed regularly, the food could never have disappeared so rapidly and well as to defy even a microscopic investigation of the intestinal tract throughout. It is, however, a mistake to suppose that they never feed in fresh water at all, just as it is one to suppose that they feed voraciously, but vomit their food when captured. The true state of matters would seem to be that the salmon when in fresh water feeds rarely and at intervals, but not from want of voracity, as the contents of the stomachs above mentioned show; and further, that such food is occasionally found in its stomach from February till August*.

Ectozoa.—I had only the opportunity of examining about a dozen grilse and salmon for these parasitic animals, and the sole species found within the period above mentioned was *Lepeophtheirus Strömii* (Baird)—four males and three females. They occurred at the base of the fatty fin, at the base of the caudal rays, in the socket of the eye, and in front of the hyoid apparatus—and all in grilse.

Nothing whatever occurred on the branchiæ to attract attention but once; and this abnormal appearance proved to be non-parasitic. A number of large villi proceeded from a bulging and thickening of the arch, but solely attached to the cutaneous textures. The villi or processes were fibro-cellular in structure, and contained at their bases numerous black pigment-corpuscles and crystalline masses. They seemed to be morbid growths of the fibrous textures of the region.

* They have also been seen to void several vertebræ *per anum*, when landed on the bank of the river.

Entozoa.—If the search for food in the digestive system of the clean salmon and grilse was only rarely rewarded by success, certainly that for entozoa was more fortunate. There was scarcely a single fish which did not contain some of the following species, and many had them in abundance. The first of these I shall describe (fig. 1, *a, b*) is seldom or never absent throughout the entire

Fig. 1.

series of grilse and salmon. It is a minute creature, of gregariniform aspect, which squeezes its gelatinous body hither and thither amongst the granular débris and oil-globules of the duodenum and pyloric cæca. In its interior are numerous globules and granules, and a larger spherical body, which, when the animal is flattened between the glasses, gives it the aspect of having a sucker. One end is generally darker from the accumulation of the granular contents. Besides the shapes depicted in the drawing, this creature very often assumes an hourglass aspect from a central constriction. One of the chief habitats of this gregariniform animal is the pyloric cæca, where it has been found amongst the dry mucus even at the tip of one entirely blocked up by the coils of a *Bothriocephalus*. It is in all probability a stage in the development of some higher parasitic form.

Occurring in the greater number of the specimens of both grilse and salmon is *Distoma varicum* (Rud.), (*Fasciola varica* O. F. Müller, *Zoologia Danica*, p. 43, plate 72). Almost without exception, this species occurred in the stomach of the salmon, imbedded amongst the tenacious mucus, or else at the border of the latter at the commencement of the organ. They varied in number from one or two up to twenty-five or thirty in extreme cases, and they were also diversified as regards size. Müller in the above work observes that he met with five in the stomach of a salmon, and Rudolphi states that it is rare. This,

as above mentioned, is not the case with the salmon from the Tay, in which this parasite is rarely wanting. The description of the foregoing authors leaves little to be added, further than that Rudolphi is correct in stating that there is no anus as described by Müller. Detached and solitary ova frequently occurred in all portions of the intestine and cæca. In some specimens, bodies that seemed to be spermatozoa-cells were seen, in constant motion within tubes. When the Distomata are put into water, they wriggle and lengthen themselves, and the ventral disc may be seen occasionally tinged with blood. In the duodenum of one fish was a remarkable Distoma, which appeared rather to be two in congress, but yet may be a malformation, since one oral sucker only could be found, and each half differed somewhat from the body of an ordinary Distoma.

A single specimen only of another species of *Distoma* (*D. tere-ticolle*), of an elongated form, occurred in the intestine of a salmon.

In the œsophagus of a salmon a peculiar flask-shaped body was met with. It equalled in size a full-grown *Distoma varicum*, was of a yellow colour, and possessed two dark-brown patches, one at the broad end, and the other an elongated lateral one. The general body of the structure was filled with cells and granules, while the dark patches were made up of the dark-brown cells or masses, and some of the latter were of an elongated form. The contained pale cells and granules floated readily out through any fissure. Whether it is a parasitic structure pertaining to the salmon or some other fish I am unable to state, further than that it once occurred in the stomach of the former.

I found a single specimen of *Tetrarhynchus appendiculatus* (Rud.) when washing the mucous surface of the stomach of a salmon. On this there was a little eminence having a minute aperture at the summit, which when pressed gave exit to a small white body—after the manner of the parasites of the human skin, and the part extruded was the posterior elongated body shown in the figure*. When a section divided the eminence, the creature firmly adhered by its anterior hooks. On removal, it progressed leech-fashion by successive waves of its soft white body, adhering by either end at pleasure. The anterior or larger portion of the body was intensely white, the posterior appendage less so. When moving, its body assumed various shapes, now like a thick round jar, or again like an elongated flask, with numerous longitudinal striæ on its external surface. The body of the *Tetrarhynchus* was

* Rudolphi, tab. 7. fig. 10.

enveloped in a tough white investment, and appeared one mass of cells of an elliptical form—some with and some without nuclei. Fibrous and muscular bands and peculiar tubes stretched backwards from the spinigerous columns. Some of the tubes were filled with cells; others, probably from bursting, were empty.

Anteriorly it was armed by the four formidable spinigerous processes capable of protrusion and retraction. Each consisted of an elongated and somewhat tapered stalk covered with a complete array of curved spines resembling on a miniature scale those on the rose, viz. with a broad base and strongly curved sharp point. They were regularly arranged on the column, and towards the base showed an interesting gradation into short, closely grouped blunt tubercles, not unlike the horny scales on the foot of a land tortoise. Below this the spinigerous column was marked by a constriction followed by a slight bulging, and ran inwards in the shape of a tubular process connected with a curved elongated sac. The sac was covered with an immense number of cross striæ as well as longitudinal furrows. From the opposite end of the sac, the tube was continued into the general body of the animal, and became filled with the oval cells and granular matter everywhere so prevalent. On the addition of acetic acid, immediate effervescence resulted in certain opaque and translucent masses in the interior of the animal; and the numerous cells formerly so conspicuous became transparent and indistinct, or were broken up into smaller cells.

Once afterwards the scolex of a species of *Tetrahynchus* (fig. 2, *a*) occurred in the rectum of a salmon. It contained the usual

Fig. 2.

small, smooth, oval bodies or cells, quite pale and translucent (*b*). Under the action of dilute glycerine and pressure they assumed the shapes (*c*) along with some of the other contents of the scolex.

Three or four specimens of *Echinorhynchus inflatus* (Rud.) occurred in the intestines.

Only two specimens of *Echinorhynchus tereticollis* (Rud.)* oc-

* [This is *Echinorhynchus Proteus* of Dujardin, Von Siebold, and other modern authors. According to Prof. Rudolf Leuckart's very recent and extremely interesting discovery, this species undergoes a series of remarkable

curred—both in the small intestines. The more perfect one had its head retracted and quite loose. The entire animal was about half an inch in length. Continuous with the base of the proboscis was an elongated muscular structure, possessing many longitudinal striæ. Attached to this were many muscular bands slanting backwards. In the space behind the sac were also many cellular, granular, and crystalline masses. Rather behind the middle of the animal were two elliptical testes, granular and opaque. Posterior to these lay the ordinary granular and cellular structures, besides a convoluted tubular organ, at whose termination was an ovoid mass with a coiled aspect. This was succeeded by a peculiarly convoluted structure shaped somewhat like the semicircular canals of the internal ear, and followed posteriorly by a barred curved portion which lies a little in front of the termination of the animal*. The investing structure formed a thick layer, marked here and there by many mottled and shaded portions. When the hooks of the creature are fixed in the mucous membrane, it is impossible to remove them without tearing the texture therewith, as may be readily imagined from their form and direction.

Bothriocephalus proboscideus (Rud.) was the only species met with; but it occurred in by far the greater majority of the grilse and salmon, generally commencing with its coils in the duodenum and pyloric cæca, and stretching down the gut. The heads were generally met with in one of the cæca; and the appearance of the various specimens was very similar, except that some (probably owing to peculiarity of pressure) showed a greater bulging of the outline just behind the anterior end. The following may be given as

transformations in its passage from the embryonic to the adult condition,—the embryo bearing a relation to the fully-developed worm similar to that which *Pluteus* and *Pilidium* respectively bear to *Ophiurus* and *Nemertes*. Dr. Guido Wagener's previous investigations had led us to believe in a more simple and direct mode of development (Siebold and Köl liker's *Zeitschrift*, 1857, vol. ix. p. 77); but Leuckart fully establishes the fact of a true alternate generation in the life-history of *Echinorhynchus*. See his "Helminthologische Experimental-untersuchungen" in Reports of Königl. Gesellschaft der Wissenschaft. for Oct. 22nd, 1862.—T. S. C.]

* [The author's description here evidently refers to the '*pavillon terminal*' of Dujardin, so efficiently described and figured by him in the '*Histoire Naturelle des Helminthes*' as it occurs in the *Echinorhynchus Anthuris* of the newt. This copulatory apparatus of the male *Echinorhynchus* has since been noticed by several authors, whilst the female organs of reproduction have been carefully examined by ourselves (Linn. Trans. vol. xxii. p. 163), and especially also by Dr. Guido Wagener, whose descriptions appeared in the 9th volume of Siebold and Köl liker's *Zeitschrift*.—T. S. C.]

a good illustration. In a salmon of ten pounds, a *Bothriocephalus* lay coiled in the duodenum, and passing down to the small intestine filled it even to distention. The anterior portion proceeded into a cæcum by a double coil; from this, other four plies (two coils) entered another cæcum close by the pylorus, and performed many intricate bends therein, filling out the sac to a size equal to the similarly distended intestine of the fish. This cæcum contained the head, the distance of which from the truncated posterior extremity was 6 feet 6 inches. About 20 inches from the head a narrowing of the segments occurred, so as to resemble those near the head,—a not unfrequent occurrence. The size of the *Bothriocephali* did not always bear comparison with that of the fish.

Ascaris capsularia (Rud.).—This species is easily recognized by a whitish opaque portion a little behind the head. It is found on the liver, pyloric cæca, stomach, intestines, and gall-bladder at the attachment of the mesentery, &c. It is enveloped in a capsule of delicate fibrous tissue, in which it lies as a finger in a glove,—a circumstance which, from the attachment of the capsule to the surrounding textures by many delicate fibrous bands, renders it difficult to pull the creature off rudely or *en masse*, while it can readily be unhoused by drawing at its free end. These *Ascari* occur in most grilse and salmon; in fact, it is exceptional to find them absent. On the liver they are met with on all parts of the surface, coiled in a circular depression of its texture, but with a portion of the latter projecting in the centre. Most form this close coil, but others stretch in a long curve or semicircle. In the former the head is always external. On the cæca they are found amongst the fat, coiled after the fashion of a nummulite, and often surrounded by a deposit of pigment. Occasionally one had the anterior part of the body pushed into a cæcum, or, rarely, into the tissue of the liver. Once, on examining a small eminence on the inner surface of the stomach, a living *Ascaris capsularia* emerged on squeezing the perforated summit. Rarely one or two occurred in the interior of the stomach and intestines. Attached to the pyloric cæca, where these are so frequently found, curious structures which seemed degenerated *Ascari* were sometimes met with. A calcareous deposit filled part of the interior of one example.

Other forms of *Ascarides* * were present, some of which appeared referable to undescribed species. It may also be noted that in the stomach I once met with several small fibro-cartilaginous

* One species especially occurred very frequently.

tumours ; and it is common to see a peculiar white appearance, often in rings, on the interior of the stomach. These portions are denser than the ordinary mucous surface, and often slightly elevated. Under the microscope they are fibro-granular. It is probable that they originate in some former parasitic inroads.

A succinct Review of recent Attempts to explain several remarkable Facts in the Physiology of Spiders and Insects. By JOHN BLACKWALL, F.L.S.

[Read April 2, 1863.]

My friend Mr. Meade, in his valuable report "On some Points in the Anatomy of the *Araneidea*, or true Spiders, especially on the internal structure of their Spinning Organs,"* has been induced by his researches to adopt the opinion that these animals can propel from their spinners, to a considerable distance, fine lines formed of the viscid fluid secreted by appropriate organs situated in the interior of their abdomen. This hypothesis, based on zoological considerations, being directly opposed to the conclusion arrived at by myself from numerous carefully conducted experiments, merits an impartial examination.

After having briefly stated the general results obtained by his dissection of several species of spiders, and minutely described the organization of the internal vessels that elaborate the material which, on issuing from the papillæ connected with the spinners, forms filaments of extreme tenuity, Mr. Meade remarks, "I have now arrived at the most interesting but most difficult part of my task, viz. the question whether there is anything in the structure of the silk-forming organs that will decide the question as to the power of spiders to eject their threads to a distance. Looking at the strong fibrous coat on the ducts of the membranous sacs, and the fibrous tissue surrounding the glands themselves, I think that they must possess a powerful contractile power, which may also be increased by the muscular coat of the integument enabling the spider to compress its abdomen. May not the striated bands of muscular fibres, which run in a parallel direction down the middle of the abdomen quite into the interior of the spinnerets, and surround the termination of the ducts, also assist in this object? They are not attached to the tegumentary coverings of the spinnerets like the other muscles, and cannot therefore be for the

* Report of the Twenty-eighth Meeting of the British Association for the Advancement of Science, p. 157.