also exists, but in them it has lost all semblance of its original nature, and is solid and replete with blood vessels. But, most curious of all, there is in the brain of man himself a small organ about the size of a hazel nut, called the pineal gland, the function of which has always been a puzzle to physiologists, and which was supposed by Descartes to be the seat of the soul. Comparative anatomy has shown that this gland is probably the last trace in man of the same organ, inherited from some remote ancestor of the vertebrates, in whom it was developed into a true eye.

There exists a certain connection between the power of seeing and the capacity for producing light possessed by some animals. Sir John, however, devotes no attention to the manifestation of this latter power among insects, where it is best known, but notices only some of the more curious phenomena regarding fishes. There are present on some fishes curious eye-like bodies more or less connected with the muciferous canal, and though the original opinion that they were accessory eyes is still entertained by some naturalists, yet later researches would seem to show that, whatever other uses they may have, they are certainly luminous organs, and are especially developed in deep sea fishes. The fishes which live in the depths of the sea are comparatively unknown, as they only ascend to the surface of the ocean by some rare accident, and even then the change from the great density of the water in which they are accustomed to live to our upper air to a great extent destroys their tissues.

On this account it is difficult to determine their real characteristics, and our knowledge of them is mainly confined to the few specimens brought up by the dredge, and particularly those obtained by the Challenger expedition. The light of the sun penetrates the ocean only to the depth of 200 fathoms, and below this the darkness is complete. Hence, in many of these deep sea fishes the eyes have altogether disappeared. But others, in which they are still well developed, are endowed in addition with organs capable of shedding light, and evidently under the control of the animal. As a rule, the coloring of these fishes is pink, silvery, or black relieved by dashes of scarlet, and the effect of an irradiation by the sudden flashing out of a light must be very striking. The largest of these luminous organs yet discovered is directly under the eye of the fish, so that the animal is, as it were, provided with a bull's-eye lantern. Others have a pair of similar very large organs in the tail, and still others have developed them at the end of long filaments springing from the head.

With regard to the production and perception of sound among the lower animals, we are told that neither the protozoa nor coelenterata and very few of the mollusca are known to produce sound. There is one genus of crab which can make a harsh, jarring noise by rubbing a sort of file or rasp on its claw against a ridge on the limb, and some of the lobsters can do the same by rubbing one part of the antennæ against another, but the power of producing sound among the crustaceans, curiously enough, seems entirely disproportionate to the development of their hearing apparatus, which is quite elaborate. We are all well acquainted with the sounds produced by many insects, such as crickets, grasshoppers, katydids, etc., and these sounds are made in various ways, by the wings or by the breathing tubes, which in insects are distributed along the sides of the body, or by rubbing one part of the body against another. In many cases the power of making sounds is confined to the male. A house fly hums on F, and to do so vibrates its wings 21,120 times in a minute, and the bee, which hums on A, moves them 26,400 times in a minute, while a tired bee, which hums on E sharp, vibrates its wings only 19,800 times a minute. Except for these slight changes, due solely to fatigue, the sounds produced by the wings of each variety of insect are unalterable, but those emitted by the spiracles or breathing tubes seem to be more or less under the control of the will, and in this respect resemble what we call a voice. One insect, the cockchafer, not only hums with its wings, but also produces a sound which is peculiarly voice-like, as right behind the opening to each breathing tube there is a horny process something like a tongue, which is made to vibrate by respiration, and thus emit a humming noise.

The auditory organs among the lower animals are situated in various parts of the body, and range through many degrees of complexity, from an apparatus so simple that it is doubtful whether it is intended to receive an impression of sound or simply to record movements of the water, to quite elaborate structures plentifully supplied with nerves. Among the higher crustaceans the auditory sac is usually at the base of the small antennæ, though in one of the lower forms the two ears are situated in the tail. Strychnine is known to increase the reflex power of the nerve centers, and one naturalist took advantage of this to prove that crustaceans are really possessed of a sense of hearing, by placing some shrimps in sea water containing strychnine, under which treatment the shrimps exhibited an extreme sensitiveness to the slightest noises.

It has been demonstrated by numerous experiments that, in some insects at any rate, the organs of hearing are situated in the antennæ, but other observations have seemed to point to a different conclusion, and the highest authorities differ on the subject. The inference from the various recorded observations seems to be that the sense of hearing is not always confined to one spot, and that while in some insects it resides in the antennæ alone, in others it is also situated in other parts of the body. In grasshoppers, for instance, two oval, drum-like structures in the legs have been proved to be auditory apparatus. In true locusts the organ of hearing is situated in the first segment of the abdomen. These, as is well known, have but one pair of wings, in place of the two possessed by other insects, the hind wings being represented by two curious little club-like processes. Yet these minute organs receive the largest nerve in the whole body of the fly, with the one exception of that which supplies the eyes, and are of the most complicated nature. Special sense organs occur also in the wings or other insects, and there is much reason for regarding all of these curious structures as organs of hearing, though many naturalists are opposed to this view, and the question is still unsettled. That in the same creature there should be various organs of hearing, constructed on different principles and situated in different parts of the body, is certainly a curious result of modern research, but it is quite in accordance with the well known tendency

in insect organizations to the repetition of similar parts.

The seat of the sense of smell in the lower animals is still very uncertain. In some of the lowest organisms it is probable that no such sense exists. In insects there is good reason for supposing that the sense of smell resides partly in the antennæ and partly in the palpi, and there are some facts which would appear to indicate that the antennæ may be sensitive to certain odors and the palpi to others.

Though it is in every way probable that a sense of taste, to assist them in the selection of their food, is possessed by mollusks, annelids, and other lower animals, yet little or nothing is known as to the organs which exercise this function. Jelly fish, for instance, are quickly affected by any change in the medium which they inhabit, and sink below as soon as it begins to rain, but it is impossible to say what sense it is which is affected. Insects evidently possess a sense of taste; ants have begun to feed on honey mixed with strychnine or alum, and rejected the food as soon as they discovered its hidden flavor, rubbing their mouth parts assiduously to remove the taste. Quinine or glycerine, mixed in honey, they also rejected, but it was evidently on account of the taste, and not from any instinctive apprehension of the injurious results, for Torel found that ants could not detect a mixture of phosphorus with their honey and swallowed it without suspicion, though they became very ill from the after effects. Certain minute pits, furnished with delicate hairs, and found on the tongue and maxillæ of all insects, are probably the organs of taste.

Among the lower animals the outer skin is often very sensitive, and though the minute anatomy of their organs of feeling is still undetermined, yet it is known that sensation is conveyed to the animal by means of nerve fibrils connecting with hairs, bristles, or cilia.

All the senses of which we have spoken correspond more or less to those possessed by man, but among the lower groups of the animal kingdom there are various organs, evidently sensory, but the functions of which naturalists have so far been unable to discover. These are often of considerable complexity, more or less fully furnished with nerves, and evidently of great importance to the creature. The immensely diversified bristles and cirri of many worms, the curiously formed appendages of the skin on many insects, the whole series of organs contained in the skins of fishes, particularly those connected with the muciferous canal, the singular groups of hairs on some jelly fish, the bright spots around the margin of certain sea anemones, are all evidently the seat of special senses, of the nature of which we are still ignorant. The antennæ of insects, too, are not only the seat of the three senses, hearing, feeling, and smell, but it appears probable from the singular variety of organs with which they are furnished that they perform still other functions. Sir John says: "Some of these antennæ organs, though obviously organs of sense, seem to have no special adaptation to any sense of which we are cognizant."

It is now a number of years since the author announced his conclusion, fortified by many ingenious experiments, that even with regard to those senses which we have in common there is a marked difference, but always to our advantage, between the powers of insects and our own. It appears that with regard to sound some of the lower animals are apparently capable of receiving impressions of which we can have no knowledge. Ants, for instance, make no noise audible to us, yet they have rasp-like organs, similar to those which in larger insects we know to produce sound, and they have also, according to the observations of the author, an auditory apparatus in the legs, similar to that of the orthoptera. Some experiments made with beetles, ants, bees, and wasps showed that while they took no notice whatever of ordinary noises, an imitation of their own sounds made with a quill and fine file immediately excited their attention. "From the fact," says our author, "that the power of producing sounds audible to us is scattered among so many groups, and that the sounds themselves are often so shrill, I am disposed to suspect that many insects usually regarded as dumb really produce sounds, which, however, are beyond our range of hearing."

Sir John also relates again the interesting experiments made by him some time ago to prove that some animals possess the ability to distinguish colors invisible to human eyes. He showed that ants were extremely sensitive to rays of light whose vibrations were too rapid for us to perceive. Experiments made on some small fresh water crustaceans, belonging to the genus *Daphnia*, seem to show that these also perceive the ultra-violet rays to which we are blind. In concluding his remarks on these subjects, Sir John says:

"It has been shown that animals hear sounds which are beyond the range of our hearing, and that they can perceive the ultra-violet rays, which are invisible to our eyes.

"Now, as every ray of light which we can perceive at all appears to us as a distinct color, it becomes probable that these ultra-violet rays must make themselves apparent to the ants as a distinct and separate color (of which we can form no idea), but as different from the rest as red is from yellow or green from violet. The question also arises whether white light to these insects would differ from our white light in containing this additional color. At any rate, as few of the colors in nature are pure, but almost all arise from the combination of rays of different wave lengths, and as in such cases the visible resultant would be composed not only of the rays we see, but of these and the ultra-violet, it would appear that the color of objects and the general aspect of nature must present to animals a very different appearance from what it does to us.

"These considerations cannot but raise the reflection how different the world may—I was going to say must—appear to other animals from what it does to us. Sound is the sensation produced on us when the vibrations of the air strike on the drum of our ear. When they are few, the sound is deep; as they increase in number it becomes shriller and shriller; but when they reach 40,000 in a second they cease to be audible. Light is the effect produced on us when waves of light strike on the eye. When 400 millions of millions of vibrations of either strike the retina in a second, they produce red, and, as the number increases, the color passes into orange, then yellow, green, blue, and violet. But between 40,000 vibrations in a second and 400 millions of millions we have no organ of sense capable of receiving

the impression. Yet between these limits any number of sensations may exist. We have five senses, and sometimes fancy that no others are possible. But it is obvious that we cannot measure the infinite by our own narrow limitations.

"Moreover, looking at the question from the other side, we find in animals complex organs of sense richly supplied with nerves, but the functions of which we are as yet powerless to explain. There may be fifty other senses as different from ours as sound is from sight; and even within the boundaries of our own senses there may be endless sounds which we cannot hear, and colors as different as red from green, of which we have no conception. These and a thousand other questions remain for solution. The familiar world which surrounds us may be a totally different place to other animals. To them it may be full of music which we cannot hear, of color which we cannot see, of sensations which we cannot conceive."

THE HARBOR SEAL.

Phoca vitulina.

By MANASSEH SMITH.

MOST of our readers are familiar with (at least the outer covering of) the fur seal, or Alaskan seal, as it is now commonly called, since the world's largest supply of the skins thereof is to-day obtained from the Alaskan waters, the Antarctic region having been nearly depopulated by unrestricted slaughter.

But few people, outside of our fishermen, know much of the habits of the harbor seal that still abounds on the Atlantic coast of North America, from the shores of Maine northward into and overlapping the domain of the Greenland seal (*P. Groenlandica*), while stray specimens of the family are still occasionally seen as far southward as Chesapeake Bay.

At the time of the early advent of Europeans to this country, *P. vitulina* was abundant as far south as the New Jersey coast, and congregated in large numbers on Robin's Reef, in New York Bay, and from that fact the reef derived its Dutch name of robyn-seal.

At the present time, I think that Saco Bay, on the coast of Maine (to which reference will be made later on), can be called the southern limit of their range in large numbers; certainly they are comparatively rare south of Cape Cod; while northward their range extends along the Labrador coast and to southern Greenland.

The pinnipeds—well named fin-footed—embracing the seals and walruses, are a sub-order of the order of *Pera* or carnivorous mammals, and their life is mostly spent in aquatic pursuits—of fish.

From what causes and through what processes they have evolutionized to so wide a variation from their land-dwelling congeners, and whether the sea lion was evolved from the African lion, or the Polar bear from the sea bear, or all from some antediluvian cat or dog, are questions for whose answers I will refer the curious reader to scientists, such as Darwin or Huxley; but that the harbor seal and say the Chesapeake Bay dog were once one, though not since indivisible, I have no doubt. The tradition among the bay men, that the Chesapeake Bay dog is derived from a cross of the Newfoundland dog with the otter will scarcely be confirmed by the scientist.

But as we have, in popular parlance, sea lions, sea bears, sea cows, river horses, etc., I have often wondered that our harbor seal is not commonly known as sea dog; its head bears a strong resemblance to that of a dog, minus the ears; the cry of the mature seal is the bark, and its voice of anger the snarl and growl of a dog, while the cry of its young is an almost exact imitation of the whine of a puppy dog.

Notwithstanding its lack of education in preceding generations, its intelligence nearly equals that of the dog, and the many trick-performing, educated seals of our shows bear witness to an equal capacity for acquiring knowledge, while there are few animals so quickly and easily domesticated, or that show so strong an affection for their human master.

Stripped of his hairy (or furry) overcoat and of his fatty undershirt, the body of the seal displays the four legs of the dog, that were previously concealed from sight by these coverings that extended to beyond the knees and elbows; and stripped of his flesh, he displays what might well pass, with an ordinary observer, as the skeleton of a dog, the bones being slightly modified to accommodate the diverse pursuits of the animal.

In other words, wide apart as is the external appearance of the two animals, the difference between their internal anatomies is comparatively slight, and the otter would serve well as a connecting link between the two.

The muscular power of the seal is enormous, their speed in the water as marvelous as their movements on land are awkward, although the celerity with which they tumble from the rocks into the water, upon the least suspicion of danger, is also awkward for their would-be slayer; and the accounts of Arctic seal-hunters walking up to their prey and killing it with a club seem almost incredible to one whose only acquaintance is with the wary, sharp-eyed, keen-nosed harbor seal, whose powers of sight and hearing must be far greater than those of his Arctic brethren, and his bump of caution more highly developed, since, abundant as they are, it is comparatively seldom that man can approach so as to shoot them—when they are on the land.

Some two and a half miles seaward from Prout's Neck, the point of land that forms the northeastern boundary of Saco Bay, on the southern part of the coast of Maine, are two small islands named Stratton and Bluff, the latter containing about eight acres of grass land, and, at low tide, about thirty or forty acres of bare rocks and ledges, and the former about double the latter in size. At high water, the passage between the islands is about one-third of a mile in width. Bluff Island is uninhabited. There is a dwelling house, etc., on Stratton, erected some fifteen years ago. Previous to that time, both islands had been uninhabited since the Indians, in sixteen hundred and something, destroyed the first settlement of whites thereon. For many years these islands were a favorite resort of a few sportsmen friends and myself, for the purpose of shooting ducks, and we frequently spent a week at a time there, in a little hut on Stratton Island, built of rough stones, half under ground, with a roof made of the cabin top of a wrecked vessel.

During my frequent visits to these islands I had frequent opportunities for, and spent many hours in, watching the habits of these seals.

They commence congregating there in the early autumn, and continue increasing in number until mid-winter, when the herd numbers several hundred; their favorite roosting place is on Bluff Island, but few coming ashore on Stratton. Here they remain until May, when they scatter up and down the coast, following the fish into the bays, and even up our rivers for long distances, being occasionally seen as far up the Kennebec as Augusta, and at Bangor, on the Penobscot, tempted, doubtless, by the anadromous fish, shad, alewives, salmon, etc., that are then pushing up from the sea to their spawning beds, but the seals return in the fall to their former quarters.

When approaching the islands, during the time when the seals are there, I have rarely known it to fail that, before our boat got half way across from the Neck, one or more seals would appear near us, fall into the wake of the boat, and escort us to the landing, and again, when we left the islands, they would see us safely to the mainland.

Shooting upon the farther side of Stratton Island would seldom disturb the seals on Bluff, but if a boat put off from Stratton for Bluff, every seal would leave the latter before the boat got across, not only those in sight of the boat, but those on the opposite side, who could neither see, hear, nor smell the boat. Just how the warning of danger was passed from one to another I cannot say, but they had always timely notice of our approach, and no one of us ever succeeded in killing a seal upon the rocks there.

On one occasion, however, when several of us were crossing the channel between the islands, a seal lifted his head high out of water within ten yards of the boat, and I put a heavy charge of duck shot into his neck at the base of the skull, making a hole about an inch and a half in diameter, from which the blood poured in a stream, reddening the water for rods around. Contrary to custom, the seal did not sink immediately, having been killed so quickly that it could not expel the air from its lungs. We got alongside of it, but the man nearest was afraid to seize it, lest he should be bitten, and the boat went over the seal forcing it under, and we lost it, not having a gaff. The curious part of the story is this: The previous day I had estimated, from a partial count, that there were at least 300 seals in the herd; the day after this one was shot, not a seal was to be seen from either island, nor did they return that spring, although the date was a month or so earlier than their usual time for leaving the islands.

Undoubtedly, some of the seals, upon seeing the blood and dead body of their companion, gave the alarm to the others, and the whole herd left for safer quarters, and yet the shooting at ducks never seemed to seriously disturb them. Of course they would all take to the water when (or rather before) the first shot was fired on Bluff Island, but many would remain in the vicinity, and occasionally one would take under a dead or wounded duck, and often within an hour after we left Bluff Island the seal would begin to crawl out on the rocks again.

I will give one more incident, showing the intelligence of the seal, that came under my personal observation. Sitting, one day, at the window of the house on Stratton Island, I observed several herring gulls (*Larus argentatus*) hovering over some object in the water, and alighting near it. Presently one of the gulls jumped into the air, evidently alarmed, but from what cause I could not imagine. Soon another and still another rose with the same manifestations of fright or trouble, but I could discover no reason for their alarm.

Their actions puzzled me, as only one rose at a time, and none flew away, but, with the aid of a field glass, I saw that the object of attraction was a crippled duck (*Harelda glacialis*), local name old squaw, whose movements were very peculiar, and I was soon satisfied it was being pulled about by some other force than that of its own feet. My first thought was that a school of large fish was the cause of all this commotion; but, after a while, as a gull jumped into the air, I saw the head of a seal appear for an instant above the water in the place where the gull had been sitting. The mystery was now solved. Calling the attention of my companions to it, we watched the performance repeated for a long time, a dozen or more gulls having meanwhile collected there.

The duck could, apparently, neither fly nor dive, but the seal, seizing it by the legs, would push it this way and that, occasionally lifting it clear of the water, and the gulls would circle around and hover close to it. When a gull lit near it, the seal would leave the duck, come up under and attempt to seize the gull. For more than an hour this game went on with a persistency, on the part of the seal, worthy of greater success. As he failed to capture a gull, although once he plucked out a handful (or rather a mouthful) of feathers, probably the clearness of water and sky was against him, and the birds saw him in time to escape his jaws. At length the seal abandoned the sport and took in his decoy.

The question naturally arises, How did the seal acquire this art of decoying? It cannot be called instinct. That would have led him to devour the duck as soon as captured. Did his parents teach him the art? Did he acquire it in imitation of human fowls who had used decoys in his presence? Or did he invent the process by his own unaided reasoning powers? Who shall say?

The Asiatic man, covering his head with the shell of a gourd, and wading out among water fowl to seize them, and the historic fox, with a bunch of moss in his mouth, swimming out among them, for the same purpose, are both tyros in the art compared to the skillful seal.

The damage done by seals to the Canadian salmon fisheries is enormous, and the quantity of fish consumed by them on the coast of Maine is beyond computation; but it is safe to say that each seal consumes a greater quantity of fish than does any fisherman's family in the State, and the total weight of fish consumed by seals on that coast must be many thousand tons. It may well be questioned if it is not an expensive luxury for the State to prohibit the killing of seals, as it has done in some localities.

Delicious as seal meat is reported by competent judges to be, our people still prefer fish upon their tables, and it is an open question which it is best to

protect, the seal or the fish. The seal can take care of himself pretty well, without the help of the State of Maine, and not until our people learn his value as food is he likely to be hunted to the point of extermination.

One fact in the history of seals has never been satisfactorily explained, viz., their habit of swallowing good-sized pebbles, sometimes in large quantities. The fishermen believe it is done to increase their specific gravity, or, as they put it, so that they can dive deeper and easier, and claim that the fatter the seal is, and the deeper the water where he is feeding, the more pebbles will there be found in his stomach.

Many naturalists say that the stones are swallowed in order to aid the process of digestion, but the *modus operandi* they neglect to explain, and so shall I.

Do the naturalists mean that the pebble in the stomach of the seal performs a service similar to that done by the gravel in the gizzard of a fowl, and aids in grinding up the shells of mollusks and crustacea, such as clams, mussels, crabs, and lobsters, on all which the seal feeds at times? If so, my personal opinion favors the theory of the fishermen.

[Continued from SUPPLEMENT, No. 679, page 10850.]

YEAST: ITS MORPHOLOGY AND CULTURE.*

By A. GORDON SALAMON, A.R.S.M., F.I.C., F.C.S.

LECTURE I—CONTINUED.

By far the greater number of species are, however, developed by means of asci; an ascus being a large cell, usually the swollen extremity of an hyphal branch of the organ of fructification. The spores are developed within the ascus, and are then known as ascospores. This term possesses an especial significance for us because it has been shown that yeast may be caused to develop ascospores, and advantage has been taken of the observation to base thereon a reliable and invaluable system of yeast analysis.

It will be shown that this method places it within the power of the brewer not only to determine the exact composition of the yeast with which he is working, but also to secure the propagation of a species of yeast

* Lectures before the Society of Arts, London, 1888. From the *Journal of the Society*.

FUNGI.

Thallophytes which have no chlorophyll.

Groups:

1. SERIES OF THE ASCOMYCETES.

Phycomycetes

So called because of close approximation to the algæ.

2. DIVERGENT ASCOMYCETES OF DOUBTFUL POSITION.

Considered in connection with phycomycetes.....

Considered in connection with 5, 10, and 6.....

1. Peronosporæ: Some live on the bodies of dead animals and plants; the greater number as parasites in the tissues of phanerogams—fertilization by male and female organs.
Ancylistæ: Parasites are fresh water algæ; closely related to peronosporæ.
Monoblepharis: Incompletely studied; closely related to peronosporæ.

2. Saprologeniæ: Closely resemble peronosporæ; live on dead organic bodies in water, mostly of large growth; male sexual organs wanting, or do not perform fertilizing functions; spores in motile state when young issue from sporangium.

3. Mucorini: Plants of the dry land; mostly grow on dead organic bodies, especially animal excrement; some parasitic on other mucorini, closely connected with peronosporæ and saprologeniæ, but differ in forming zygospores and onidia. Subdivisions:
(a) Mucoræ: Spores found endogenously in terminal sporangia.
(b) Chætocladiæ: Spores abjoined acrogenously one by one.
(c) Piptocephalidæ: Spores formed acrogenously and serially by cross septations.

4. Entomophthoræ: Penetrate the cavities of bodies of living insects and there develop; form gonidiphores on hyphal branches; make their way through the body of the insect after its death, and complete their development on its outer surface.

5. Ascomycetes: Composed of branched hyphæ; always septate; all form spores in asci; the asci are sporocarps or parts of them, and often collected together into hymenia.
(a) Ascomycetes bearing apothecium.
(b) Ascomycetes bearing perithecium.
(c) Cleistocarpus Ascomycetes: Spores released by rupturing cell wall.

6. Uredinæ: Closely allied to ascomycetes; all parasites or living phanerogams and ferns; many complete their development on one host; others obliged to migrate from one host to another in order to arrive at certain stages of their development.

7. Chytridiæ: Microscopic; mostly live under water; swarm spores formed in sporangial cells. Subdivisions:
1. Rhizidiæ.
2. Cladochytriæ.
3. Olpidiæ.
4. Synchitriæ.

8. Protomyces and Ustilaginæ:
Protomyces—parasites in intercellular spaces of umbelliferous plants.
Ustilaginæ—endophytic parasites in phanerogamous plants; phylogenetically a more highly developed group proceeding from the chytridiæ.

9. Doubtful Ascomycetes:
Laboulbeniæ—grow on outer surface of beetles, have no mycelium.
Exoascus—parasitic on the surface of parts of living plants.
Saccharomyces—YEAST.*