HOW THEY SURVIVE.

An account of the various methods employed by Nature to protect animals unable to fight successfully against their stronger foes. In many cases the colouring and general characteristics of an innocuous animal have acquired a resemblance to its usual surroundings, which enables it to remain undetected by its would-be destroyer. This article also explains the marvellous experiment whereby Mr. A. H. Thayer shows how the coloration of an animal is so disposed as to cause strong light to become a protection, and even one of its best means of concealment; though it might reasonably be supposed that a dark spot would most favour the animal's safety. By this experiment Mr. Thayer demonstrates almost indisputably his theory as to why most animals are darker on the back than on the breast.

THE subject of the utility of the external colouring and form of animals in relation to their manner of life and habitual surroundings is attracting much attention among naturalists at the present time, and illustrations of some of the theories that have been propounded in connection with it may be seen in several of the cases in the Central Hall of the Natural History Museum at South Kensington. Striking examples of adaptation of the colour of animals to their natural surroundings, by means of which they are rendered less conspicuous to their enemies or their prey, may be observed in the two cases containing specimens from Norway. The first contains a specimen of a mountain or variable hare (the common species of the North of Europe), a stoat, and a weasel, some willow-grouse and ptarmigan in their summer dress, obtained in the neighbourhood of Christiania in the month of July, showing the general harmony of their coloration at this season with that of the rocks and plants among which they live. The second case shows the same species of animals obtained from the same spot in mid-winter, changed to white like the snow which completely covers the ground around them. Such absolute changes as these

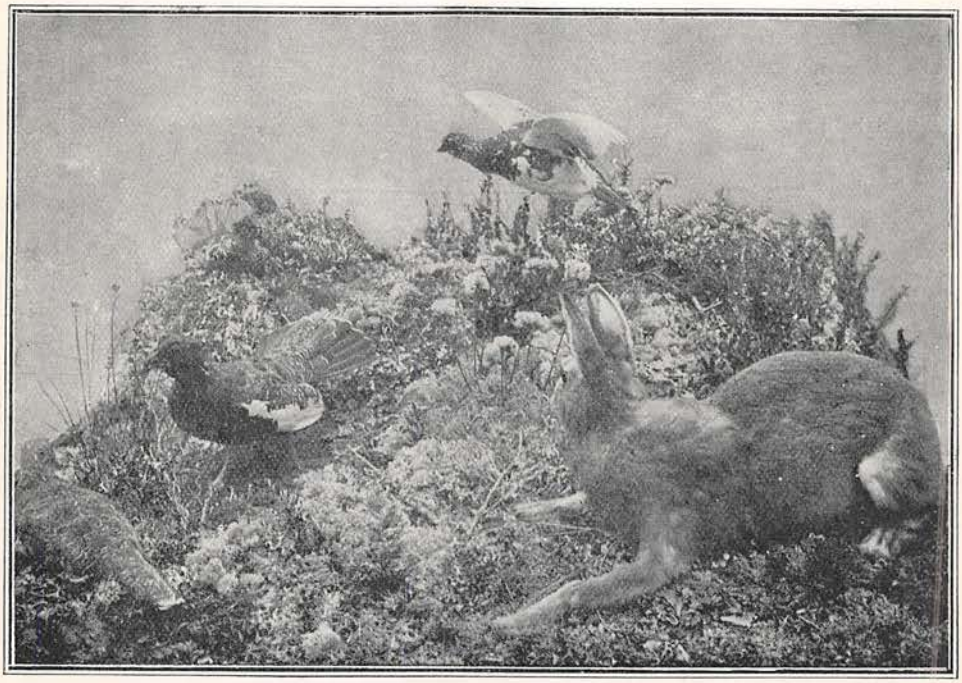
In Egypt most of the reptiles and birds take the colour of the sand.

only occur in latitudes and localities where the differences between the general external conditions in the different seasons are extreme ; where the snow entirely disappears in summer and remains continuously on the ground during the greater part of the winter. And it has been noticed that even some of these species do not turn white in the less severe winters of the southern portion of their range. This would seem to prove that the change is in direct adaptation to the surroundings, the advantage gained being concealment from their enemies or their prey, as the case may be.

Another striking example of adaptation to environment is seen in our Illustration of the series of specimens of an insect (*Platoides dealbatus*), obtained by the Museum, from the forest of Maramanga, about sixty-five miles east of Antananarivo, Madagascar, each specimen being mounted on the piece of bark sent with it by the collector. These insects differ remarkably from each other individually, but all closely resemble the particular colour of the lichen-covered bark of the trees upon which they habitually rest, a circumstance which seems well calculated to afford them protection.

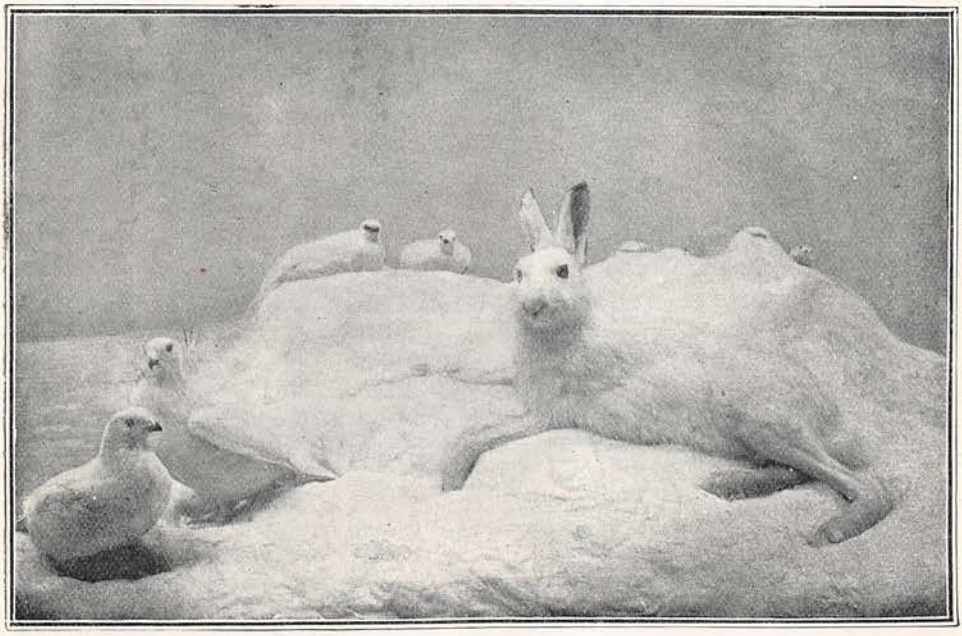
Our picture also includes an illustration of six specimens of a beetle (*Lithinus nigrocristatus*) from Madagascar, with their natural surroundings. The black and white or yellowish colour and black hairs of the beetle and of the lichen agree completely, and should afford the insect ample protection ; it being borne in mind that the beetles are not so easily seen in a state of nature as they are in a museum case where special attention is drawn to them.

Compared with the immense number of species which inhabit the land-surface of the warm and temperate parts of the globe, which is continuously clothed with dark or rich coloured herbage, rocks, or soil, the number of those of which white is the prevailing colour is infinitely small. On the other hand, birds which habitually



The summer dress of animals in Norway.

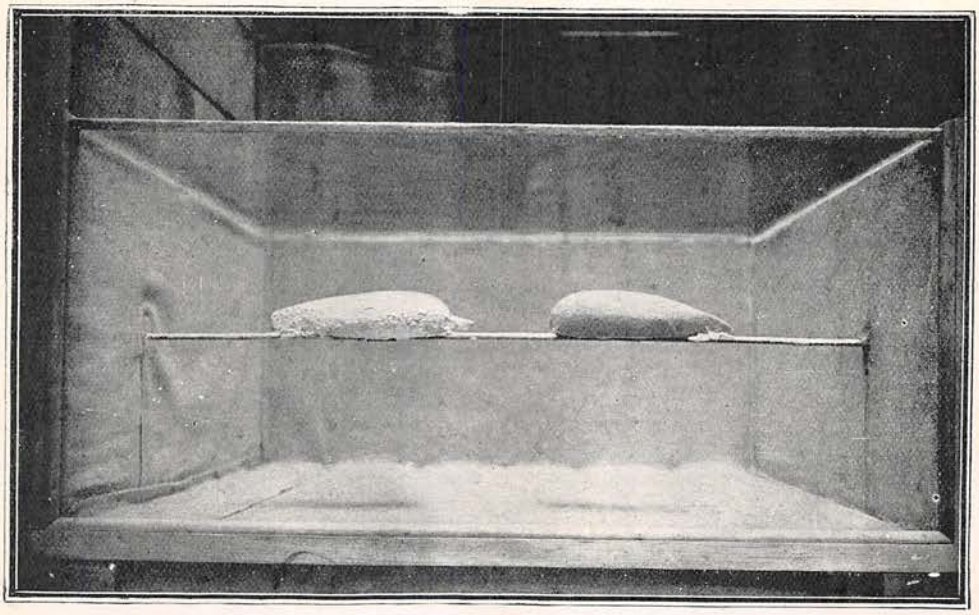
dwell among the foaming waves of the sea are usually either partially or entirely white; and white is rather the rule than the exception among the comparatively few inhabitants of the northern regions, where the ground is either permanently or during a considerable part of the year covered with snow. These facts and other evidence pointing in the same direction have led naturalists to assume, as a very general principle in nature, that the colour of animals frequently conforms to their habitual surroundings. So little is, however, known of their habits and life-history, that many of the purposes supposed to be served by particular colours or appearances can only be regarded at present as conjectural.



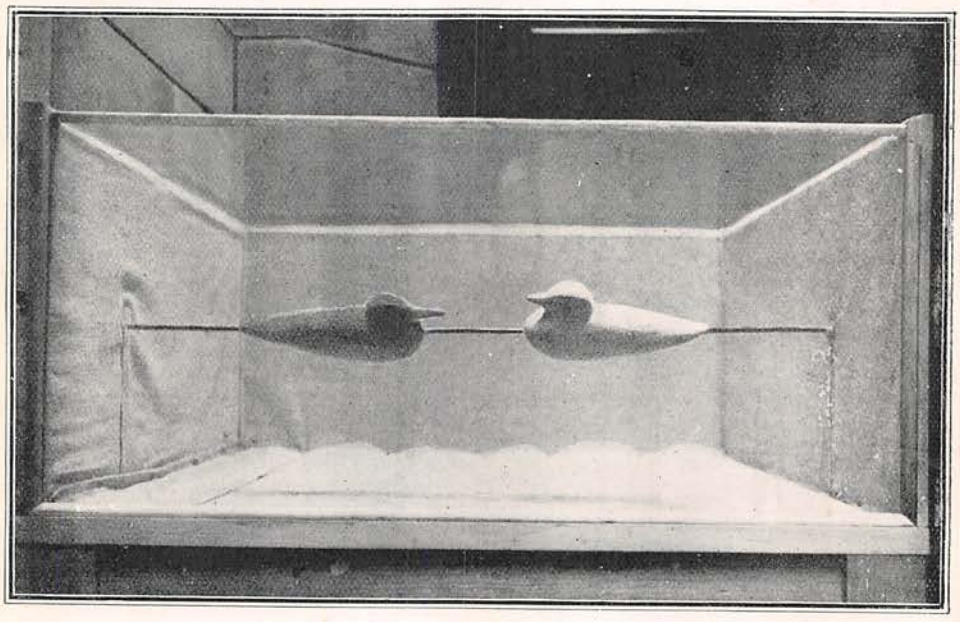
The winter dress of animals in Norway.

A discovery recently made by Mr. Abbott H. Thayer, an American artist, demonstrates how much has yet to be learned before a definite opinion can be pronounced on the subject.

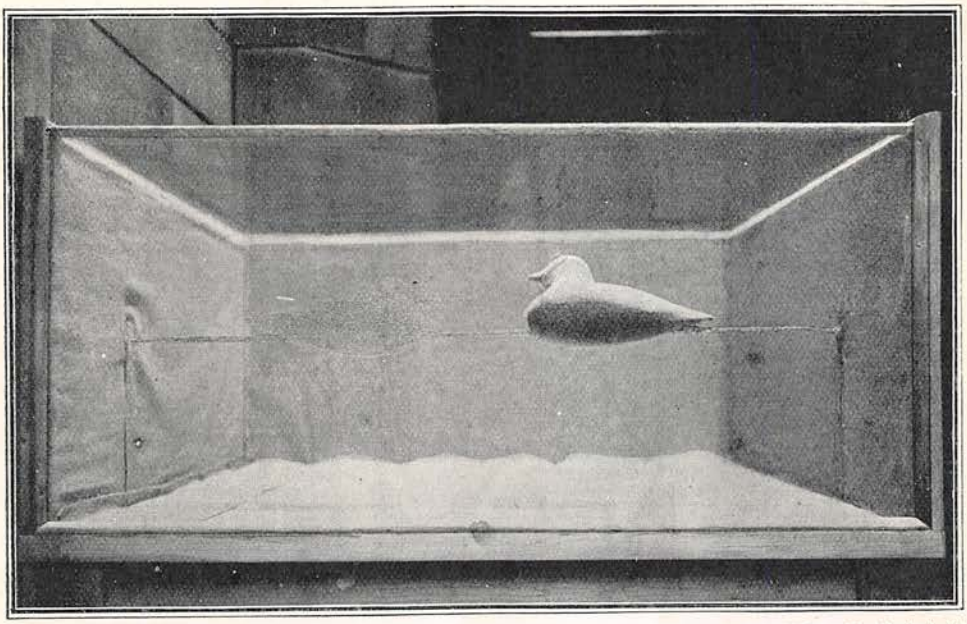
There has just been placed in one of the galleries of the Natural History Museum a case containing two models of birds, an examination of which does certainly suggest a reason why animals are, as a rule, dark above and lighter in colour below. The apparatus consists merely of a box, open at the top, and with one side replaced by glass, and lined with light grey felt. In the middle, on a perch, are two roughly modelled birds. One is covered with the same grey felt as the surrounding box, and the other is coloured darker than the felt on the top and white below. The spectator standing close to the box sees both birds clearly, but a few yards away the coloured bird entirely disappears from sight. The models and apparatus are the work of Mr. Abbott H. Thayer, who is inspired by a conviction derived from prolonged and 'cute observation of nature, and who has designed them as an object-lesson of the theory which he has so cleverly advanced as to the law which underlies protective coloration. Mr. Thayer asserts that it is not resemblance to the colour of its surroundings, or "protective coloration," as ordinarily defined, which prevents an animal from being seen, but that the true cause of the concealment is



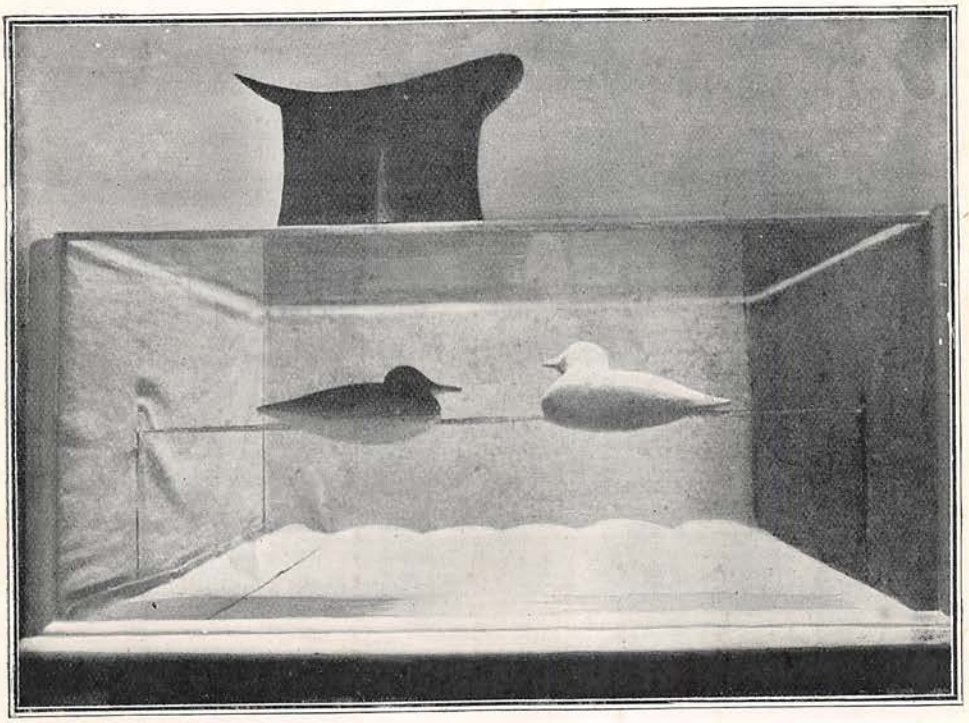
The two birds shown in the above case, which is lined with grey felt, are on a revolving perch. This makes it possible to see every side of them. The bird on the right is made of the same coloured felt as the lining of the case, the bird on the left is painted darker on the back and lighter on the breast than the felt lining. The photograph shows that the breast of the bird on the left is lighter than its surroundings.



Here we see the backs of the two birds. The back of the one on the left is evidently darker than the lining.



Directly the birds are placed in a normal position, the one on the left becomes nearly invisible. In fact, to the naked eye it becomes more indistinct than it appears in this photograph, though the photograph is absolutely genuine, and has not been touched up by the operator in any way whatsoever.



Here we see a hat placed directly over the top of the left-hand bird, which immediately becomes even more distinct than the other. The reason of this is obvious, and we may understand it at once by observing the right-hand bird, which appears as if its back were lighter than its breast. This is because the light, falling from above, brightens the normal colouring of the bird's back, while, on the other hand, the shadow beneath darkens the bird's breast. In the left-hand bird this is counteracted by painting the bird dark above and light below, making a compound gradation of colour and light. By this experiment Mr. A. H. Thayer explains why so many animals are thus arranged in colouring.

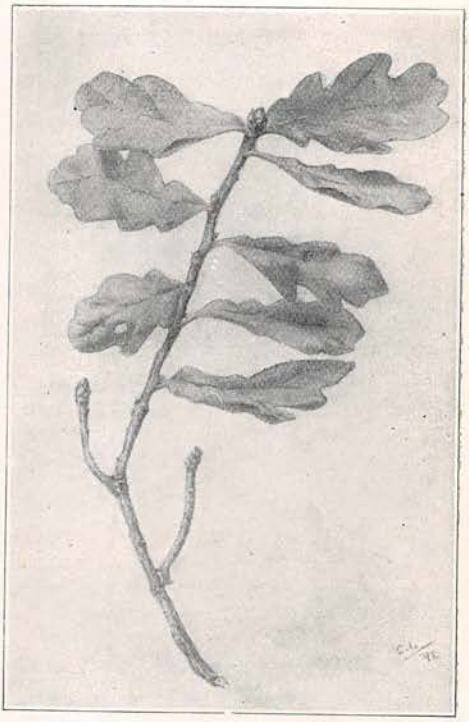
a compound gradation of colour and light. His experiments with painted decoys have shown that even brilliant top-colours,

This crab has hooked hairs all over its body, which catch up seaweed and cause it to acquire a resemblance to that marine plant.

however strongly contrasted to surroundings, scarcely tend to betray the wearer, if his *ensemble* be a gradation from dark above to light below. In an article which he contributed in April 1896 to the *Auk*, an American ornithological journal, Mr. Thayer was, we believe, the first to set forth in print this explanation for most of the phenomena of protective coloration in animals, except those properly called mimicry. "Animals," he wrote, "are painted by nature darkest on those parts which tend to be most lighted by the sky's light, and *vice versâ*. Mimicry makes an animal appear to be some other thing, whereas this newly discovered law makes him cease to appear to exist at all." In the models prepared by him for our National Museum of Natural History he has, it seems to us, successfully demonstrated his theory of the effect of gradation in colour, the reason of the disappearance of one bird being obviously that the white under-surface counteracts the effect of the shadow thrown by a top-light, making the bird which is graded from dark above to white below, at a little distance, one uniform colour; while in the case of the other model, wholly coloured the same as its surroundings, a shadow throws it in strong relief, showing how ineffectual for concealment such colouring would be. The reason for omitting naturalistic background, such as grasses, twigs, or pebbles, and the corresponding markings on the models, is to give the principle the severest test, since the pattern on the animal, being pictures of his background, involve a more varying degree of concealment.

When nature has made the animal cease to appear to exist, it follows, Mr. Thayer says, that his surface must grow to wear the picture of the background; hence one may read in the design of the creature's colouring the story of his life and haunts. The tiger wears a picture of sunbaked, matted vertical stems of large flags, etc.; the partridge, a wonderful reproduction of bare earth, stones, and dead grasses; and the sandpipers the delicate horizontal linings of the ocean sands.

We now come to the theory of warning



Caterpillar of Moth Emomos tiliaria: Resembles a twig.

colours and protective resemblance or mimicry—a condition which makes an animal appear to be some other thing.

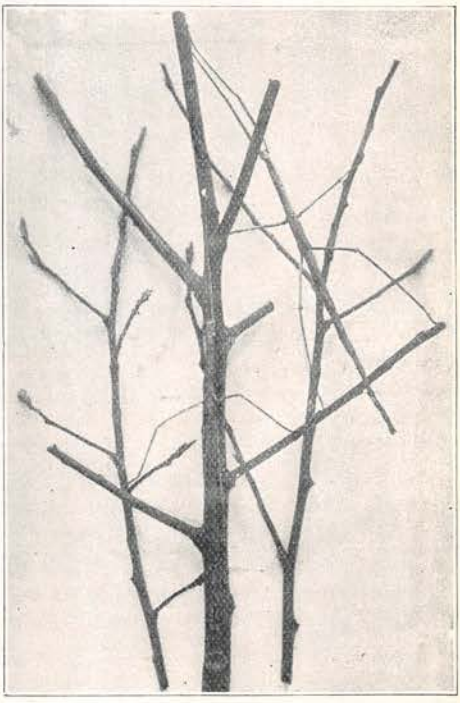
presumably for the purpose of self preservation amid the tremendous struggle for existence continually going on in the wild

Insects and dead leaves.

state of nature. The subject is of extreme interest and importance in relation to that of natural selection with which the name of the great naturalist, Charles Darwin, will ever be indissolubly connected. The researches and writings of Wallace, Bates, Poulton, Finn, and many others have made the theory one of the most interesting which the student of Nature's wonders has before him. The similarity of many insects to leaves, twigs, flowers, and other inanimate objects among which they live is so remarkable that it is not difficult for the layman to believe that the resemblance must be for protection, or is in some way advantageous to the animal possessing it. The subject, however, is not one on which to dogmatise yet; and "mimicry" may be, as some naturalists hold, in many cases nothing more than the influence of similar surroundings acting in a similar manner upon different forms inhabiting the same district.

In the Natural History Museum may be seen many extraordinary instances of "mimicry." The close imitation of a dead leaf, presented by the butterfly (*Kallima inachis*) when its wings are closed, could not be surpassed. It is stated that these butterflies, if pursued by a bird, take refuge among foliage, the resemblance of the under side of the wings to a dry leaf enabling them to conceal themselves. They have been observed also to rest, head downwards, on the trunks of trees, where their leaf-like appearance protects them from lizards. It is noteworthy that the tail of the wing corresponds to the stem of the leaf, the dark line through the wings, and the oblique lines on each side of it, corresponding to the midrib and veins. Unlike most butterflies, there is a great variety in the style of markings on the under side of the wings, and this fact, and the transparent spot, the mottled appearance of some specimens, and blackish blotches in others, all help to complete the resemblance to dead, injured, or fungus-marked leaves in different stages of decay. The same phenomena can be observed in our Illustration of a locust (*Cycloptera speculata*), the wings of which present an extraordinary resemblance to a decaying leaf.

Another phase of "mimicry" is where the object resembled, or mimicked, is



The stick insect explains itself.

another living animal, belonging to a different species, family, or even order, known to be nauseous and inedible on

account of taste, odour, or some other reason. Insectivorous birds, mammals, and reptiles destroy for food immense numbers of insects, and it is important to those which are distasteful and repellent that they should be easily distinguished from those which are harmless and good to eat. Hence the former are supposed to assume bright or gaudy colours as warning to the insect-eaters, while the edible species mimic them to secure an equal immunity from attack and destruction. In referring to this subject we may draw attention to the interesting experiments with various birds, and mimicking and warning-coloured or "nauseous" butterflies, carried out by Mr. F. Finn, Deputy Superintendent of the Indian Museum, Calcutta. As a result of these experiments, Mr. Finn concludes: (1) That there is a general appetite for butterflies among insectivorous birds, even though they are rarely seen when wild to attack them. (2) That many, probably most species, dislike, if not intensely, at any rate in comparison with other butterflies, the "warningly coloured" species. (3) That the mimics of these are, at any rate, relatively palatable, and that the mimicry is commonly effectual under natural conditions. And lastly that each bird has separately to acquire its experience, and well remembers what it has learned. Professor Poulton's suggestion that animals may be forced by hunger to eat unpalatable forms is more than confirmed by Mr. Finn's experiments, since the unpalatable forms were commonly eaten without the stimulus of actual hunger, generally also without signs of dislike.

This shows how ptarmigan look like the rocks on which they stand.

Whatever may be the real explanation of the phenomena of protective resemblances and adaptation of external colouring to the conditions of life among animals, the facts here recorded and as exemplified in our National Museum of Natural History, of which we have given a few Illustrations, are very curious, and well worthy of careful consideration.

1.—A Locust (*Cycloptera speculata*), the wings of which present a remarkable resemblance to a decaying leaf.
2.—A Beetle (*Lithinus nigrocristatus*) from Madagascar. The black and white or yellowish colour and black hairs of the beetle and lichen agree completely, and must afford the insect ample protection.
3.—Group of Butterflies (*Kallima inachis*). These butterflies, if pursued by a bird, take refuge among foliage, the resemblance of the under-side of the wings to a dry leaf enabling them to conceal themselves.
4.—An Orthopterous Insect (*Phyllium*), often called the "Leaf-insect." Its general form and the veins in the wings are very leaf-like, and seem well calculated to afford it protection.
5.—A Homopterous Insect (*Flatoides dealbatus*), from the Forest of Maramanga, Madagascar. This species is extremely variable, no two specimens being quite alike; but all more or less resemble bark, moss, or lichen.

HOW THEY SURVIVE.