

COLOUR AND PATTERN

PROFESSOR L. R. RICHARDSON, Professor of Zoology at Victoria University College—who, readers may recall, attacked the theory of the "survival of the fittest" on this page some time ago—looks sceptically at another dogma of popular natural history.

COLOUR is an obvious feature of animal life, where colour and pattern range from the pleasing to the appalling, from brilliance to drabness. The display of colour is as extravagant and brilliant in many insignificant animals as in the larger and well known. To understand coloration requires a knowledge of animal life such as was unknown in the last century.

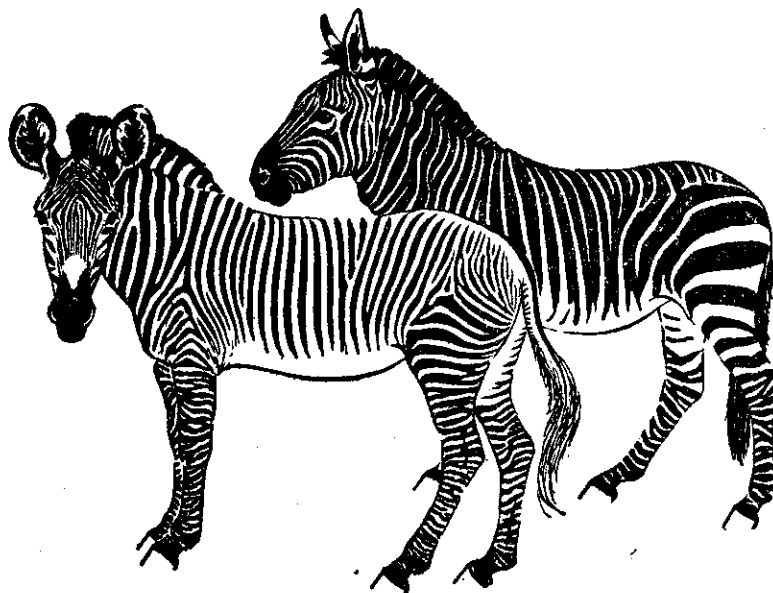
Zoologists of that period sought to explain all coloration in terms of perfection and usefulness. They recognised camouflage, with colour and patterns blending an animal with its surroundings or by irregular patchiness interrupting outline and so hindering recognition. Other creatures have a colouring rich in red and black which, instead of concealing, reveals them to the observer. Many such animals are poisonous or armed with stings, and such coloration was considered a warning to other animals which, after one experience, would subsequently avoid them. Similar colouring of harmless animals was regarded as giving protection by the mimicry of venomous species.

Another type of coloration, well known in birds, is found in animals where the female is drab and the male brilliant. Such sexual difference was held to result from female selection, the female breeding with the more brilliant of the males courting her. Other types of "useful" colouring were recognised, and convincing proof of the utility of animal colour was seen in the fact that where animals live in caves in an absence of light, when colour could have no value, the animals are colourless.

TO support these interpretations of animal coloration today demands rejection of much data. For example, Dr. J. T. Salmon has described tiny but none the less brilliantly coloured insects from the dark recesses of the soil and of the forest floor in New Zealand. Animals living in the great depths of the seas, which are as lightless as the deepest caves, are richly coloured. Under ordinary conditions, at the beginning of a breeding season, several male birds court a single female, but usually to no result, for pairing follows much later. It is often found that a female pairs with a male not concerned in competitive courting for her favour. In fact, since few males fail to mate in a season, the theory of sexual selection leading to brilliance in the male is untenable, and so male brilliance seems to have no value for species survival. Although courting is universal in birds, courting has not produced brilliance in the males of all species. Where both species occupy the nest the male and female commonly have similar colour, and there is little doubt that relative drabness is of value in protecting the bird covering eggs in the nest.

The idea of warning coloration is hardly tenable when we recognise that

many such startlingly marked venomous species are nocturnal, as are many tropical snakes, desert lizards and others, while equally venomous but day-active species usually lack warning coloration and commonly show a camouflage coloration. The red or orange "warning colour" on bees and wasps is no protection, since they are eaten more freely by birds than are less conspicuous insects. If warning colour is sus-



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pect, the idea of protective mimicry is even less supportable.

So, too, examining camouflage, we come to doubt its overall usefulness. Camouflage is fully effective when the animal is immobile. The sudden "appearance" of the animal when it springs into motion may startle a predator or prey, lead to confusion and so facilitate capture or escape; but since predator and prey depend highly on senses other than vision, camouflage is recognised as having far less value than before. The seasonal change in colour of some snow-land animals is impressive, but similar animals survive without change to white in winter time. Ptarmigan, which change to white, are closely related to grouse, which under similar conditions make no such change to a white dress for winter. Albino deer, rabbits, porcupine and others survive in the wilds as well as do their ordinarily coloured fellows.

ATTEMPTS to explain all aspects of coloration in terms of usefulness have been numerous, ingenious, but unsatisfactory. We can recognise a usefulness in some cases, as in the colour and pattern changing mechanisms in fish, but no such explanation for extravagant, brilliant coloration.

When we examine the basis of coloration we find it is due to either prisms or pigments. Much of the light falling on the wing of a butterfly or the feathers of a bird is separated into colours, as when white light passes

through a prism. Also, as in worms, fish, frogs and others, colour comes from pigments deposited as granules in the skin and elsewhere. We now know many of these granules are manufactured from poisonous waste substances which the animal cannot otherwise excrete. Such waste substances are changed from a dissolved and harmful form into a harmless solid, and stored as granules beneath the skin and in other tissues where they interfere least with bodily activity. This location of granules in inert areas produces pattern. Light has some effect on this process, which is probably the reason why the upper parts in many animals are darker than the lower, as is seen in fish, frogs, cows and many others. The formation and deposition of these granules has then a functional basis; but its primary purpose is excretion, not useful colour, for

with the animal's functions and creating colour and pattern. Since much pattern coincides with the distribution of nerves, and we now know that there is secretion and much metabolic activity at the end of nerves, this is possibly the basis of the formation of much delicate, intricate and stable colour patterns.

AGAIN we reach an understanding of ornateness and variety in animal life without relation to usefulness; but we have not explained all the problem. It is asking too much to believe that the brilliant male bird has a different diet or a different excretory mechanism from his drab mate. Colour in birds is largely prismatic, which we cannot yet fully associate with diet or excretion, although we know it has a metabolic basis. Many experiments show that the colour and pattern of plumage in birds are under glandular control and can be changed by feeding birds with, for example, dried thyroid gland.

We are far enough on the road to an interpretation of animal colour and pattern to see that extravagance in these respects can have a meaning different from the "usefulness" which was the basis of interpretation in former years. Brilliant extravagant colour is found, for example, in butterflies, birds of the forest tree-tops, nocturnal animals, animals of the ocean deep, etc. We can see even in this brief list that there are at least two categories, those animals which by flight can escape a predator and so can become as brilliant as a macaw, a white cockatoo or a monarch butterfly; and those animals which are active in the dark where colour can have no protective value. To these we can add another group including such animals as the brilliant sea-anemones of rocky coasts, the magnificently coloured sightless worms, and others whose extravagance of coloration in no apparent way influences their survival.

Contrast these categories with the well-recognised cases of useful coloration: the moderately coloured male and female nesting bird, the relative drabness of ground birds and other ground dwellers. Compare the ease with which we can identify survival value in such colour and pattern, with the great difficulty in determining survival value in brilliant extravagant coloration, and we have an indication that we are probably at error in attempting the one explanation for the full range of this matter. The ardent evolutionists of the past century recognised some features of animals as having high survival value, others as having low survival value, and some features which lost survival value and became vestigial.

This led to the difficulty that highly developed structures were regarded as always having great survival significance; but here it is suggested that in certain cases, such as colour and pattern, these reach an extravagant level when they have no survival value. The wing of a kiwi could be larger than it is without affecting the survival of the bird. The process leading to reduction of the wing has clearly continued after the wing had reached a necessary minimum size, so that the wing of the kiwi or the leg of the whale and other vestigial non-functional structures have been reduced more than is necessary for survival. The process has become extravagant, just as brilliance in colour and grotesqueness in pattern can be extravagances in a feature which has no survival value.

such pigments are deposited in many deep and hidden tissues as well as in the skin.

WE can now approach a new understanding of the colour and pattern making process. Much colour develops through embarrassment of the excretory mechanism. As metabolism increases in complexity, or excretory mechanisms lose efficiency, substances which are harmful by-products from metabolism and which cannot be otherwise excreted are deposited as harmless pigments beneath the skin and in other inactive tissues. This means that any animal has the potentiality of becoming increasingly brilliant.

All animals are not brilliantly coloured. Their diets are limited or the excretory mechanisms are adequate, so these are moderately coloured or drab. The range of pigments in others has the opposite significance. We can understand in this way the brilliance of colour and the striking patterns often found in sightless worms and other animals where colour has no recognisable possible protective or other similar useful value. In these animals, the excretory mechanisms are inadequate for the removal from the body of all wastes, some of which are accordingly deposited as granules in tissues, so interfering least

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