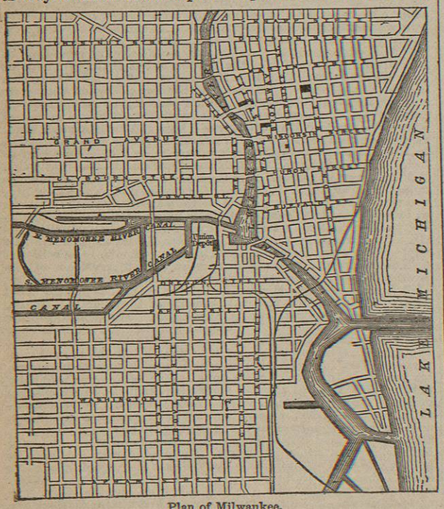
principle of the treatise is that, as the Bible is a revelation from God of things that man could not have found out for himself, all that the Bible says on any matter is to be accepted implicitly, in the plain sense of the words, and without sophistication, however strange it may seem to the natural human reason. Hence, in all those essentials of Christianity which consist in the doctrines of the fall of man, atonement by Christ, and restoration and sanctification through Christ only, Milton is at one with the great body of Christians. Altogether, what the treatise makes clear is that, while Milton was a most fervid theist and a genuine Christian, believing in the Bible, and valuing the Bible over all the other books in the world, he was at the same time one of the most intrepid of English thinkers and theologians.

For further information reference may be made to Masson's *Life of Milton and History of his Time*, 6 vols. (1859–80), and to his editions of Milton's *Poetical Works* (Cambridge edition in 3 vols., 1874, and smaller 3 vol. ed., 1882), as well as to Todd's variorum edition of the *Poetical Works*, with Life (5th ed., 1852), to Keightley's *Life, Opinions, and Writings of Milton* (1855), to *Milton und Seine Zeit*, by Alfred Stern (1877–79), and to Mr Mark Pattison's *Milton* in Mr Morley's series of "English Writers." Collective editions of the prose works since that of 1698 are—Symmons's (7 vols., 1806); Pickering's, with *Life* by Mitford (8 vols., prose and verse together, 1851); and St John's, in Bohn's Standard Library (5 vols., 1848–59). This last includes a revised edition of Bishop Sumner's translation of the *Treatise of Christian Doctrine*, originally published in 1825. (D. MA.)

MILWAUKEE, the largest city in the State of Wisconsin, United States, is situated on the west shore of Lake Michigan, 100 miles north of its southern end, 80 miles north of Chicago, and 1000 miles north-west of New York by rail, in 43° 3′ N. lat., 87° 56′ W. long. (44 min. W. of Washington). The shore of the lake is 600 feet above the level of the sea.

The Milwaukee and Menomonee rivers unite in the centre of the business portion of the city, about half a mile from their entrance to Lake Michigan, where they are joined by a third and smaller stream—the Kinnikinnic. A bay 6 miles from cape to cape, and 3 miles broad,



Plan of Milwaukee.

stretches in front of the city, which commands a fine water view, the ground rising along the shore 80 feet above the level of the lake, then gradually sloping westward to the Milwaukee river, and again rising on the west and north to a height of 125 feet. The ground also rises to a commanding elevation south of the valley of the Menomonee. Few cities present so many natural attractions of site, as indeed its Indian name indicates ("the beautiful hollow or bay"); and art has added to nature. In the residence parts of the city there are miles of avenues from 70 to 100 feet wide, lined on both sides with elms and maples, behind which stand handsome houses with spacious lawns, fountains, and evergreens, giving the appearance of a continuous park. The material used for building is largely the cream-coloured brick made in the vicinity, from which Milwaukee is sometimes called the "Cream City." The climate, tempered by the great lake, is remarkably pleasant and healthy. The mean temperature, as shown by the records of twenty years, is 46°·7 Fahr. The coldest month is January (average 22°·37), the hottest July (70°·4).[1] During the last nine years the average death-rate has been but 20 per 1000, showing it to be one of the healthiest of American cities. Besides a full complement of the usual religious and charitable institutions, there is adjoining the city the national home for disabled United States volunteer soldiers, consisting of several buildings situated in grounds of 400 acres extent, which serve the purpose of a city park. There are numerous lodges belonging to the freemasons and other guilds; and the Turners' societies, which embrace a large membership and own some valuable buildings, have done much to create and keep up the practice of athletic exercises among the citizens. Two excellent musical societies are also established here.

Before the year 1835 Milwaukee was known only as an Indian trading-post occupied by a Frenchman named Solomon Juneau, who is generally spoken of as the founder of the city. The total inhabitants in 1838 numbered only 700; in 1840 there were 1712; but in 1846 the population amounted to 9666, in 1850 to 20,061, in 1855 to 30,118, in 1860 to 45,246, in 1870 to 71,440, and in 1880 to 115,578 (57,475 males, 58,103 females). In 1882 the population was estimated at 130,000,—more than one half of them of foreign parentage, a very large majority being Germans. Notwithstanding the multitude of nationalities represented in the population, there are few cities more orderly and law-abiding, the number of police employed being less than one for every 1500 inhabitants. Another feature worthy of mention is the large proportion of families who own their own houses, and this is true not only as to the mercantile and professional classes, but especially as to the labouring population. Although the grain trade, formerly very large here, has now greatly diminished, the growth and prosperity of the city have not materially suffered, owing to the development of manufacturing industries, for which the low rents, healthy climate, and advantageous location make it well adapted. About a sixth of the population are engaged in the manufacture of clothing, cigars, cooperage, leather, bricks, sashes, doors, and blinds, machinery, and flour (of which one million of barrels are annually made), and in meat-packing. Milwaukee has become famous for its "lager beer," of which there are one million of barrels annually produced, valued at $8,000,000. The lake commerce is very large. The tonnage entered and cleared in 1880 was 5,322,373 tons, being about as large as that of Baltimore, Boston, or Philadelphia. The Wisconsin Central, the Milwaukee and Lake Shore, the Milwaukee and Northern, and the Chicago, Milwaukee, and St Paul Railways have their head offices here, and the last-named, owning 4000 miles of lines, has immense workshops in the Menomonee valley near the city.

Milwaukee is governed by a mayor and a common council of thirty-nine aldermen. The streets and public buildings are under the charge of the board of public works, composed of three commissioners and the city engineer, all subject to the common council. A bountiful supply of water is obtained from the lake, and the streets are well supplied with sewers. The value of property as assessed for taxation was $62,000,000 in 1882,—the city debt being $2,500,000, mostly for the water-works, which are city property.

There is an efficient system of public schools under a superintendent and board of school commissioners, the value of the buildings with their sites being estimated at $700,000. For the higher education there are a high school, a normal school, and three commercial colleges, while the Roman Catholics and Lutherans have several excellent denominational seminaries and colleges. A public library belonging to the city contained 20,000 volumes in 1882. (J. J.)

[1] The monthly averages for twenty years are:—January, 22°·37; February, 25°·13; March, 33°·35; April, 43°·94; May, 53°·75; June, 64°·39; July, 70°·04; August, 67°·89; September, 61°·68; October, 48°·48; November, 36°·27; December, 25°·53.

MIMICRY is the name given in biology to the advantageous resemblance (usually protective) which one species of animal or plant often shows to another. The word was first applied in this metaphorical sense by Mr W. H. Bates, and it has since been accurately defined and limited, in its biological application, by Mr A. R. Wallace. Briefly put, the essence of the phenomenon of mimicry consists in the following relation. A certain species of plant or animal possesses some special means of defence from its enemies, such as a sting, a powerful and disagreeable odour, a nauseous taste, or a hard integument. Some other species inhabiting the same district or a part of it, and not itself provided with the same special means of defence, closely resembles the first species in all external points of form and colour, though often very different in structure and unrelated in the biological order. For example, a South-American family of butterflies, the *Heliconidæ*, are distinguished by their very varied and beautiful colours, and their slow and weakly flight; they might easily be captured by insectivorous birds, but their remains are never found on the ground amongst the rejected wings of other butterflies which cover the soil in many places. They also possess a strong pungent odour, which clings to the fingers for many days; and this fact led Mr Wallace to suspect that they have a disagreeable taste, and would not therefore be eaten by birds after a single trial. Mr Belt has since experimentally proved the truth of that belief. But among the totally distinct family of the *Pieridæ*, most of which are white, there is a genus of small butterflies, known as *Leptalis*, edible by birds, some species of which are white like their allies, while the greater number exactly resemble one or other of the *Heliconidæ* in the peculiar shape and colouring of their wings. As regards structure, the two families are widely different; yet the resemblance of a species of one family to a species of the other is often so close that Mr Bates and Mr Wallace, experienced entomologists, frequently mistook them for one another at the time of capture, and only discovered their mistake upon nearer examination. Mr Bates observed several species or varieties of *Leptalis* in the Amazons valley, each of which more or less exactly copied one of the *Heliconidæ* in its own district. Accordingly, they seem to be mistaken by birds for the uneatable insects they mimic, and so to be benefited by their resemblance. This, which may perhaps be regarded as the most typical instance of true mimicry, is also the first to which the word was applied.

In considering the phenomena under review, it may be well to give first the chief observed facts, which are quite independent of any particular explanation, and then the theory which has been started to account for them by Mr Bates and Mr Wallace. Before doing so, however, true mimicry should be carefully discriminated from one or two superficially similar modes of resemblance among organic beings, whose real implications are very different. It must not be confused with mere accidental or adaptive resemblance, due either to simple chance or to similarity of external conditions. As a case of the first sort, we may adduce the real or fancied resemblance between certain orchids and flies or spiders; as a case of the second sort, we may take certain African *Euphorbiaceæ*, which, growing in dry deserts, have acquired a very close likeness to the cactuses that cover the equally dry deserts of Mexico; or again the sub-Antarctic gallinaceous bird, *Chionis alba*, which, living on the sea-shore, has acquired a coloration like that of the gulls, together with the legs of a wader. These resemblances, however, do not as such subserve any function. The species apparently mimicking and the species apparently mimicked either do not inhabit the same district or do not come into any definite relation with one another. The likeness is either accidental, or else it is due to similar adaptation to similar circumstances. In cases of true mimicry, on the other hand, the mimicking species derives a direct advantage from its likeness to the species mimicked; the resemblance is deceptive; and this is equally true whether we suppose the mimicry to be produced by creative design or by natural selection. On either hypothesis, however it came by its likeness, the mimicking species escapes certain enemies or obtains certain sorts of food by virtue of its resemblance to some other kind.

It should also be added that the word mimicry, as applied to such cases, is used only in a metaphorical sense. It is not intended to imply any conscious or voluntary imitation by one species of the appearance or habits of another. All that is meant is the fact of an advantageous resemblance, a delusive similarity, which gives the mimicking animal or plant some extra protection or some special means of acquiring food which it would not otherwise have possessed but for its likeness to the creature mimicked.

Taking animals first, mimicry does not occur very frequently among the higher classes. In the vertebrates it is comparatively rare, and among mammals probably only one good case has yet been adduced. This is that of *Cladobates*, an insectivorous genus of the Malayan region, many species of which closely resemble squirrels in size, in colour, and in the bushiness and posture of the tail. It has been suggested by Mr Wallace (from whom most of the following examples have been borrowed) that *Cladobates* may thus be enabled to approach the insects and small birds which form its prey under the disguise of the harmless fruit-eating squirrel. In this case, as in some others, the resemblance is not protective, but is apparently useful to the animal in the quest for food

Among birds, Mr Wallace has pointed out that the general likeness of the cuckoo, a weak and defenceless group, to the hawks and gallinaceous tribe makes some approach to real mimicry. But besides such vague resemblances there are one or two very distinct cases of true mimicry in this class of vertebrates. In Australia and the Moluccas lives a genus of dull-hued honey-suckers, *Tropidorhynchus*, consisting of large, strong, active birds, with powerful claws and sharp beaks. They gather together in noisy flocks, and are very pugnacious, driving away crows and even hawks. In the same countries lives a group of orioles, forming the genus *Mimeta*; and these, which are much weaker birds, have not the usual brilliant colouring of their allies the golden orioles, but are usually olive-green or brown. In many cases species of *Mimeta* closely resemble the *Tropidorhynchi* inhabiting the same island. For example, on the island of Bouru are found the *Tropidorhynchus bouruensis* and *Mimeta bouruensis*, the latter of which mimics the former in the particulars thus noted by Mr Wallace:—"The upper and under surfaces of the two birds are exactly of the same tints of dark and light brown. The *Tropidorhynchus* has a large

bare black patch round the eyes; this is copied in the *Mimeta* by a patch of black feathers. The top of the head of the *Tropidorhynchus* has a scaly appearance from the narrow scale-formed feathers, which are imitated by the broader feathers of the *Mimeta* having a dusky line down each. The *Tropidorhynchus* has a pale ruff formed of curious recurved feathers on the nape (which has given the whole genus the name of friar-birds); this is represented in the *Mimeta* by a pale band in the same position. Lastly, the bill of the *Tropidorhynchus* is raised into a protuberant keel at the base, and the *Mimeta* has the same character, although it is not a common one in the genus. The result is that on a superficial examination the birds are identical, although they have important structural differences, and cannot be placed near each other in any natural arrangement." Allied species of *Tropidorhynchus* in Ceram and Timor are similarly mimicked by the local *Mimeta* of each island. Mr Osbert Salvin has likewise noticed a case of mimicry among the birds of prey near Rio Janeiro. An insect-eating hawk, *Harpagus diodon*, is closely resembled by a bird-eating hawk, *Accipiter pileatus*. Here the advantage seems to be that the small birds have learned not to fear the *Harpagus*, and the *Accipiter* is able to trade upon the resemblance by catching them unawares, both birds being reddish-brown when seen from beneath. But the *Accipiter* has the wider range of the two; and where the insect-eating species is not found it no longer resembles it, but varies in the under wing-coverts to white. Here again the resemblance, though advantageous, is not protective.

Among reptiles, Mr Wallace has instanced some curious cases where a venomous tropical American genus of snakes, *Elaps*, with brightly-banded colours, is closely mimicked by several genera of harmless snakes, having no affinity with it, but inhabiting the same region. Thus the poisonous *Elaps fulvus* of Guatemala has black bands on a coral-red ground; the harmless *Pliocerus æqualis* of the same district is coloured and banded precisely like it. The likeness affords the unarmed snakes a great protection, because other animals probably will not touch them, mistaking them for the venomous kinds.

It is among the invertebrates, however, and especially among insects, that cases of mimicry are most frequent and were first observed. In the order *Lepidoptera*, besides the classical instance of *Leptalis* and the *Heliconidæ*, a genus of another family, the *Erycinidæ*, also mimics the same group. The flocks of one species of *Ithomia*, an uneatable butterfly, often have flying with them a few individuals of three other widely different genera, quite indistinguishable from them when on the wing. In the tropics of the Old World, the *Danaidæ* and *Acræidæ* possess a similar protective odour, and are equally abundant in individuals; they are closely mimicked by various species of *Papilio* and *Diadema*. Mr Trimen, in a paper on "Mimetic Analogies among African Butterflies," gives a list of sixteen species or varieties of *Diadema* or its allies, and ten species of *Papilio*, each of which mimics a *Danais* or *Acræa* of the same region in the minutest particulars of form and colour. The *Danais tytia* of India has semi-transparent bluish wings, and a border of reddish-brown; this coloration is exactly reproduced in *Papilio agestor* and *Diadema nama*, all three insects frequently coming together in collections from Darjiling. In the Malay Archipelago the common and beautiful *Euplæa midamus* is so exactly mimicked by two rare species of *Papilio* that Mr Wallace generally mistook the latter at first for the ordinary insect. An immense number of other instances among the *Lepidoptera* have been quoted from other parts of the world.

Occasionally species of *Lepidoptera* also imitate insects of other orders. Many of them take on the appearance of bees or wasps, which are of course protected by their stings. Thus the *Sesiidæ* and *Ægeriidæ*, two families of diurnal moths, have species so like hymenopterous insects that they are known by such names as *apiformis*, *vespiforme*, *ichneumoniforme*, *sphegiforme*, and so forth. The British *sesia bombiliformis* closely resembles the humble bee; the *Sphecia craboniformis* is coloured like a hornet, and carries its wings in the same fashion. Some Indian *Lepidoptera* have the hind legs broad and densely hairy, so as exactly to imitate the brush-legged bees of the same country. Mr Belt mentions a Nicaraguan moth, *Pionia lycoides*, which closely mimics a distasteful coleopterous genus, *Calopteron*; and Professor Westwood pointed out that the resemblance to the beetle is still further increased in the moth by raised lines of scales running lengthwise down the thorax.

Among the *Coleoptera*, or beetles, and other orders, similar disguises are not uncommon. Mr Belt noticed species of *Hemiptera* and *Coleoptera*, as well as spiders, in Nicaragua, which exactly resemble stinging ants, and thus no doubt escape the attacks of birds. The genus *Calopteron* is mimicked by other beetles, as well as by the moth *Pionia*. In the same country, one of the *Hemiptera*, *Spiniger luteicornis*, has every part coloured like the hornet, *Priocnemis*, which it mimics; "in its vibrating coloured wing-cases it departs greatly from the normal character of the *Hemiptera*, and assumes that of the hornets." Mr Wallace mentions the longicorn beetle, *Cyclopeplus batesii*, which "differs totally in outward appearance from every one of its allies, having taken upon itself the exact shape and colouring of a globular *Corynomalus*, a little stinking beetle, with clubbed antennæ." *Erythroplatis corallifer*, another longicorn, almost exactly resembles *Cephalodonta spinipes*, one of the common South-American *Hispidæ*, which possesses a disagreeable secretion; and Mr Bates also found a totally different longicorn, *Streptolabis hispoides*, which resembles the same insect with equal minuteness. Some of the large tropical weevils have the elytra so hard that they cannot be pierced by a bird's beak; and these are mimicked by many other comparatively soft and eatable insects. In southern Brazil, *Acanthotritus dorsalis* closely resembles a *Curculio* of the hard genus *Heiliplus*; and Mr Bates found *Gymnocerus cratosomoides*, a longicorn, on the same tree with the hard weevil, *Cratosomus*, which it mimics. Other beetles resemble bees, wasps, and shielded bugs. Hairy caterpillars are well known to be distasteful to birds, and comparatively free from attack; and Mr Belt found a longicorn, *Desmiphora fasciculata*, covered with long brown and black hairs, and exactly mimicking some of the short, thick, woolly caterpillars common on the bushes around.

Amongst other orders, one of the most interesting cases is that of certain *Diptera* or two-winged flies which mimic wasps and bees. Sometimes this likeness only serves to protect the insect from attack, by inspiring fear of a sting. But there are also a number of parasitic flies whose larvæ feed upon the larvæ of bees, as in the British genus *Volucella*; and these exactly mimic the bees, so that they can enter the nests or hives to deposit their eggs without being detected even by the bees themselves. In every country where such flies occur they resemble the native bees of the district. Similarly, Mr Bates found a species of *Mantis* on the Amazons which exactly mimicked the white ants on which it fed. On the other hand, the defenceless species itself may mimic its persecutor, as in the case of several crickets, *Scaphura*, that exactly resemble various sand-wasps, and so escape the depredations of those cricket-killing enemies. Another cricket from the Philippine Islands, *Condylodera tricondyloides*, so closely copies a tiger-beetle, *Tricondyla*, that even Professor Westwood long retained it among that group in his cabinet.

and only slowly discovered his mistake. The cases here mentioned form but a small part of all those that have hitherto been observed and described in the insect world. They amount altogether to many hundreds.

Among plants, though included in the above definition for the sake of formal completeness, instances of true mimicry are rare or almost unknown. Perhaps the nearest approach to this phenomenon in the vegetal world is found in the resemblance borne by the dead-nettle, *Lamium album*, and a few other labiates, to the stinging nettle, *Urtica dioica* and *U. urens*. The true nettles are strikingly protected from animal foes by their stinging hairs; and the general appearance of the dead-nettle is sufficiently like them to prevent human beings from plucking it, and therefore probably to deter herbivorous mammals from eating it down. Mr Mansel Weale mentions another labiate, *Ajuga ophrydis*, of South Africa, which closely resembles an orchid, and may thus induce insects to fertilize its flowers. Mr Worthington Smith has found three rare British fungi, each accompanying common species which they closely resembled; and one of the common species possesses a bitter and nauseous taste; so that this would seem to be a case of true mimicry. Many diverse instances alleged by Mr A. W. Bennett, Dr Cooke, and others cannot be considered as genuine mimetic resemblances in the sense here laid down. They are mere coincidences or similar adaptations to similar needs; and the word ought to be applied strictly to such likenesses alone as benefit the organism in which they occur by causing it to be mistaken for another possessing some special advantage of its own.

The theoretical explanation of mimicry on evolutionary principles may best be considered in connexion with the general subject of protective coloration and variation in form, of which it is a very special case. There are two ways in which imitative colouring may benefit a species. It may help the members of the species to escape the notice of enemies, or it may help them to deceive prey. In the first case imitative hues enable the animal or plant to avoid being itself devoured; in the second case they enable it to devour others more easily, and so to secure a larger amount of food than less deceptively coloured compeers. In the former instance we must suppose that such individuals as did not possess the deceptive colouring have been discovered and destroyed by enemies with highly developed sight, while those which possessed it have survived. In the latter instance we must suppose that the individuals which have no protective colouring have failed to secure sufficient prey, through too readily betraying their presence, and that only those which possessed such colouring have become the parents of future generations. It is difficult, however, to separate these two cases, and in many instances the same colouring may aid a species both in escaping its peculiar enemies and in deceiving its peculiar prey. They may therefore most conveniently be considered together.

Colour is always liable to vary from individual to individual, as we see in the case of domesticated fowls, rabbits, dogs, and other animals, as well as in most cultivated flowers, wherever natural selection cannot act to keep the typical specific hues pure and true. But in a wild state certain conspicuous colours are sure to prove disadvantageous by betraying the individual, and these will sooner or later get weeded out, under certain circumstances, either through the action of enemies or by starvation resulting from the inability to escape the notice of prey. On the other hand, certain other colours are sure to benefit the individual by harmonizing with the tints of the environment, and these will be spared by natural selection, so that the individuals possessing them will pair with one another, and will hand down their peculiarities to their descendants. In this way many species will acquire and retain a coloration that harmonizes with their environment as a whole or with some special part of it. The degree to which the protective coloration will be carried, however, must depend upon the sharpness of the senses in those other organisms which it is desirable to deceive. Large dominant herbivorous or frugivorous mammals or birds, with relatively few enemies, would not be benefited by protective coloration, and so they seldom exhibit it. The grasses or fruits on which they feed cannot make any attempt to escape them. But carnivores generally require to deceive their prey, and therefore a large number of them exhibit marked deceptive colouring. Still more especially do small defenceless birds or mammals need to escape the notice of the carnivores, and they accordingly very generally possess dull colours, because any variation in the direction of conspicuousness is certain to be promptly cut off. Above all, among insects, which are so largely the prey of birds, of reptiles, and of other animals possessing highly developed vision, protective coloration in one form or other is almost universal, except where a nauseous taste, hairy skin, or hard external coverings afford a different kind of protection. In every case the weeding out of ill-protected forms must depend upon the relative keenness of vision in the various enemies or of the prey, be they mammals, birds, reptiles, insects, or spiders. Hence the existence of protective coloring and of mimicry incidentally affords us valuable hints as to the perceptive faculties of the various classes against which each organism is thus unconsciously guarded.

Where the general aspect of the environment is most uniform, and where little but a vague impression of colour without individual form can be conveyed, the hues of animals are also usually uniform, to match their surroundings, and no special imitative adaptations of form occur. Thus, among the Arctic snows, a brown or black animal would immediately be perceived, and if defenceless at once devoured, while if a carnivore it would seldom or never approach unperceived near enough to its prey to effect a capture. Hence all such variations are at once repressed, and almost all Arctic animals, like the American polar hare, are pure white. Elsewhere bears are black or brown; in the polar region the native species is nearly indistinguishable from the snow in which it lives. Where the environment undergoes a regular change from season to season the colour of the fauna varies with it. The Arctic fox, the ermine, the alpine hare, the ptarmigan and many other birds, are all more or less brown among the brown hill-sides of autumn, and snow-white among the winter snows. Almost equally general is the sandy colour of deserts, though this, instead of being uniform, is slightly varied from grain to grain; and nearly all the birds, reptiles, and insects of Sahara exactly copy the sandy grey hue of the desert around them. Soles and other flat-fish (*Pleuronectidæ*) closely imitate the colour and speckled appearance of the sand on which they lie. The fishes and crustaceans which inhabit the sargasso weed are coloured the same yellow as the masses of algæ to which they cling. Aphides and many small leaf-eating caterpillars are bright green like the neighbouring foliage.

Where the environment is somewhat more diverse, the resemblance begins to show more specialized features. The lion, a large ground-cat of desert or rocky districts, is uniformly brown; but the tiger and other jungle-cats have perpendicular stripes which harmonize with the bamboos and brown grass of their native haunts; while the leopards, jaguars, and other tree-cats have ocellated spots which conceal them among the mingled light and shade of the forests. Large marine animals have the back black, because the water looks dark when seen from above, but their bellies are white, so as to harmonize with the colour of the surface when seen from below. Dr Weismann has shown that most edible unprotected caterpillars imitate the stripes and shades of the leaves among which they feed. Those which live upon grasses are longitudinally striped like the blades, those which live among small leaves are spotted and varied so as to resemble the distribution of light and shade in the bushes, and those which live upon large veined leaves with oblique ribs have oblique lines to harmonize with them. In some cases even the unripe berries are represented on the caterpillar by small reddish spots. A specialized form of this particular protective device is found in the chameleon, the chameleon-shrimp, many flat-fish, and some amphibians, all of which can vary their coloration to suit that of the surface on which they rest. The action is reflex, and ceases if the animal is blinded.

Where the environment is very varied, as in tropical forests, we find the greatest variety of colouring as well as actual imitation of particular forms; and the protective resemblances become at once closer and more common. Birds, reptiles, spiders, monkeys, and other active predaceous creatures are constantly hunting for insects and similar small prey amongst the fallen sticks or leaves; and among the most powerless classes of insects only those which very closely resemble specific objects in the environment can easily escape them. A gradual passage can be traced from the most general to the most special resemblances under such circumstances. Many forestine birds have a ground-tone of green in their plumage, which occurs nowhere but in the tropics. Some tree-lizards are green like the leaves on which they sit, others are marbled to resemble the bark where they lie in wait for their prey. Arboreal snakes often hang like lianas or other creepers. Insects which cling to the trunks of trees can seldom be distinguished from the bark. A Sumatran butterfly, *Kallima paralecta*, always settles on dry bushes among dead leaves, and can then hardly be perceived among the brown foliage, which it imitates even in the apparent blotches and mildew with which its wings are covered. The family of *Phasmidæ*, including the leaf and stick insects, carries such forms of imitation very far indeed. Most of them are large, soft, defenceless creatures; but some, like *Phyllium*, closely resemble green leaves, so as to be almost indistinguishable while feeding; and others exactly imitate short broken twigs of bamboo. Mr Wallace found one such insect, *Ceroxylus laceratus*, in Borneo,

apparently overgrown with a creeping moss or jungermannia; and Mr Belt discovered a larval form in Nicaragua whose body was prolonged into thin green filaments, precisely like the moss in which it lurked. In other instances the insect probably uses its disguise rather to deceive its prey than to escape its enemies. Sir Joseph Hooker believes that an Indian *Mantis* deludes the little creatures which form its food by its singular likeness to a leaf; while Sir Charles Dilke found one which had its head and fangs moulded into the deceptive appearance of an orchid, so that small flies were actually attracted in search of honey into its very jaws. Outside the class of insects, similar phenomena sometimes occur. Thus, according to Mr Bates, many showy little tropical spiders double themselves up at the base of leaf stalks so as to resemble flower buds, and thus delude the flies on which they prey. Even among the vertebrates Mr Belt mentions a green Nicaraguan lizard looking like the herbage by which it is surrounded, and decked with leaf-like expansions, which hide its predaceous nature from passing beetles or butterflies.

These last instances are divided from true mimicry by a very narrow line. But they differ in the fact that some vague object only in the general environment is simulated, not a particular protected species, as in genuine mimetic resemblance. If we allow, however, that natural selection can produce the white colour of Arctic animals, and the sandy hue of the sole and the flounder, it is easy enough to extend the same principle to the leaf-insect and the stick-insect, or even to real mimicry, as in the case of the *Leptalis* and the *Heliconidæ*. Certain *Phasmidæ* may at first have varied in the direction of green coloration, and these would naturally escape the eyes of birds more readily than their fellows. After the lapse of many generations, all the *Phasmidæ* of that special group would have become green, and the birds which preyed upon them would have learned in many cases to penetrate the disguise; for, as Mr Belt has observed, each fresh deceptive resemblance in the prey is sure to be followed by increased keenness of discrimination in the enemies of the species. At this stage the ordinary green *Phasmidæ* would often be killed, while only those which happened to approximate rudely in the venation of their wings to leaves would now escape the sharper and more experienced eyes of the birds. Thus step by step the disguise would become more and more perfect, only the best-protected of each generation escaping on the average, while all the worse-protected would be discovered and devoured. Given the usual luxuriance of tropical life, it is not difficult to understand how favourable variations might continually occur, until at length we get such perfect deceptions as those of the leaf-insects, the stick-insects, and the moss-grown larvæ.

The phenomena of true mimicry may be explained by a parallel genesis. Suppose, to begin with, a group of large and brilliant butterflies like the South-American *Heliconidæ*, protected by a nauseous taste and odour, and therefore never eaten by birds. To such insects slow flight and conspicuous hues are a positive protection, because they enable birds readily to discriminate them, and therefore prevent attacks, just as the banded body of the wasp and the hum of the bee prevent us from catching and killing them upon a window pane. Suppose, again, that in the same district there lives a widely different species of edible butterfly presenting some very slight and remote resemblance to the protected species. At first, no doubt, the resemblance will be merely an accidental one of general hue; it may even be so slight as to deceive nobody except upon the most distant and casual glance. Now, suppose these edible butterflies to be devoured in large quantities by birds, then a few of them may happen to gain safety by associating with the flocks of inedible butterflies which the birds refuse. After a time, even if the habit of consorting with the protected species becomes fixed in the race, the birds will begin to recognize the edible insects amongst the flocks, especially such as vary most in the opposite direction from the protected species. On the other hand, they will overlook such as vary most in the same direction as the inedible kind; and thus the least mimetic individuals will be destroyed, while the most mimetic will be left to pair with one another and to produce young, most of whom will present the like peculiarities. From generation to generation the birds will go on picking out every bad copy, and sparing all the best ones, till at last the two species become absolutely indistinguishable upon the wing. But the mimicry will never of course affect any but the most external and noticeable parts of the organism; it will be to the last a mere matter of colour, shape of wing, visible appearance of legs or antennæ, and so forth. The underlying structural differences will remain as great as ever, though externally masked by the deceptive resemblance in form and hue.

In like manner we may explain the genesis of the mimetic resemblance borne by *Volucella* to the humble bee. Suppose an undisguised fly to enter the bees' nest, it would be at once attacked and killed. But if it presented some very slight resemblance to the bee it might manage to lay its eggs undisturbed, and its larvæ would then be able to feed quietly upon the larvæ of the bee. With each new generation the more flimsy disguises would be more and more readily detected, and only those flies which varied most in the direction of resembling the bees would survive or lay their eggs in peace. On the other hand, those which actually succeeded would possess great advantages over their neighbours, because their larvæ would thus obtain a safe and certain supply of food, and be guaranteed the protection of the bees' nest. In this way the flies would at last, by constant survival of the best-adapted, come exactly to imitate the bees amongst which they lived.

The theory of the origin of mimetic forms thus briefly sketched out is due to Mr Bates and Mr Wallace, and it explains all the facts more fully than any other. It shows us, first, why the mimicking organism always imitates a specially protected species; secondly, why the two always inhabit the same district; thirdly, why the mimicking species is always much rarer than the species mimicked; fourthly, why the phenomenon is confined to a few groups only; and fifthly, why several different mimicking species often imitate the same protected form. It also accounts for the absence of mimicry amongst large or dominant animals, and its comparative commonness amongst small and defenceless kinds. And by affiliating the whole of the phenomena upon the general principles of protective colouring it reduces a seemingly strange and marvellous fact to a particular case of a well-known law.

Whatever theory be adopted, however, the facts and most of their implications remain the same For, whether we suppose these imitative resemblances to be due to direct creative design or to survival of favourable variations, it is at least clear that the disguise subserves a function—that it is purposive and not accidental. Hence we may draw from the phenomena of mimicry certain important psychological implications. On the hypothesis of evolution, it is obvious that the mimicry can never go further than the senses of the creatures against whom the disguise is advantageous would naturally carry it; and even on the hypothesis of special design it is not likely that the imitation would be made more accurate than would be necessary for practical purposes of deception. There is much evidence in favour of this view. Mr B. T. Lowne, for example, who has carefully measured the curvature of the facets in the compound eyes of insects, upon which depends the minimum size of apprehensible objects, finds that the mimicry in the case of the flies parasitic upon bees' nests has proceeded just so far as the structure of the bee's eye would lead us to expect, and no further. In other words, so far as measurements of angular distance subtended can guide us, such a fly seems to be absolutely indistinguishable by a bee from one of his own species, within the limits of ordinary vision. The pictures cast upon the sensorium by the fly and by a brother bee are simply identical. In many other cases it can be shown that the mimicry seems specially intended to deceive the eyes of a particular class of animals; while there is no case of mimicry where the only enemies or prey consist of plants or eyeless animals. Naturally there can be no mimicry without a creature to deceive; the very conception implies an external nervous system to be acted upon, and to be acted upon deceptively. Thus mimicry in plants must have reference to the eyes of animals, in animals themselves to the eyes of one another. We may conclude, accordingly, that if a leaf-insect is green with faint violet-brown veins to the wings, exactly like a certain leaf, in order to deceive sundry tropical birds, then those birds are capable of perceiving the forms and colours imitated to that particular degree. So the presence of mimicry in any group may guide us to a rough idea of the perceptive powers of those creatures whom the mimicry serves to deceive. The exact imitation of sand and coloured pebbles in the flat-fish is a fairly safe indication that the predaceous fish by whose selection they have been developed (through the weeding out of ill-protected variations) can pretty accurately distinguish form and colour. The long green pipe fish which cling around green sea-weed have probably acquired their existing hues to deceive the eyes of small sharks; the *Phyllopteryx eques*, a hippocampus which looks precisely like a piece of tangled and waving fucus (see figure, vol. xi. p. 852), has doubtless in the same way taken on its delusive likeness to the algæ among which it lives. So the cricket which resembles its foe the sand-wasp must have gained its present shape and hue by deceiving its enemy, and therefore it suggests the probability of highly developed vision on the part of the wasps. There seems every reason to believe that in many instances insects, spiders, and even lizards have developed mimetic or other deceptive resemblances in order to delude the eyes of insects; while in other cases the disguise has been unconsciously adopted to deceive fish, amphibians, reptiles, birds, and mammals. Moreover, we have some grounds for believing that the sense of colour is exceptionally strong in birds and in one or two insect orders; and the mimicry of colour seems to have proceeded to the greatest length amongst animals which are most exposed to the attacks of these classes, or which would find it advantageous to deceive them. It may be added that these same classes have been most effective in producing the bright hues of flowers and fruits, on Mr Darwin's hypothesis, or are at least in any case most intimately correlated with such vegetable structures as fertilizers of blossoms and dispersers of seed. Mimicry is thus to some extent a rough gauge of the perceptive faculties of the species deceived by it.

The vocal mimicry which occurs among certain birds, such as the mocking-bird, starling, parrot, and bullfinch, must of course be placed in a wholly different category from these biological cases. It is a direct volitional result, and it is mimicry in a literal not in a figurative sense. The faculty seems to be due to the play-instinct alone, and not to subserve any directly useful function. (G. A.)

MIMNERMUS, a Greek elegiac poet, born at Smyrna, lived about 600 B.C. His life fell in the troubled time when the old Greek city of Smyrna was struggling to maintain itself against the rising power of the Lydian kings. One of the extant fragments of his poems refers to the struggle and contrasts the present effeminacy of his countrymen with the bravery of those who had once defeated the Lydian king Gyges. The poet mentions in another fragment that he belonged to the stock of the Colophonians who had seized the Æolic Smyrna. But his most important poems were a set of elegies addressed to a flute-player named Nanno; they were collected in two books called after her name. Hermesianax mentions his love for Nanno, and implies that it was unfortunate. Only a few fragments of these poems have been preserved; and their soft melancholy tone and delicate language give some idea of the poet's character. His ideal is the sweet soft luxurious Ionian life, and he would enjoy it free from sorrow and die as soon as he could no longer enjoy it. Yet there is apparent some of the old stronger strain of character which in early time raised the Ionian cities to greatness, pride in the glories of his race and scorn for those that are unworthy of their fathers' renown. His experience of life was evidently sad; he felt that his country was gradually yielding to the enemy it had once defeated, and he knew that his own hopes were disappointed. The sun himself has endless toils from rising to setting and again from setting to rising. The life of man is as transitory as the leaves of spring, he says, referring to a passage in the popular epic poetry of Ionia (*Iliad*, vi. 146). He wishes to die in his sixtieth year, a wish to which Solon replied bidding him reconsider and rather long to die when he was eighty years old. Mimnermus was the first to make the elegiac verse, which had previously had more of the epic character, the vehicle for love-poetry, and to impart to it the colour of his own mind. He found the elegy devoted to objective themes; he made it subjective. He set his own poems to the music of the flute, and the poet Hipponax says that he used the melancholy νόμος Κραδίας. He bears the epithet Λιγυαστάδης, by which Solon addresses him. It is doubtful whether this epithet is peculiar to himself or whether it marks him as belonging to a musical and poetic family or school; it is evidently akin to the epithet λίγειαι Μοῦσαι.

MIMOSA. The *Mimoseæ* (so named from their mimicry of animal movements) form one of the three suborders of *Leguminosæ*, and are characterized by their (usually small) regular flowers and valvate corolla. Their 28 genera and 1100 species are arranged by Baillon in four series, of which the acacias (see ACACIA) and the true mimosas are the most important. They are distributed throughout almost all tropical and subtropical regions, the acacias preponderating in Australia and the true mimosas in America. The former are of considerable importance as sources of timber, gum, and tannin, but the latter are of much less economic value, though a few, like the talh (*M. ferruginea*) of Arabia and Central Africa, are important trees. Most are herbs or undershrubs, but some South-American species are tall woody climbers. They are often prickly. The roots of some Brazilian species are poisonous, and that of *M. pudica*, L., has irritating properties. *M. sensitiva* has been used in America in the treatment of fistula, &c., probably as an astringent. The mimosas, however, owe their interest and their extensive cultivation, partly to the beauty of their usually bipinnate foliage, but still more to the remarkable development in some species of the sleep movements manifested to some extent by most of the pinnate *Leguminosæ*, as well as many other (especially seedling) plants. In the so-called "sensitive plants" these movements not only take place under the influence of light and darkness, but can be easily excited by mechanical and other stimuli. When stimulated, say at the axis of one of the secondary petioles, the leaflets move upwards on each side until they meet, the movement being propagated centripetally. It may then be communicated to the leaflets of the other secondary petioles, which close (the petioles, too, converging), and thence to the main petiole, which sinks rapidly downwards towards the stem, the bending taking place at the pulvinus, or swollen base of the leafstalk. See BOTANY, vol. iv. p. 113, fig. 117. When shaken in any way, the leaves close and droop simultaneously, but if the agitation be continued, they reopen as if they had become accustomed to the shocks. The common sensitive plant of hot-houses is *M. pudica*, L., a native of tropical America but now naturalized in corresponding latitudes of Asia and Africa; but the hardly distinguishable *M. sensitiva* and others are also cultivated. The common wild sensitive plants of the United States are two species of the closely allied genus *Schrankia*.

MINDANAO, MINDORO. See PHILIPPINE ISLANDS.

MINDEN, the chief town of a district of the same name in Prussia, province of Westphalia, is situated about 22 miles to the west-south-west of Hanover, on the left bank of the Weser, which is spanned there by two bridges. The older parts of the town retain an old-fashioned appearance, with narrow and crooked streets; the modern suburbs occupy the site of the former fortifications. The most interesting building is the Roman Catholic cathedral, the tower of which, dating from the 11th century, illustrates the first step in the growth of the Gothic spire in Germany. The nave was erected at the end of the 13th century, and the choir in 1377–79. Among the other chief edifices are the old church of St Martin; the town-house, with a Gothic façade; the extensive court-house; and the Government offices, constructed, like many of the other buildings, of a peculiar veined brown sandstone found in the district. Minden contains a gymnasium and several hospitals, besides other charitable institutions. Its industries include linen and cotton weaving, dyeing, calico printing, and the manufacture of tobacco, leather, lamps, chicory, and chemicals. There is also some activity in the building of small craft. In 1881 107 vessels of an aggregate burden of 12,569 tons entered and cleared the river-harbour of Minden. The population in 1880 was 17,869.

Minden (Mindun, Mindo), apparently a trading place of some importance in the time of Charlemagne, was made the seat of a bishop by that monarch, and subsequently became a flourishing member of the Hanseatic League. In the 13th century it was surrounded with a wall. Punished by military occupation and a fine for its reception of the Reformation in 1547, Minden underwent similar trials in the Thirty Years' War and the wars of the French occupation. In 1648 the bishopric was converted into a secular principality under the elector of Brandenburg. From 1807 to 1814 Minden was included in the kingdom of Westphalia, and in the latter year it passed to Prussia. In 1816 the fortifications, which had been razed by Frederick the Great after the Seven Years' War, were restored and strengthened, and as a fortress of the second rank it remained the chief military place of Westphalia down to 1872, when the works were finally demolished. At Todtenhausen, 3 miles to the north of Minden, the allied English and German troops under the duke of Brunswick gained a decisive victory over the French in 1759. About 3 miles to the south of Minden is the so-called "Porta Westfalica," a narrow and picturesque defile by which the Weser quits the mountains and reaches the plain.

Minden is not to be confounded with the Hanoverian Münden, also sometimes written Minden (population 6355), at the confluence (*Mündung*) of the Werra and Fulda.

MINE. See MINING.