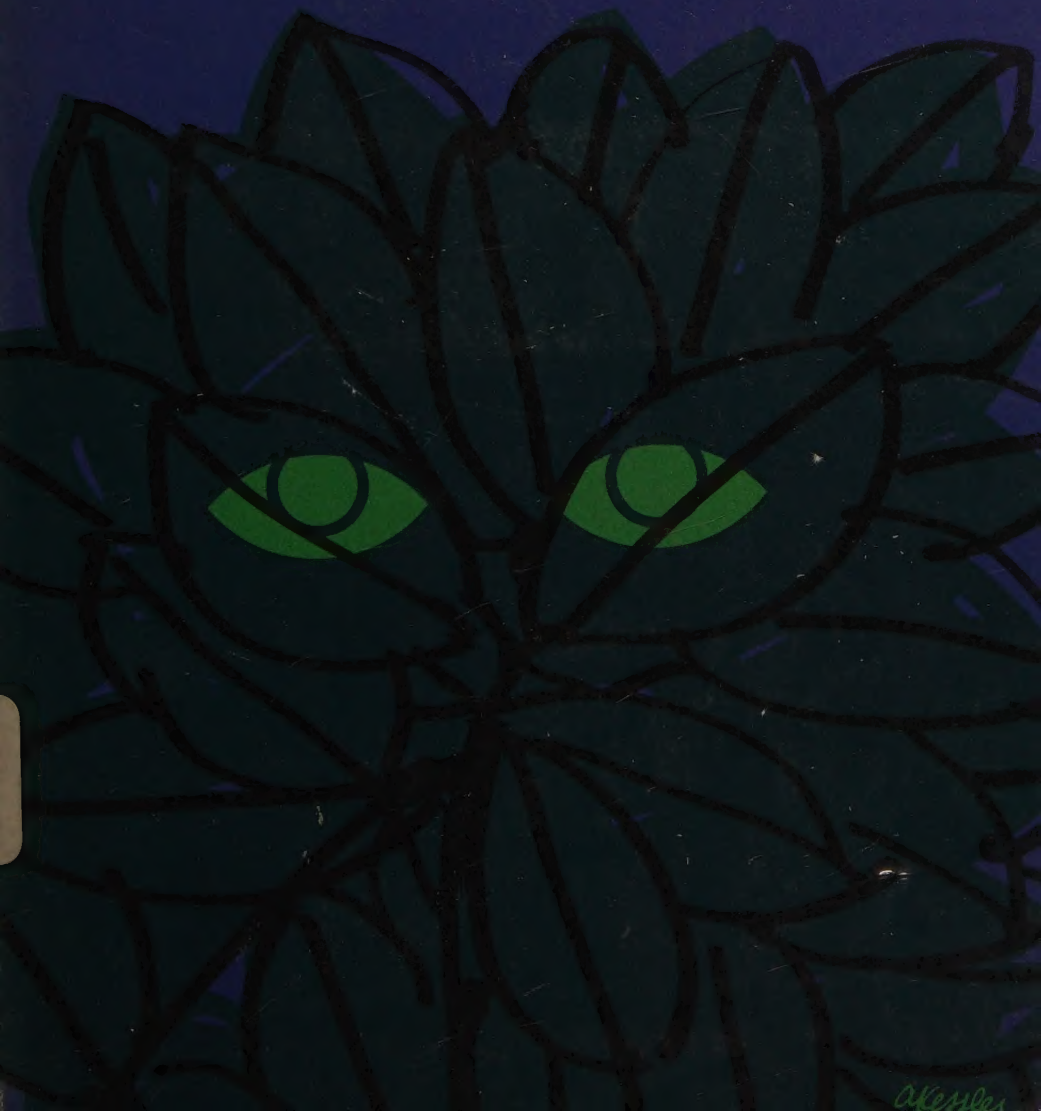
THE MASK OF MEDUSA

BY ROGER CAILLOIS

TRANSLATED BY GEORGE ORDISH

A brilliant and suggestive study of the relationship and contrast between insect and man as suggested by mimicry, disguise, and camouflage in nature.



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This is a daring and provocative study of natural history and aesthetics that cuts across many scientific disciplines and considers some strange parallels between the world of man and insects.

Between the myths of man, and the behavior, and even the anatomy, of certain insects fascinating parallels suggest themselves. Can there be a hidden relationship between apparently unconnected phenomena such as the strange sexual habit of the female praying mantis, who devours the male during copulation, and the exceptional interest taken in this insect by primitive peoples, who usually regard it as divine or of the devil?

(Continued on back flap)

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ROGER CAILLOIS

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I am most grateful to Miss Melba Kershaw for assistance in preparing the English edition of this book.

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THE PROBLEM

DIAGONAL SCIENCES

THE ADVANCEMENT OF knowledge is partly brought about by penetrating beyond superficial resemblances to uncover the deeper relationships between things, which, though less obvious, may be more important and significant. In the eighteenth century, books were published in which animals were classified according to the number of their legs, so that the lizard found itself alongside the mouse, zoologically speaking. Today, the former is put in the same family as the snake, which has no legs at all but which, like the lizard, lays eggs and is covered with scales. These characteristics are now known to be more important than the one that first impressed us—the number of legs. By the same token, we know that, despite appearances, the whale is not a fish, nor the bat a bird.

I have deliberately cited elementary and irrefutable examples. But as soon as one studies, however cursorily, the history of the sciences, one is struck by the countless traps which the scientist must constantly avoid in order to identify the different phenomena which set the limits of each scientific discipline.

What is more, these traps, these deceptive similarities, are not just shams or sketchy resemblances. They are genuine likenesses which, in the end, are found to be of less significance than certain others. It is true that, in common with the mammals they are not, the lizard and the tortoise have four legs, and the bat, which is not a bird, has wings.

The secret of classification, then, is to pick out the key

characteristics which different creatures have in common. The similarities which are ignored are not, strictly speaking, false; but they fit into classifications which would, sooner or later, end in difficulties and inconsistencies.

It should, however, be pointed out that, for certain purposes, these subsidiary or disregarded features may become important once more. If, for instance, I want to study the action of wings, it is clear that I must take into account bats, birds and butterflies, in fact all winged creatures, whatever the reasons (valid, one must admit) which led to their being classified in different families —invertebrate Lepidoptera, vertebrate birds, etc.

Should I wish to study some particular aspect of wing action, for example hovering, where a creature, by vibrating its wings, remains suspended motionless in the air, I cannot do other than consider animals which belong to widely separated species—the humming-birds and the *Macroglossus* sphingids (the humming-bird hawk-moths)—which hover above flowers, using the same wing action, and which feed themselves from this position through their long thin beaks or suction probes.

Everyone admits the legitimacy, the necessity even, for this approach to the study of particular problems. When one looks closer, however, one sees that it is only considered permissible within the limits of any one discipline or of any one kingdom of living things. In effect the sciences correspond to the kingdoms and their classification is but a copy of the fundamental divisions in nature. From this arises the tacit disapproval of any attempt to relate phenomena belonging to different "kingdoms" and consequently to different sciences. A sort of reflex action makes the scientist regard as almost sacrilegious or, at the very least, wildly foolish any attempt to compare, for instance, the healing of wounded living tissue with that of the regrowth (in their mother

liquor) of damaged crystals. However, it is a fact that crystals repair damaged parts, just as do living organisms, and that the area affected is the scene of increased activity which tends to make good the damage and to restore the harmony and shape destroyed by the original disturbance.[1]

Is this not simply a false analogy, a metaphor, pure and simple? However this may be, it is certain that a burst of activity restores the original appearance in the mineral as in the animal. I know as well as anyone else the immense gulf that separates living from non-living matter. But I see it as a possibility that both kinds of matter may have properties in common, such as a tendency to become whole again after being damaged. I can think of nothing more likely to defy any attempt to relate them to each other than a nebula, holding thousands of worlds, and a shell secreted by a seashore mollusc. Nevertheless both obey the same law of spiral development. Nor does this surprise me, for the spiral form fulfils two fundamental laws of the universe, symmetry and growth; it combines order with expansion. It is almost inevitable that animals, plants and stars should all equally be bound by these laws.

[1] See the Mémoire de Pasteur, 1857 in the *Annales de Chimie et de Physique* (3e série, XLIX, pp. 5-31): "Il résulte de l'ensemble de ces observations (accroissement des cristaux de bimalate d'ammoniaque) que, quand un cristal a été brisé sur l'une quelconque de ses parties et qu'on le replace dans son eau-mère, en même temps qu'il s'agrandit dans tous les sens par un dépôt de particules cristallines, un travail très actif a lieu sur la partie brisée ou déformée; et en quelques heures il a satisfait non seulement à la régularité du travail général sur toutes les parties du cristal, mais au rétablissement de la régularité dans la partie mutilée." De façon très significative, Pasteur aperçoit le rapprochement possible avec la cicatrisation des plaies, mais sa prudence le conduit à noter le fait, sans prendre parti: "Beaucoup de personnes aimeront à rapprocher ces faits curieux de ceux que présentent les êtres vivants lorsqu'on leur a fait une blessure plus ou moins profonde. La partie endommagée reprend peu à peu sa forme primitive, mais le travail de reformation des tissus est, en cet endroit, bien plus actif que dans les conditions normales ordinaires." Quoted by J. Nicolle, *La Symétrie dans la Nature et les Travaux des Hommes*, Paris, 1955, p. 75.

The opposition between right and left is found throughout nature, in everything from quartz and tartaric acid to the snail's shell (which, with few exceptions, turns to the right) and so on until we reach man, in whom the right hand predominates. This contrast is built into the very structure of matter, just as it is found in the anatomy of living things. In 1874 Pasteur thought he could explain the phenomenon by ascribing it to some cosmic influence or to the movement of the earth. The mystery, however, remains unsolved. In the circumstances one may reasonably hazard a guess that the answer, whatever it turns out to be, will be the same for all the very different cases found in chemistry, crystallography, zoology, sociology and the history of religion. It may apply even to art and the theatre, for neither in a picture nor on the stage is equal emphasis placed on things depicted on the right and left. Similarly one identical, organic law should explain the symmetrical pattern of rays common to sea-urchins, certain crystals and flower petals. On the whole keyboard of the natural world many such compositions are being played and he would be a rash man who would maintain they were meaningless, serving only to conjure up dreams and powerless to inspire rigorous scientific research.

Man, by a thousand triumphs, by eluding a thousand cunning traps, has unquestionably classified the attributes of the natural world into a system at once the most fruitful, the most rational and the most exact. But this arrangement by no means exhausts all the different possible combinations. It ignores the "diagonal" relationships in nature which occur in those domains apparently least related and of which I have given a few modest examples. Such procedures come into strong conflict with our current system of classification. Science has been the less able to countenance them since, by definition, they cross the boundaries between disciplines.

Moreover, if they are to be brought to light, it is necessary to relate observations from widely separated sciences, of which the most distinguished students are specialists, living, almost necessarily, in ignorance of each other's work. It might well be that such transverse studies would play an essential part in our understanding of those phenomena which, by themselves, always appear exceptional but of which the significance would be much more readily seen if one dared assemble these exceptions, examine them and see if their mechanisms were related.

Everyone remarks on and deplores the extreme specialisation of science while at the same time recognising that this is the price of progress. It is useless to rail against a state of affairs the recognition of which is today a prerequisite of any attempt at reform. Men who are working to extend knowledge can no longer communicate with each other; at times they do not command a broad enough view of their own field of research to be able to place in its right context a detail which baffles them. Scientific progress always used to and certainly should stem from a central point. The time has come to make an attempt to join the various points of an unduly large circumference by putting in the necessary internal lines of communication, or the risk will continue to grow that each scientist will dig only in his own field like a blind and obstinate mole; in some cases, one might add, obstinate because blind.

The facts to be brought together are by no means obvious. It is clear that we do not want to return to superficial analogies; science freed herself from these when she set up our present system of knowledge, which is methodical, subject to controls and capable of improvement.

From this point of view the dreams of the medieval philosophers and of the learned men of the Renaissance represent a lure all the more dangerous because, respond-

ing to an ever-present need of the soul, today held vigorously in check, they seemed to offer a quick and fascinating answer to those attracted in advance by the plausibility of their propositions. The tables of concordance in which a Paracelsus arranged natural phenomena are no longer acceptable, any more than is the analogous science, essentially visual, of which Leonardo dreamed, drawing a head of hair like a river, a mountain like a draped cloth. "He did not want," notes a commentator,[1] "to establish a relationship between immense concepts, but, as he said, *transmutarsi nella mente di natura*, to put himself into the mind of nature to find out how she works." So much so that he conceived a new kind of living organ in much the same way that a technician invents a new machine. Now insects alone, in blind and mechanical obedience to the laws of another kingdom, have "learned" how to incorporate into their bodies other organs which are the equivalents of machines. The mechanical and the living obey two opposed principles, between which no exact comparison is possible but where ordinarily some correlation should exist because both tool and living organ are destined to do the same work. Whether for this reason or another, all Leonardo da Vinci's genius was not enough to enable him to design a single machine that worked: his aircraft are too much like birds and his submarines practically have gills. He never thought of replacing the wing, i.e. the organ, by the propeller, i.e. the machine. Like Goethe later, Leonardo was always looking for prototypes of phenomena. In his researches he was wrong to make use of the senses alone, above all the sense of sight, which is most easily deceived. This was to do the work of a painter, a poet, not of a scientist, for the true task of the latter is quite the contrary: it is to find hidden

[1] Robert Klein, postscript to *La Civilisation de la Renaissance en Italie*, by Jacob Burckhardt, Paris, 1958, p. 30.

relationships, invisible to and unimaginable by the layman. It is only rarely that such correlations appear obvious, logical or likely. On the contrary these connections link together phenomena which at first sight seem to have no common basis. They unite unexpected features in groups of things with apparently little in common but which obey the same laws, are subject to the consequences of the same principle and respond to the same challenge. The complex relationships of the processes of an entire economy of life (in short its ecology) will not be uncovered by naïve separate investigations, though a unifying principle will always be there, the same throughout. It is this principle that must be found.

Scholars, who know a lot in a limited field, are rarely in a position to perceive a type of relationship which only an expert in many fields is able to establish. Mostly it is chance, allied to a certain boldness of imagination, which puts us on the road to this type of discovery. Meetings of scientists from different fields of study but curious about developments in other fields, eager to compare results, methods and difficulties, would serve equally well to multiply the opportunities for unmasking these relationships which are still to be uncovered and which for the moment I shall call the transverse factors in nature. Finally, it is probable that a small number of research workers allotted to the *ad hoc* study of phenomena now straddling the boundaries of many traditional sciences would be the best placed to find correlations neglected up to now but able to complete the network of those already established.

It is time to try our luck with *diagonal sciences.*

ANTHROPOMORPHISM

PRACTICALLY ALL THE arguments in this small book can be challenged with a single word; "anthropomorphism". This name is given to a tendency to endow all beings and things with the feelings, emotions. reactions, cares, ambitions and so on appropriate to man. It is obvious that this is a dangerous temptation which must be carefully guarded against. Yet it seems to me that such caution has its drawbacks; I am inclined to think of it as a double-edged weapon. Indeed if this mistrust becomes hidebound the slightest analogy with human behaviour is immediately tainted with suspicion and, from prejudice and in order to avoid the reproach of anthropomorphism, a different, alien, explanation is sought which offers no link with the nature and customs of man. Is not this going rather far? Does not this isolate man unduly, under the pretext of not projecting on to another species, or on to other kingdoms of nature, what seems to belong to him alone?

Man is an animal like the others, his biology is that of the other living things; he is subject to all the laws of the universe; those of weight, of chemistry, of symmetry and all the rest. Why suppose that to claim to find elsewhere the characteristics of his nature, or, on the other hand, to rediscover in him the laws that one sees operating in other species, is necessarily cranky, delusion or a mirage? All the odds are in favour of continuity. It seems to me that to exclude man from the universe and to deny his subjection to universal laws is, if not anthropomorphic, still anthropocentric. A negative

anthropocentricism, but as pernicious as its opposite form, which places him at the centre of the world and evaluates everything in relation to him. Two effects from the same cause—vanity.

Therefore, while agreeing that it behoves one to be circumspect and on one's guard against deceptive similarities which do not take into account the context and the overall perspective of things, I suspect that the accusation of anthropomorphism ends, in the long run, in isolating man in the universe and in refusing to admit that the other creatures are in the remotest way connected with him and, in some respects, his brothers. There is more real anthropomorphism, more presumption in any case, putting aside just superficial analogies, in denying in advance any deep relationship than in accepting the inevitable consequences of a common background. These cannot fail to show themselves, always in strange ways, often opposite ways, but where they do it is possible to uncover the fundamental related factors.

MAN RESTORED TO NATURE

THE PRAYING MANTIS

IN A STUDY I made twenty years ago on the praying mantis, I tried to establish a relationship between certain facts which were apparently and perhaps in reality unrelated: the sexual habits of the female mantis which devours the male during copulation; the exceptional interest that man has in this insect, which he regards as divine or as devilish almost everywhere he finds it, whether in Provence, in Greece, in Southern Africa. The interest springs from terror to which numerous myths or obsessions bear witness, e.g. tales in which a woman possessed by the devil swallows, kills or mutilates her lover at the very moment of union.

When the study was done it seemed for the moment convincing. I refused to believe in coincidence. I thought there was some connection between the behaviour of the insect and these beliefs of man. I went even further. For if I opposed the hypothesis of a chance similarity I had to find a more suitable explanation, better argued and more coherent. To postulate a coincidence is always second-best if not an admission of failure. To resort to it with resignation is to give up the struggle. It means you have found an anomaly and have not explained it. But I was looking for a law, a norm, a universal key to the situation. I did not hesitate, then, nor should I have done, to explain man's fascination with the insect by the prescience of a relationship between two things. It seemed to me that in man, in the above case, the terror released by this dark fantasy replaced an implacable and fatal reflex action.

I recalled that science readily shows man and insect to be the two opposed poles of biological evolution. The forms taken by life become more and more complex. It is true they develop along paths which become separated and incompatible. But my tentative postulate was that *complexity itself creates certain relationships*, implying parallel responses to similar situations. At the end of the longest chains of evolutionary development, where creatures seem to be the result of a great persistence of change in one direction, may be found two very diverse worlds—that of man and that of the insects: these are the only two realms to recognise that new dimension for the species which the existence of societies represents —the organisation of a life in common, with its many restrictions and hitherto unknown devices, for instance the need for a language, or rather, of a means of communication.

This is not to say, then, that all opposition has been abolished. It is needed, especially in the case of language. The bee's dance, which informs her companions of the distance and direction from which the load has been collected, constitutes without any doubt, in the place of language, a body of conventional correlation between the sign made and the information to be conveyed, in fact sign language. Like human language, these correlations between sign made and meaning are used and understood within a community. However it is a matter of a code of signals, fixed and unchanging, which cannot be answered and which precludes discussion, misunderstanding, change and the creation of whole dictionaries of words and genuine syntaxes.

The same contrast is seen in the nature of these different societies: that of the insects has a form fixed thousands of years ago, not only static in itself but prompt to make good any disturbance to its equilibrium by automatic regulation of its processes. The genetic in-

heritance ensures that the society has an unbreakable continuity. Castes are determined by feeding and become apparent in the very anatomy of the creature. When the proportion of the different castes becomes upset, either by accident or design, the larvae in the nest go back to a less developed state, one might say to the first cross-roads, and take another road: they thus develop into castes able to fill the vacancies and restore the old and ancient *status quo*. With man, on the other hand, there is a constant confusion, directed to some extent perhaps but where nothing happens twice. One word epitomises this succession of chance occurrences —*history*. And this history which develops erratically, always along new and unknown paths, does not stop man's imagination from being obsessed by cycles, by the nightmare of the *Eternal Return*, by the menace of a cyclical future where all starts yet again without progress, without end: *this picture is suggested by the return of the seasons and the generations of animal life.*

We must admit there is a decided difference between these worlds, not in the least obscure or doubtful. It has been known for a long time. The life of insects is one actuated by instinct, by mechanical and inevitable responses to circumstances; that of man is one of imagination and, as a result, of freedom: a world where the individual has acquired the power to refuse immediate and blind response to a mechanical stimulus. Instinct does not act except through the *interposed image*. Certainly an image of this kind, full of potential power, is not without effectiveness: it fascinates, like, it has been said, a "developing hallucination". But still it is only an image, an external representation, that can be struggled against, modified or driven out. However despotic it may appear it will at least allow one to hesitate, even to think over the matter, even if the thought be frightening or enslaving. What was an absolute mechani-

cal and immediate response becomes no more than an impulse, an *idée fixe*, reminiscence or fantasy.

This basic opposition can and should be agreed to without too many scruples by everyone. It is the result of innumerable observations. But if its general trend is hardly arguable, how to draw satisfactory conclusions from it is not so easily seen. Between the two series of data the gulf is too big for any verification in depth. Thus the parallel I have just established between the habits of the mantis and human myths runs the risk of being considered more as an ingenious play of the mind or as a kind of shameful or dissembling story. In fact at the time my study appeared many people did not hesitate to say that they considered it only of value from an autobiographical point of view.

I agree. Moreover if I did not I would only take away credit from my hypothesis, for then everyone could ask by what miracle it was that I was free from the hereditary mythology which I maintain affects the whole species. On the contrary if the accusation is just it gives weight to my conjecture. If I am a victim I am also a proof in my turn, but if I am unscathed there might be grounds for an objection. For it is true that I have not invented any of the many facts I have assembled, the convergence of which leaves one more perplexed than one would wish. However, while I could only find one example of this sort of almost unverifiable correlation in support of my theme it was difficult to convince those who held it to be just simple coincidence. For, of course, there are such coincidences: a fair number of them. It is only from the point where one finds too many that it becomes important to consider that the similarities found are not just due to pure chance. I decided I must accumulate examples similar to that of the mantis, of the same kind and with the same significance, which would reinforce each other. If not I had no way of demonstrating that

my theory was nothing more than a personal dream, or a mere chance resemblance.

To the theory of the mantis, in connection with the making of myths in man and the action of instinct in insects as opposed and corresponding things, I now add two more theories yet more daring. The first deals with butterfly-wings and studies the relationship between the aesthetic in nature and human art. The second concerns mimicry. It is presented under three different aspects each having their counterpart in man. They are disguise (mimicry proper), camouflage and intimidation. The myths of metamorphosis and the love of disguise speak for mimicry: the legends of the cap or cloak of invisibility for camouflage: the fear of the evil eye and of the Medusa stare, the use man makes of masks, mainly, though not exclusively, in the so-called primitive societies, compare with the intimidation produced by the ocelli on insect wings and completed by the frightening appearance or mimicry of certain insects.

In each case there is the same contrast between insect and man, between a mechanical response and freedom of action, between fixity and history. I know quite well that each one of these parallels, taken by itself, could be considered one of those deliriums which characterise mad logic. But it must also be allowed in return that the convergence of so many different factors brings with it some doubt as to the correctness of a verdict as sweeping and precipitate as this. It suggests that revision be considered and that the enquiry be generalised. The world of insects should be considered along with that of man. I shall not tire of saying: they are both part of the same world.

PATTERNS OR DRAWINGS

BUTTERFLY WINGS

THE WINGS OF butterflies and moths, their shape, patterns and colours, continue to be a sort of eternal enigma. I do not think anyone really knows the purpose of so much splendour. It is possible that the colour is of use but not the pattern (with one exception).[1]

The lungs of butterflies are contained within a narrow and rigid framework. In order to fly, these creatures need an additional respiratory surface, which the extended wings provide, and thus serve to absorb oxygen and light. Both are more easily obtained the darker the wings are. I agree. But once more, why the patterns? Plain wings, of the shade suitable to supply the insect with energy, would serve as well or better and I dare say with greater economy of effort. Of course it is affirmed that the striking or soft colours are useful in both cases: the soft colours to make the insect invisible and confuse it with its background, the striking colours to act as obliterating colouring, that is to dazzle the retina of a predator just that fraction of a second which is enough to ensure the escape of the insect. But the patterns are not explained by this. A vivid colour, all over, without a pattern, that the escaping insect shows and then immediately hides, as in some grasshoppers, would serve equally well. For these reasons I dare to advance the opinion that the patterns and the colours of the butterfly wings are insects' "paintings".

However I do not maintain that a Lepidopter has

[1] I refer to the ocelli (wing spots): I will deal with these below when discussing masks, another similarity between man and insect.

anything in common with an artist. Still less do I say that a butterfly paints its wings or that one of its far-off ancestors conceived or willed this form at some point in the evolutionary process and that they have been the same ever since and will be transmitted unchanged for many centuries to come. Even using the word "painting" for the fixed positioning of the small scales that make up the wing is a flagrant abuse of language. I must not overlook any of the points in which a painting differs from a butterfly-wing. But I notice—this is my task—that these differences are just those that separate insect and man, so in a certain sense they are expected and reinforce the view that the argument is well founded. Here are two kinds of surfaces both having coloured parts, brilliant or soft, forming a whole. The two things moreover are both equally useless. They cannot really be compared: nevertheless they are homologues.

The wings owe nothing to the intervention of consciousness, of will, of free choice; they arise through the working of uncontrollable animal mechanism. There are patterns but no plan. They are always the same and have been for thousands of years in all the members of the same species: they seem to be those things that would have been created had some ideally perspicacious spirit, in the undeviating insect world, made in advance the objects which were going to become man's paintings.

On the other hand, the other surfaces—the paintings—are original things by very definition. The artist's personality is shown in every one of them. He does not carry them about with him as he does his finger nails, his hair or eyes (but he has colour in his eyes and hair). He alone is responsible for every shade and every stroke in the picture. If a free and capable being, able to work outside himself, started spreading colours on a surface so as to get something like a butterfly's wing and if you allowed him to use any colour he liked, so as to get the

best possible result, he would invent painting, more precisely abstract painting, the geometrical patterns of baskets, pottery and embroidery.

To sum up, the theory leads one to believe that there is with living creatures in general a tendency to produce coloured designs and this "tendency" shows itself particularly in the two evolutionary extremes—a butterfly's wings and an artist's paintings. I would not dream of denying—indeed I am stressing—the vast differences which separate the painting and the wing, but I think that these differences are already implied in the all too evident fact that the wing is part of the butterfly whereas the artist invents and carries out his picture himself. It follows from this statement that it becomes interesting to try and determine the singular reasons for man's achieving a very different destiny from that of other living beings.

This is usually explained by man's erect posture and the fact that his thumb is opposite his fingers. Neither one of these reasons is completely convincing. The erect posture has not helped the penguin or the kangaroo very much. The lobster and crab do not make much use of their claws to hold before their eyes objects arousing their curiosity. As for monkeys, who stand up when they want to and have the use of four hands, it is clear that they have not profited much from this plurality and abundance. It would seem that the advantages put forward are less decisive than is claimed.

Perhaps the approach to these problems could be helped by making a more exact record of what is gained and what is lost. Man, by assuming the erect posture, sacrificed his running speed and thus became an easier prey for swift predators. On the other hand he liberated his front limbs. Thereafter the conception of the hand became possible. But the selection of the hand with its

opposing thumb and gripping fingers was once more to sacrifice some possible alternative such as the hoof or claw. Each time it was as if man "chose" a solution which was at first harmful to him, but which was soon to reward him with additional powers. Man seems to have advanced by a series of successive eliminations. In a way he impoverishes himself and denudes himself to the extreme, finally to gain a greater diversity of useful gifts. At the same time he has "avoided" any too specialised organ, such as the wing or fin, wonderfully adapted as they are, but only to one use. The fur-covered mammal has "invented" its fleece to protect itself from the cold; the crab its carapace and the mollusc its shell for protection against predators. Man has invented clothes and armour, which he can take off and put on according to his need, always for the purpose of protection or self-defence. His policy is therefore to avoid any organic solutions which would involve a modification of the body, for they have the fault of being permanent and incompatible with each other. Man makes solutions which are external and, as a result, capable of an infinite number of combinations. This is a general principle. The crayfish "chooses" its armour-plating, the bird its wings; but there are no flying crustaceans nor any armour-plated birds, whereas, for man, the construction of an armoured aeroplane—a flying fortress—presents only one difficulty to be overcome, a new relationship to be established between the total weight of the machine and the power of the engine which drives it. The electric eel "invents" its electric discharge and equips itself with a sort of internal accumulator. Man makes use of virtually all the possible applications of electricity.

Another example and not the least. Man does not have that faculty possessed by bees and ants of being able to orientate himself practically infallibly. He has

invented for his own use a compass independent of his body, which does not simply help him find his own home but gives him direction over the entire planet.

There is no need to labour the point. It is well known that man differs from animals in that he makes tools, weapons and machines. He has no claws or talons nor natural suckers, but if he needs them he manufactures as many of them, and makes them as powerful and as intricate, as he wants: he sets himself up with a mass of varying articles which he possesses all at the same time and which he can use in turn.

We are, however, dealing with insects. The intention of this brief digression is to show how commonplace my observation is in as much as it does not extend the case beyond the objectives already stated, ones which, I am afraid, are more obvious and superfluous than paradoxical and controversial. However, the opposite happens as soon as I try to suggest the least connection between a butterfly's wings and an artist's paintings, although the relationship is the same. On reflection it is no more and no less acceptable in either case. The only difference that I can perceive between the two series of analogies is that the first concerns organs, machines or useful functions: the second superfluities the usefulness of which is obvious.

I have used butterfly's wings as a special example. I could have chosen others from all the spheres of nature and might have given preference to crystals, flowers, the skins of certain mammals or the scales of numerous fish. These recurring patterns—for the most part it is not a question of anything more than just regularities—simply reveal the principle of distribution which governs living matter. Examples are the allotment of seeds in a pod or the shape of a starfish. Other schemes progress in a modulated rhythm, as the spiral of a shellfish. These

geometric patterns, which are easily discerned by man, please him and he is led to speak of beauty. In fact he is only noting equilibrium or symmetry, that is to say, neat arrangements. If the butterfly's wings seem to present a special case, it is, I think, for two reasons: in the first place the outline and the pattern would appear under the circumstances to be a superfluous ornament which has been arbitrarily added to the organism of the insect and would not appear to be an essential part of its make-up; further, the patterns are often very complex, whereas the symmetry of butterflies—strictly lateral—is reduced to the most simple shape possible—as is the case with the human body. Geometry and simple regularity seem in this case to give way to a richer composition, free of the laws which govern the balanced economy of living matter.

Can we then speak of art? In the human sense of the word, certainly not. But a new principle has appeared over and above geometry. I will explain what I mean. Geometry is a constant principle of the universe, and the universe has examples of it at far from elementary levels. Life, in a way which one might call altogether abstract, at times, develops what could be called polyhedral structures, similar to the perfect bodies which Plato, in the *Timaeus*, regards as the only things worthy of divine construction.

The Radiolaria are remarkable collections of spherical bodies formed of regular polygons united to each other. Slender spikes radiate from the centres or the angles of the polygons, like rays of light frozen into immobility. In his work E. Häckel[1] alone amassed several hundred types. I shall only quote two examples of these, chosen from among the most simple because they seemed to be complementary to each other. The *Circorrhegma dodecahedra* (Häckel plate 117, 2) with twelve faces and

[1] E. Häckel, *Die Radiolarien*, Berlin, 1862-1888, 3 volumes and atlas.

twenty spines and the *Circogonia isocahedra* (Häckel plate 117, 1) which has inversely twenty faces and twelve spines. From the depths of the warm seas they appear like a set of delicate tiny models pre-dating the ideal solids deduced by Plato, who knew nothing of these natural prototypes.

At times the central sphere, as is the case with *Tuscaretta globosa*,[1] remains empty and uninhabited, the eight animalcules which secreted it in common remain suspended from the perforated surface spread out like the eight corners of a phantom cube.

There exists, therefore, a geometry which derives more spontaneously from life and which is considerably more developed than that which is apparent in a spider's web, a ring of petals, the distribution of leaves on a stem, the spiral on a seashell or the shell of a sea-urchin. I do not intend to enthuse over the alleged wonders of nature. On the contrary it seems to me completely natural, or rather, more probable and foreseeable than the contrary, that the intelligence of mankind and the purely biological phenomena of calcification among the lower orders of life have, in spite of the abyss which separates them, a deep-seated relationship. However I must stress one point: however many varieties of Radiolaria there are, it is the organic geometry which, in spite of the flexibility of sap and lymph, is important and which shows itself to be limited and unchangeable, without possibilities of development. And it is rigorous reasoning that enables man even to go as far as to operate in a medium without properties and to create there logical entities which the imagination itself cannot represent and which can only be understood on a mathematical basis. Taking the Radiolarians, with their symmetrical forms unchanged since their origin, as prototypes, I am thinking of an endless series of models made of string

[1] Valentin Häcker, *Tiefsee Radiolarien*, Jena, 1908, 4 vol., plate 129.

and wire. Man needs these puzzling fragile constructions in order to make for himself a very rough and almost symbolic representation of the flow of the abstract surfaces which his mind is able to conceive.

The design of corollas and the rhythms of growth are perhaps in accordance with the Law of Golden Proportion, of which the Pythagoreans made such great play. Why should it not be so? The Golden Number is a formula for the perfect use of resources. The symmetrical placing of the Radiolaria spines can be seen to end by giving a creature in which the available resources are used to the best advantage. A simple law of inertia should be able to explain this so economical use of resources. If sand is poured, it forms a regular shape, a cone, which, barring external intervention, keeps the form which its weight gives it. Alain expressed no surprise at the great age of the pyramids: monuments which, when they were built, were already the natural shape they would be in decay.

Let us return to the butterfly's wings with their spots, streaks and piping, crescents, seed-like dotting, cameos, scalloping and ocelli vying one with the other, in the display of designs which, on the single wing, in this case owe nothing to symmetry. There is no less fantasy, richness and variety in the colours. What is more, they are not just flat colours. They are greatly enriched by various physical qualities which make them deep or glistening, metallic or *moiré*. Thus there is the black or brownish velvet of the great ornithoptera, the electric blue of the *Morpho*, the fiery reflections and variegation of the *Uranus* and *Arcturus*, the enamel, mother-of-pearl and mica of numerous species, the light which flickers on the wing whenever the grains which make up the scales have a different index of refraction. Their shapes are elongated, jagged, crenellated, slashed or whole. The wings of *Actias* are prolonged by its enormous stiff tails

which appear to be starched. With the *Hypolycena*[1] they are thin, downy and rolled up in coils. In this mass of shapes, patterns and colours, there is an excess all the more surprising in that it appears to be in complete contradiction to the consistent discipline which has just been operating to make the best distribution of a valuable jelly quivering with life.

This consistency would doubtless give rise to harmony, but only because *harmony* is a property common to mathematics and aesthetics. A rose window in the form of a corolla is drawn by a compass. In speaking here of beauty man equivocates and is satisfied to designate by an all-embracing and ambiguous name a pleasure which springs directly from a harmonious division of space. He might with as much right (and lack of propriety) speak of justice.

On the other hand, with butterflies' wings there is a genuine beauty in the broadest sense of the word. They are a biological creation combining most pleasing shapes and colours which cannot be wholly explained in practical terms. Therefore it is reasonable to speak of art, and more particularly the art which concerns itself with the relationships of shapes and colours, that is, painting. Of course it is important to remember the differences which I have stressed above: on the one hand the external pictures resulting from the inventions of a free imagination; on the other hand, the internal and unalterable pictures, created without conscious invention by the change taking place inside the chrysalis, when the organs and tissues of the caterpillar dissolve and rearrange themselves into the wing of the particular species. The individual has no choice in this matter. Here each species is the artist. The picture, repeated indefinitely, gives all the individual members of each

[1] The difference in size between the wing and this elongated appendage is always greatest in *Eudaimonia bracchyusa*.

species the livery which they bear in perpetuity from season to season.

Samivel described the insect as an "introverted technician". He says that they have become "their own machinery, forming the details of their own structure with a view to a particular use".[1]

Thus, by the simple fact that *the function creates the organ*, what was primitively merely a paw has become "a fin, a weapon, a musical instrument, a burrowing shovel, a spring mechanism, etc.". It would be easier to lengthen this list than to exhaust its possibilities. By contrast in this field which is by definition characterised by superfluity it cannot be a question of the function creating the organ. With butterflies I imagine everyone would be willing to agree that flight developed the wing, but it could just as easily have developed a transparent wing like the dragonfly's or the bumble-bee's, the strong wing of the stag-beetle, the cockchafer, the water-beetle or the rose-chafer which, with a minimum lifting-surface, carries a far heavier body. Besides in this last case the concealment of the closed, supple wing under its sheath contrasts with the "vanity" of the butterfly who plays with his wings, slowly opening and closing them on a flower, by a stretch of water or on the pebbles of the road.

Therefore, if so many insects appear to be introverted technicians, might not the Lepidoptera be the *artists*, the *introverted painters*. In the same way that the others transform parts of their own organisms into specialised tools—hooks, knives, pincers, scissors, borers, syringes or siphons—they, by means of the incredible chemistry of necrosis, produce on themselves a rich and distinctive display less like a picture than a flag or armorial bearings, but armorial bearings so rich and detailed that

[1] Samivel, *Univers Géant*, Paris, 1958, p. 18.

they suggest not so much heraldry in the human world as painting.

In my opinion this unusual proposition comes up against two major difficulties: the first is that stated by Samivel in connection with the tools and utensils so perfectly adapted by these introverted engineers, when it comes to supposing them created by the insect technician's decision, even a confused one, a choice, however rudimentary, or a foresight, however obscure. "It is hard to believe that creatures who are in the majority of cases incapable of modifying their own behaviour would be endowed with the extraordinary power of shaping their own structure." From this he derived a hypothesis which is, to say the least, daring. If one systematically neglects in this instance the theory of natural selection, is it possible to imagine that insects or certain types of insects, ants for example, were, at some given time, intelligent beings, in the sense which we give this term, that is, endowed with a mystique, philosophy, art, science and technology? And that after a mysterious avatar—who knows?—perhaps as the result of a voluntary physiological conditioning brought about by methods similar to ours but further perfected, they have become, by virtue of an unalterable consequence, what they now are, that is to say, machines for living, nothing more, nothing less?[1]

This problem of initiative in the construction of their own selves, the problem of the original decision, even in the weakest sense of that term, would, if it were just a question of any number of purely mechanical consequences brought on by the repetition of one phenomenon at the cellular level, still remain mystifying in the extreme; in fact, unfathomable, to a point where it is perhaps ridiculous to imagine it, because it has no meaning when applied to man. Man's progress is in the

[1] Samivel, *op. cit.*, Paris, 1958, p. 21.

opposite direction, for he, who can fabricate everything externally, is, by way of compensation, virtually unable to modify his own organic structure.

The second great objection arises from the assimilation of useful qualities and attributes of no use. A doctrine of natural selection readily admits or even postulates the pliability which produces the fin of the Hydrophilus, the mantis's jagged harpoon and the mole-cricket's excavator, but it refuses by the very nature of its theories to conceive of a similar mechanism for the pattern and colour of the butterfly's wings. The opposition between the necessary and the superfluous seems here to be decisive. It is argued that anything serving no definite purpose cannot be a determinant. Any non-utility of characteristics cannot be admitted. In other words anything which is superfluous is *a priori* inexplicable.

I maintain that there is here what I call a "deep anthropomorphism". At all costs people want to avoid talking of art or beauty, blazonry or pictures when considering butterflies' wings, for these are words which only make sense in relation to human emotions or to human history and little does it matter that anyone who uses these words in this connection takes care to emphasise the differences and contrasts. To avoid the forbidden words it is commonly held preferable to exalt the concept of utility, that is, of survival, as all-important. However, if we stop projecting our human reactions on to the non-human part of nature we find that an immense squandering of resources is the rule there. It is a world where there is nothing, absolutely nothing, to indicate that an ostentatious outpouring of resources, with no intelligible end, may not be a wider and more universal law than the strict vital interest, the imperative of the survival of the species.

Thus man remains convinced that nature does nothing in vain. Just about everything in it suggests the opposite,

but he does not cease to believe, if not in the best of all possible worlds, at least in one with the least loss of energy. To me it seems dangerous to accept such a theory. I wonder at least to what criterion it would be legitimate to resort, to give here a clearly defined meaning for the expression "in vain". In the last analysis, I fear, the discrimination is purely human. Herein lies, I suspect, the final anthropomorphic error. Indeed, I have no doubt that it is I who will be accused of delirious anthropomorphism: what could be more ridiculous than to dare compare butterflies' wings to the works of painters? However, it could be that my system of references might show itself to be the least *distorted* of all: for it also provides a presentation of a painter's pictures as the human equivalent of the butterflies' wings.

What could such a relationship indicate if not that there appears to be an autonomous aesthetic force in the world of biology in general? This force, doubtless inexplicable, shows the impossibility of going any further in this progression of causes and effects, in certain cases a final goal just as imperious and tyrannical as the sacred survival of the species. It happens that, in different conditions, the most divergent paths lead to the same end: the interplay of shapes and colours. Both men and insects, knowing nothing of their hidden docility, obey the same organic law of the universe. This law, like the law of economics, wherever it reigns, reigns absolutely, without any half-measures, at least when there are no forces to counteract it. A butterfly, which has no consciousness or insight, would not be able to make for itself a wing that was ugly, for it has no power to erect obstacles to this development of forces which produce harmony and beauty *naturally*. This is too little: I should have said to this *natural expansion* by which harmony and beauty define themselves, because man (an integral part of this same *nature*) necessarily perceives

harmony and beauty, in conformity with that great canvas which determines the shape of crystals, shells, leaves and corollas and which cunningly suggests to him the relationships wherein he imagines, not without some presumption, that he is exercising his personal genius.

Man is free, clumsy, and wicked on occasions. Without knowing anything about it, and as the result of an incomprehensible metamorphosis, the Lepidopter makes gaily-coloured wings out of the dull paste with which the pupa is filled. Between himself and his work man sets the risk of a decision taken deliberately which may be of doubtful value. He also has to carry out what he has conceived. He calculates and then makes it real. Each time he risks making a mistake. His reward is to be the true creator of his pictures; but on the other hand an unsuitable choice or bad workmanship by this one fallible being can result in bad painting. It is a far cry from the age-old norms, whose works, being repeated indefinitely, could not help but have a cold and unchangeable perfection about them.

NATURA PICTRIX

WHETHER THE WINGS of butterflies do, or do not seem to be paintings, it must be admitted that history shows no painter with a special preference for these shimmering surfaces, where his work has already been done. On the contrary painters seem to avoid them, and never reproduce a butterfly-wing except as a minor element in a still life. For instance, they never take part of a wing of some butterfly, enlarge it to the full size of their canvas, all the time most carefully keeping the wing's pattern, proportions and colours. I put this down without comment. I suspect, however, that this arises from the fact that the artist already sees the wing as a picture and that to paint it would not be to paint a picture but to duplicate an existing work.

In any case it seems possible to admit that butterflies' wings might be *their* pictures, where, if you wish, the exact contrary of human pictures is found. With the butterfly they appear as the only possible aesthetic work of beings condemned to automatism, only able to produce such works at the species level and not at the individual level of a free and independent being.

Rocks, too, supply natural works of art that have such a resemblance to paintings and have so struck the imagination of observers that at times they have been led to think of nature herself as an artist.

For as long as painting remained emblematic, or representational, for as long as it was content to display people, landscapes, things, for so long did man believe he could see these same things in patterns found in

marble, jasper and agate, It is true that such similarities were fanciful, arbitrary, but they are all the more significant the more the supposed resemblance was weak and difficult to see.

On the other hand, with today's non-factual art, shapes lose their firm outlines and represent no definite person or object: the resemblance between pictures and the patterns and colours of certain rocks is so strong that one could believe that the painter had merely set out to copy the rock. However, such is not the case. The artist is not aware of the rock, of which his picture seems to be an exact copy. He is careful to avoid copying. Rather might one postulate that he paints as if the object of his art were to create, without his knowledge, by a thousand trials and errors, a composition which is the exact equivalent of the patterns and colours of an ancient geology, itself firmly bound by exact and inflexible laws.

Moreover there are many coincidences, much interference, even falsification between the two orders, the natural and artificial, that fit in with opposing theories, both equally tempting, and so it is worth while making a closer examination of the cases of collusion or agreement between the artist and nature in this realm of the rocks.

From ancient days men have exercised their ingenuity in finding resemblances to animals, people, landscapes and whole scenes in the veins and marks of stones. Pliny the Elder (*Hist. nat.*, XXXVII. 3.) recounts that Pyrrhus had an *unworked* agate representing Apollo, his lyre in his hand, accompanied by the nine Muses, each with her respective attributes. This mysterious agate was talked about for centuries: in the sixteenth century G. Cardano (*De Subtilitate*, Nuremberg, 1550) thought it was a petrified picture; in the seventeenth Gaffarel, Richelieu's librarian and the King's almoner, maintained it was a

"spontaneous wonder" (*Curiositez inouyes sur la sculpture talismanique des Persans*, Paris, 1629). In short, for a long time such picture stones have been looked for, catalogued, improved, completed, forged and even fabricated. In fact from the thirteenth to the seventeenth centuries there was a passion among certain collectors for these pictures that nature seemed to have shut up inside agate, jasper, marble and porphyry. Jurgis Baltrusaitis, who has examined the history of this craze,[1] was right to introduce it with the following celebrated advice from Leonardo da Vinci. "If you look at walls with dirty marks on them, or made of different kinds of stones, with an imaginative eye, you can see the equivalent of landscapes with mountains, rivers, rocks, trees, plains, great valleys and hills all arranged in different ways. You can also see battles and figures in quick movement, strange faces and costumes and hundreds of things you can reduce to a quite definite outline. And this appears indistinctly on the walls, as in the sound of bells you can find all the sounds of words you can imagine." (Ms. 2038, Bibliothèque nationale, Paris, p. 22, and A. Chastel, *Léonard da Vinci par lui-même*, Paris, 1952, pp. 100-101.)

Phillippe Hainhofer, a merchant of Augsburg, had a business in these picture stones, which he obtained in Italy. Among his customers were the Duke of Pomerania and the King of Sweden. The flattened stone or rock was the background of the picture: a flight of clouds, great waves on a stormy sea, anything likely to be found naturally in a mineral. The artist was simply content to add the figures. Johan König painted the crossing of the Red Sea on an agate background in this way, and also the Last Judgement. Antonio Carracci painted the

[1] Jurgis Baltrusaitis: *Aberrations*, Paris, 1957, 3rd. part, "Pierres imagées", pp. 47-72. I have abstracted from this revealing study nearly all the following information on picture stones.

Annunciation and a scene showing the Virgin, the Child and St. Francis, on an alabaster base. Baltrusaitis says: "The artist has placed his figures well; they are graceful; but the supernatural element in the picture, its mystery, comes from nature" (p. 50). The alabaster has a slow winding pattern, and the pale, milky lines give an otherworld light to the picture.

It is a question of co-operation between the artist and nature. In most cases the artist plays a minor part; he is often eliminated altogether, as in several remarkable pieces in the collection of Olaus Worm, a doctor of Copenhagen. His catalogue was issued in Leyden, in 1655. He particularly draws attention to an untouched marble where the veins show a town built on two rivers, with towers and ruins "all as well executed as if they had been painted by an artist's brush". This is undoubtedly the description of one of those Ferrara marbles whose geological faults form panoramas of ruined towns. The English call these "ruin marbles".[1] Their vertical lines, which cross other faults at a sharp angle, sometimes bring to mind the vistas of serried skyscrapers which come from the brush of Bernard Buffet.

The catalogues of that period usually make a careful distinction between minerals touched up by an artist, which is shown by the phrase "adapted by art" (*ars adaptavit*), and those quite untouched, indicated by the words "painted by nature" (*a natura depicti*) or "natural, with no intervention of art" (*a natura sine omni artis ministerio*).

There are, moreover, certain natural pictures of an intermediary type to which the old catalogues have given no consideration and which are not mentioned by Baltrusaitis. They are made by splitting plates of marble or porphyry off a solid block which has some promising

[1] Another kind of marble, where the eye thinks it sees trees and woods, is called "landscape marble".

veins in it. The workman "opens the stone" so to speak, and places the two halves along one common axis, just as one opens a book, so that he creates a symmetry that does not exist in nature. Man has intervened in this case, in order to find the desired image, by simply adding symmetry. Children do the same thing when they fold a piece of paper over an ink blot. The stone panels which decorate the inside of the nave and the interior of St. Sophia at Constantinople are an example of this work. The veins of these marble panels, doubled and placed together, show camels, demons and many other more or less vague figures, which at times firmly hold the spectator's imagination and at others leave him more or less free to imagine he can see anything he pleases.

In the last case the artist does not add to the natural object, neither does he modify the shapes that nature offers. But he combines these into a symmetrical pattern which has the power of suggesting some identifiable similarity. He corrects nothing; he isolates certain elements which he then uses for decorative purposes by the clever duplication of the chosen pattern.

In the above particular case, it is a question of a painstaking effort for purely decorative ends of which geometry is the mainspring. On the other hand in Western Europe it seems that people were looking for the prodigies of inexplicable analogy—quite arbitrary, however, and of little importance—displayed by the forms of certain rocks which have the appearance of various things in the real world.

A Bologna naturalist, Ulysses Aldrovandi (1522-1607), in his book of minerals, *Museum Metallicum*, published in 1648 by B. Ambrosini, gives the period's most complete list of these anomalies, which he regards as wonders of nature. What is more, he classifies these marbles according to the subjects displayed and makes classes of religious subjects, water-courses, waves, forests, faces,

dogs, fish, dragons, etc. The work is profusely illustrated, as it should be.

Athanasius Kircher, in his *Mundus subterraneus* (Amsterdam, 1664), has drawn largely on Aldrovandi. He also gives a system of classification and advances several explanations to account for the objects: they run from the commonest physical properties to the direct intervention of God, who would not disdain, should the occasion arise, to co-operate with nature, as He did in marking the cross on the backs of Chinese shrimps and across the sap-wood of Japanese trees (vol, II, book VIII, part 1, chapters VIII & IX, pp. 22-45).

Kircher, like the Halian catalogues of his period, does not stint his praise of the virtues of these spontaneous pictures from the hearts of marble and chalcedony: here we find a Troy in flames that Xeuxis himself could not have painted better; there are found landscapes, towns, mountains, skies, all held by enthusiasts to be better than ordinary works of art.

Two characteristic features define this craze. In the first place, it was always a matter of the interpretation of patterns necessarily confused and imperfect, where the imagination was able to find certain familiar shapes, but also where there was a need to finish, or at least homologise, the shapes: thus the artist was frequently called in to correct or complete the incomplete picture given by the stone. He added his art to nature. He played with nature, as Hainhofer says in his letters (*Ars und Natura mit einander spielen*).[1] Analogy and resemblance controlled the aesthetic and men loved to see God's hand in the inexplicable religious pictures: crucifixes, virgins, saints, hermits, heretics with turbans are all found at the same time as panoramas of ruined towns, inpenetrable forests, long chains of clouds from which strange ranges of mountains emerge, or the lace-like

[1] Baltrusaitis, *op. cit.*, p. 52.

foam of a rough sea breaking against rocks. All is suspected of being there, uncovered and then seen, often with the assistance of a great deal of imagination.

In the second place, none of these stones is signed: they are wonders of nature. It is the formal resemblance that is of interest, not the aesthetic value of the piece. No artist had the idea (certainly a controversial one) of promoting these objects to the ranks of personal works of art by the sole act of their being chosen by him, as Marcel Duchamp did later with artefacts. This promotion changes the very nature and destination of the discovered objects by the single fact that the artist invites the spectator to like and appreciate the most trivial thing from the standpoint of a new set of rules. The essential boldness of Duchamp resides in the fact that he takes the responsibility of putting his signature on any object, that he may or may not have made, but which he makes his own by revealing it as a work capable of arousing an artistic emotion just as much as the painting of a finished master.

Marcel Duchamp was not the first to take this course. In China, in the nineteenth century, there were a number of artists who, instead of painting, cut plates of marble, framed them, gave them a title and offered them to the public just as if they were true pictures. I own one where the "painter" has simply engraved, in addition to his seal, his name, "K'iao Chan", and a title, "Solitary Hero" (*Ying hiong ton li*). Another marble, signed in the same way, can be found in the Natural History Museum in London.

I find here two differences which contrast with the Western taste for picture stones: the first is the signature; the second the fact that in this case it is a harmony of form or colour that is sought, not a wonderful and chance resemblance with such and such an image or scene in nature or history. It is true that in China the

practice of decorative calligraphy had for a long time accustomed the eye to the charms of non-representational art. Not that the Chinese stones fall absolutely within this class. The title suggests a factual subject, but it is very clear that the picture is still completely allusive, that is to say that the correspondence between title and picture is much more imaginative or abstract than morphological or representative.

At present, in the West, painters are trying to destroy the usual forms, after escaping from the conventional way of looking at their subjects. They try to get away from the repertoire of shapes that the ordinary man familiarly sees in the solid world around him. Hence we get these canvases of stripes, blending colours, spots, marblings, much nearer to the basic structure of matter, as seen by some precision instrument (microscopes, spectroscopes, etc.), than to common vision. A picture may look like a biological section, such as the cortex of an elder-twig mounted on a microscope slide and enlarged by the objective, or it may be an insect's limb, or incandescent silver, or any picture of matter revealed by today's technology, that is, as long as it is one that reveals the basic construction. It is significant that today it can be difficult, even for an art critic experienced in this field, to distinguish between good colour reproductions of pictures from the latest painting schools and such scientific or industrial photographs as one finds in great numbers in the specialist technical publications.

If one were to mix up the titles I doubt if anyone could tell them apart. For my part, relying on the Chinese precedent, I have dared to classify as pictures several mineralogical specimens, chosen with great care, after long examination of a number of natural history collections. Neither from the point of view of composition, nor colour, nor that irreplaceable something which is the essence of a work of art, is it possible to

consider them in any way inferior to the pictures of the most ambitious and careful modern painter. On the contrary, these stones (septaria, Labrador feldspar, serpentine, malachite, marble with insertions of encronite) once polished and conveniently centred—human effort is limited to this one task—show, both as regards composition and colour, a surety, a delicacy and a boldness all equally striking. They are truly "nature's pictures". In the same way, I put a Chinese sculpture and a selected crystal side by side. The first consists of a polished rock crystal penetrated by joining galleries and by subtle rays of light, showing the deep gulfs and swelling roundness of an imaginary torso, complex and disconcerting. The other, hardly more abstract, was almost geometric, its transparency showing up a sloping band of rutile needles, faintly less transparent than the pure light of the crystals, like a gentle presage of opacity.

Athanasius Kircher, the enthusiastic panegyrist of the *Mundus subterraneus,* holds that nature is a geometrician, an astronomer and even a painter, and that she reproduces polygons, stars, landscapes and faces far better than an artist. He gives more proofs—unfortunately all disputable—than one wants. But he was only thinking of representational painting. Here perhaps we should contradict him; on the other hand, in abstract painting, when the artist is seeking to show the elemental absolute, beyond the formal and definite, it matters little if he seeks his inspiration from minerals or from the coloured photographs of technical journals. When a modern artist paints a still life he may, without being aware of it, and sometimes by accident, produce a picture which corresponds closely to the most up-to-date view gained by his scientific contemporaries into the ultimate warp and weft of matter. It seems fitting that in this hitherto unexplored field nature herself should have

opened the way. She seems to have anticipated the artist in such things as the detail of a butterfly's wing and the pattern of rare stones and to have started as he finished. She has preceded the artist as much in the wing chemistry of the fluttering, evanescent, woodland nymphs as in the slow geological deposition of rock. Growing tired of their traditional role of painting the human world, the artists now seem to be turning to a path where sooner or later they will find themselves confronted with the very hardest competition, that of nature herself.

Such a comparison is inevitable, for the criteria which allow one to assess the originality, charm and value of these works are in both cases exactly the same. Only the way in which they are produced is different. On the one hand there is a work of art conceived and executed by an artist who is a unique and irreplaceable individual, on the other there are the dark, age-old workings of an anonymous system of physics. But the results must be judged exclusively by the aesthetic merits of their plastic qualities. Consequently why start by disqualifying compositions of incontestable splendour, often of a striking superiority, for the sole reason that they are not due to the initiative and effort of an intelligent being but to the confused metamorphism of another less differentiated class of matter?

It is the painters themselves who have sought this competition, at their own risk. Have they thought about it? Have they considered, in choosing abstract forms, that their brave and fumbling endeavours have been anticipated by that unknown somnambulistic power that forged the immemorial patterns of volcanic rock? The greatness of man was always his fallibility and his ability to create experimentally.

CONTRASTS AND PARALLELS

THE THREE FUNCTIONS OF MIMICRY

MIMICRY, IN THE broadest sense of the word, comprises a great number of very different phenomena. To bring a little light into this darkness it was first necessary carefully to analyse the different characteristics and to arrange them according to their recognised nature or the function they are supposed to perform. These valuable, nay indispensable, classifications, which, moreover, are recent, suffer from two fundamental defects. Firstly, they do not agree with each other. Secondly, they easily overflow the limits of true mimicry and become general theories on the coloration of animals and secondarily of their morphology. The very title of the authoritative book on the subject shows this: *Adaptive Coloration in Animals* by Hugh B. Cott.[1]

But we must clearly understand the principles on which these classifications rest. The most commonly accepted system is that of Poulton as modified by Cott. The main distinctions are colours destined to mislead (*apatetic*) and colours destined to warn (*sematic*). Deceptive colours are in their turn divided into *cryptic* ones, which dissemble, and *pseudosematic*, which warn in error.

Colours which serve to conceal their wearer are either *procryptic* (for example, the grasshopper has a colour like grass in order to escape predators) or *anticryptic* (the mantis resembles a leaf or a flower so that its prey will approach without fear). These represent two comple-

[1] London, 1940.

mentary attitudes: the game hides itself to avoid the hunter, and the hunter, lying in wait, changes his appearance to overcome the caution of his victim.

The *pseudosematic* colours and shapes show a more extensive range of possibilities. They are *pseudoaposematic* when they wrongly suggest the idea of an unpleasant taste (*pseudoproaposematic*) or of danger (*pseudoantiaposematic*). Thus pleasant-tasting butterflies may mimic the appearance of unpleasant-tasting ones (Batesian mimicry[1]); or we have the numerous inoffensive insects which look like stinging ones—wasps or ants. They are *pseudepisematic* when the insect assumes an appearance that will attract its prey, for example, the likeness of a special flower where the victim usually finds its food. Finally, it is tempting to make a class of *parasematic* colours and patterns, that is to say colours and patterns which deflect the attack from vital organs (generally the head and eyes) towards less important parts of the body, or, in the case of social insects, from the more useful towards the less useful and more easily replaceable members of the society.

In these different categories, the noticeable colours are deceptive (*apatetic*). On the contrary, the so-called *sematic* colours give a true warning. They are called *aposematic* or premonitory when they indicate that the coveted prey is distasteful or to be feared. Insects armed with a sting boldly sport lively colours and easily identifiable patterns. These liveries constitute a threat which is not empty and which other insects imitate—insects which lack the means to punish the boldness of a predator and so influence that predator's future choice of prey. *Synaposematic* colours are those which occur when several species, all equally protected, copy one another. Such insects seem to adopt one single style

[1] See below, p. 66.

which is thus rapidly impressed on the memory of the predator (Müllerian mimicry).[1]

Also included in the group of warning colours are the so-called *episematic* colours, which allow individuals of the same species to recognise each other and to assemble together. To these two fundamental categories of colours another may be added—the *epigamic*; for example the colours which certain birds adopt during the sexual parade. It is obvious that this is a matter of a specialised and periodic display, a period of supplementary splendour, which does not have much to do with true mimicry.

This preliminary classification only takes account of the anatomical factors in mimicry. But sometimes the habit of mimicry does not affect the organism itself and is not built into it; often mimicry is achieved with objects found in the environment. In this way certain classes in the above classification have their parallels in other cases:[2] there is the *allocryptic* activity of certain crabs, which cover themselves with weed; the *allosematic* colouring of the hermit-crab which clothes itself with stinging sea-urchins; the *alloepigamic* behaviour of the male bower bird of New Guinea which, in its courting behaviour, constructs a tunnel of interlaced branches in which it arranges a multitude of strikingly coloured objects: feathers, shells or little stones.

These differences, it goes without saying, can be multiplied without end. On the other hand one is not quite sure that there is not some overlapping. Thus the same *cryptic* appearance can serve to frighten an aggressor or deceive a prey. Moreover, as I have already said, other classifications are no less plausible, for instance that suggested by Sir Julian Huxley.[3] He contrasts the *cryptic*

[1] See below, p. 66.
[2] These are characterised by the prefix *allo*: stranger.
[3] *Proc. 8th Internat. Ornithol. Congr.*, Oxford, 1934.

colours, which hide the creature, with the *phaneric*, which draw attention. This last class is divided into the two groups we have already seen, in effect the *aposematic* when they offer a real threat and the *pseudosematic* when the threat is empty.

It is then a question of the same facts but seen from new points of view. Poulton and Cott are concerned firstly to see if the indication given is true or false, so that they put into the same class those creatures which use concealing dress and those that advertise themselves. Sir Julian, on the other hand, is chiefly interested in the effect produced, the creature's disappearance into the background or the wearing of a striking and conspicuous costume. It follows, then, that he is not mainly interested in whether the creature is giving warning against a real or an imaginary danger: the essential for him is that is makes itself known. One can see at once that numerous combinations are possible, even inevitable. In fact the criteria chosen are ambiguous: the creature may hide for the purpose of fleeing or for the purpose of attacking; it may threaten deceptively or with justification. To be effective in either case its appearance must be the same, whatever its true intentions or its resources for attack or defence. The creature acquires a pleasant appearance in order to attract, a disagreeable one to drive away, and a fearsome one to frighten. It may make no attempt at mimicry and prefer to disappear into its background, or it may suddenly transform itself and become monstrous and terrifying, quite unlike anything known in the real world.

In my view the second fault of the current systems of classification is that they are based on colour rather than on form and scarcely at all on habits of mimicry, which, however, are absolutely decisive in certain cases. Not that authors neglect these last. On the contrary they have been much studied. But they have not introduced such

habits into their system of classification, as if they only had to consider anatomical details and not behaviour. Numerous errors would have been avoided if these creatures had been more studied in the field and less in the laboratory. To give consideration to behaviour is not only a necessity but also a guarantee of accuracy.

Under the circumstances I hazard another system of classification based on the nature of the aim attempted or achieved by the creature. Consequently I make three classes: *disguise* (fancy dress), where the animal passes itself off as belonging to another species; *camouflage* (allocryptic, homochromatic, disruptive colours, homotypes), by means of which the animal is able to blend into its background; *intimidation*, where the animal paralyses or frightens its enemy (or its prey) without this terror being justified by a corresponding danger.

Each of these will be examined in turn, but first some preliminary remarks are needed.

The first is that I set aside, on principle, all that is not to some degree deception, that is, no consideration is given to sematic colours, whose object is to fix the memory of a disagreeable experience, to remind the aggressor that the attacked creature is armed or is not edible. In effect I am only concerned with mimicry and not with the much greater question of the function of colour among animals.

In the second place, the classes proposed can include all cases of mimicry without distinction, whether offensive or defensive. I see only advantage in this, because the two ends of mimicry are frequently indistinguishable in nature: many animals are hunters and hunted at one and the same time. The bogy-like appearance of the praying mantis serves just as much to frighten the bird who hopes to capture this morsel as to paralyse the cricket which the mantis is getting ready to eat. Another mantis, *Scanthops falcatara* G., is a perfect copy of a dead

Description		*Name*	*Examples*	
			Vertebrates	*Invertebrates*
Disguise	Within a family	Endophratic		Danaid butterflies
	Within an order	Endogenic		Danaid and nymphalid butterflies
	Outside the order	Exogenic		Sesia butterflies and wasps
Camouflage	By means of external accessories	Allocryptic		Caddis worms, *Xenophora*, oxyrhynchus crabs
	By taking on the background colour	Homochromy	Partridge, tree-frog, chameleon	Praying mantis
	By breaking the line	Disruptive coloration	Tiger, boa-constrictor	Geometrid moths and caterpillars
	By the exact imitation of some object, vegetable or animal in the environment	Homotypes	*Phyllopterix eques*	Stick and leaf insects, some grasshoppers, *Kallima*
Intimidation by means of	Ocelli (eyespots)	Cyclophobism	Owls	Caterpillars of *Choerocampa* and *Elpenor*
	Menacing, though inoffensive, protuberances	Ceratophobism	Toucan	*Lucanidae*
	Appendicular mask	Phantasmophobism		Surinam lantern-fly

Equivalent in human imagination	*Action*	*Object*	*Sex chiefly involved*
Mythology of disguise and change: tendency towards disguise	Imitation of an actual thing and a recognisable behaviour-pattern	*Resemblance* To be thought to be another creature or object	Female
Invisibility in mythology and folklore: certain children's games: the magic of a secret, of immobility or of impassibility	Immobility, inertia, balancing in harmony with the movement of the supporting object	*Disappearance* Not to be noticed, melting into background: to lose the appearance of an individual living alone	Male and female
Belief in the evil eye and power to transfix: tattooing: painting of shields: crests of helmets: importance of masks in primitive societies and during times of carnival	A terrifying or frenzied mimicry (frights, shudders, spasms), special sounds (*phricophobism*)	*To produce panic* To cause fright while not really being anything to be feared	Male

leaf: it thus deceives its enemies and dupes its victims.

This said, the three classes of mimicry proposed are the following:

Disguise: found (a) within a family, such as a danaid imitating another danaid (this would be called *endophratic* disguise);

(b) within an order, thus a butterfly imitating a butterfly of another family; for instance a danaid might mimic a nymphalid (*endogenic* disguise);

(c) between different orders, for example the *Sesias* (Lepidoptera) imitating the wasps (Hymenoptera) (*exogenic* disguise).

Camouflage: (a) using external adjuncts, such as the oxyrhynchus crabs (*allocryptic camouflage*);

(b) taking on the colour of background (the *homochromatic* colours of the grasshopper, the white owl, partridge, chameleon, etc.);

(c) relying on patterns of contrasting colours which break up the apparent shape of the animal (the confusing colours of the tiger, boa-constrictor and several reptiles).

(d) the production of a perfect imitation, both as regards form and colour, of a vegetable or mineral object in the environment (*homotypic* elements of stick insects, leaf insects and *Kallima* and pterochroze grasshoppers.

Intimidation: (a) the animal has recourse to the hypnotic influence of circles, brilliantly coloured and motionless, which it suddenly reveals, sometimes paralysing the other creature and sometimes provoking it to a panic flight (the giant eyes of owls transformed to *ocelli*, the *ocelli* of caterpillars and saturnid butterflies);

(b) sometimes horns of no use or great protuberances, impressive but useless, are found (jaws of the lucanids, crests of the dynastids);

(c) occasionally a frightening and empty mask is carried in front of the creature, as in the case of the Surinam lantern-fly.

From another point of view *disguise* is essentially imitation, that is to say the taking on of a definite, deceptive appearance, one that not only can be identified but will also put the creature seeing it on the wrong track. *Camouflage* is a disappearance, an artificial loss of identity; it makes the creature fade into its background so that the observer can no longer mark it down. *Intimidation* is an appearance or action tending to produce an exaggerated fright, one with no real basis, by means of sight, sound, rhythmic movements, smells etc., which allows the weak to escape the strong and the voracious to transfix their prey.

Disguise implies as much activity on the part of the mimic as camouflage implies inertia and immobility. As regards *intimidation*, its mainspring is of the nature of reflex action, of a fright or spasm. It is generally a horripilation which transforms the animal and causes it to make movements it is unable to control.

Finally disguise, camouflage and intimidation very well describe man's activities in this domain. Man may well try, by means of a disguise, to pass himself off as another individual or another living creature, or he may wish to hide himself or some object, or, by means of a mask, he may try to spread around himself an aura of terror half consented to and half an uncontrollable urge. After what I have said about anthropomorphism the reader will easily see that such similarities are far from unwelcome to me.

I am all the more pleased that it is not so much human behaviour that falls into these classes as it is human myths or irrepressible impulses: the classes do not recall useful human disguises but rather the folk-lore of transformation, the taste for disguises; rather than actual camouflage they bring to mind stories where the invisibility of the hero is of paramount importance, just as is the power of secrets or of impassibility. It is not so

much calculated or political intimidation that such classes justify or explain as superstitions about the evil eye or the look which transfixes one to the spot or kills, the sorcerer's mask, war-paint, designs on shields, in fact every symbol designed to paralyse the enemy or give him a fright.

Once again we can see opposed the physiology and automatism of the insect and the uncertain and fallible conduct of man, particularly his obsessions, phantasms, his world of obsessive dreams and stubborn fears.

DISGUISE

BY ITS VERY nature mimicry is baffling and has therefore given rise to much controversy. The arguments, however striking and ingenious they may be, nevertheless present a curious impression of monotony. They always centre around two similar questions: whether or not the disguise noted is an illusion of the human observer and whether or not it effectively protects the insect. Such problems should, in principle, be capable of solution by observation and experience. In fact the reasoning and attitude of each protagonist in the argument is inevitably influenced, whether explicitly or implicitly, by the theory of natural selection. The adversaries therefore either judge the reality of the disguise by the efficiency with which it protects or, on the other hand, assume that the protection must be effective if the imitation is obvious. In other words, if a likeness is irrefutable, then it must be useful, if its usefulness is not in doubt, then it is proof of disguise. In short, naturalists can only envisage two points of view and these they share between them: (i) mimicry exists, hence it is useful (Poulton, for example); (ii) mimicry is of no use, therefore it is just an optical illusion of the observers.

Both sides quote examples to support these arguments. There is no doubt that mimicry exists in the case of the polymorphic butterflies, whatever argument there may be as to its utility. In the case of the death's head found

on the moth *Acherontia atropos*[1] or the figure 88 on the ventral wing surfaces of the Brazilian butterfly of this name, it is obvious that these are nothing more than human interpretations of chance patterns. But is this any reason for the step by step denial of the existence of every case of mimicry, even the most exact and complex?

It is time to consider the case of this most debated of *causes célèbres*, of mimicry in the strict sense of the word.

It is a fact that some butterflies imitate others, which are distasteful to predators, in order to benefit from the latter's immunity to attack. The shape, pattern and colour of the wings are mimicked and thus the butterfly comes to resemble its model perfectly. It is usually only the females that do this; they are more important for the survival of the species. This type of mimicry is called "Batesian", after the traveller H. W. Bates, who pointed out and described the phenomenon. To qualify for the term "Batesian", the mimicry must conform to the following five conditions, set out by Wallace, which clearly allow it to be attributed to natural selection:

(1) It must take place in the same region and at the same season.

(2) The mimicking species must not itself be protected.

(3) The mimicking species must be considerably rarer than its model. Otherwise the predators would have more pleasant than disagreeable experiences and would hunt the disagreeable species as well, looking on the occasional unpalatable capture as an unfortunate accident.

[1] Notwithstanding the fevered explanation of Strindberg in *Inferno*, who said the moth lived on the juice of henbane, which led to megalopsy, or enlarged vision, and that the insect also frequented charnel houses and thus often saw skulls: he thought that the image became printed on its thorax in the same way that a pregnant woman was said to have a picture of a particular craving impressed on the body of her baby.

(4) The mimicking species should differ from its own group by external characteristics clearly visible and able to create an illusion.

(5) The mimicking characteristics should be only superficial and should produce no fundamental change in the species.

More and more butterflies were found which fulfilled these conditions. Nevertheless the edifice so cleverly protected by such elaborate regulations gradually crumbled under the sheer weight of evidence brought forward. To begin with, butterflies of kinds all equally distasteful to predators were found imitating each other (Müllerian imitation, after the entomologist Fritz Müller). A reason had to be found for an apparently useless imitation which contradicted Wallace's second law. It was postulated that under these conditions this mimicry served to teach the predator, which, without such a simplification, would not remember, or would only learn slowly, the pattern and colours which indicated that the insect was neither pleasant to eat nor digestible. At times three hundred protected species were found in one region: if they all had different patterns the predator would doubtless find it difficult to remember them all. A smaller number of designs makes it easier to register the patterns in the mind.

Later on F. A. Dixey established the fact that not only does the rarest species copy the commonest, but also the commonest, in its turn, imitates the appearance of the rarest (contrary to Wallace's third law). Moreover, cases have been reported of mimicry among species inhabiting very distant areas. Thus certain Chinese butterflies imitate the *Hypolimnas misipus*. Poulton supposed, ingeniously, that this mimicry was for the purpose of deceiving migratory birds. *Papilio antimachus* mimics the appearance of an enormous *Acrea*. Roland Trimen, celebrated for his studies of South African butterflies,

conjectured no less ingeniously that there was once upon a time a large *Acrea* in existence which has now vanished.

Up to now, more and more subtle, but less and less convincing, reasons have been found for these phenomena. But there is a more serious matter to come. In 1919 F. A. Dixey found that *Delias*, a pierid with yellow gold underwings and black and red spots, was perfectly imitated by another pierid of the *Huphina* genus and by nymphalids of the *Mynes* genus (for instance, in the Sunda islands *Huphina laeta* copies *Delias splendida* and, in New Guinea, *Mynes dorica* and *H. abnormis* mimic *D. ornytion*). Now all these butterflies are pleasant to eat and sought after by predators.[1] It is the same in the case of the *Charaxes*, which are but little protected and imitate each other,[2] and also for the pierids *Dismorphia*, the *Physiodes* and certain *Papilio*.[3]

At best it is a question of an entirely useless characteristic, and logically, if one applies the reasoning underlying the Müllerian argument, it is indisputably a damaging phenomenon. In effect it leads equally well to the training of the predator, who this way learns more quickly how to identify pleasant-tasting butterflies. In its greed it does not have to hesitate between different and confusing patterns: all the nice-tasting prey has, in effect, had the decency to wear the same uniform. If the mechanism is useful in one case it must be damaging in the other. It is better to suppose that it is inoperative in both cases and to give up the idea of any presumed utility in Müllerian mimicry.

However, there are numerous examples of Batesian mimicry, conforming to Wallace's rules. It is time to examine the hypotheses implied. Batesian mimicry is based on the idea of a gradual change drawing the mimic

[1] L. Chopard, *Le Mimétisme*, Paris, 1949, pp. 203-204, fig. 84.

[2] E. B. Poulton and C. F. M. Swynnerton, paper given at the *International Entomological Congress*, Zurich, 1923.

[3] L. Chopard, *op. cit.*, p. 197.

nearer to the model. In each generation there are a few individuals with an infinitesimal modification which makes them a little more like the model. Only these survive and the law of the survival of the fittest eliminates those less like the protected model. The cycle starts again and induces further eliminations, each time more far-reaching and more and more exact. In the end the survivors wear a livery almost indistinguishable from that of the unpleasant-tasting species. Mimicry is thus a phenomenon which is explained by the sole mechanism of the struggle for existence.

When presented in this fashion the argument seems unanswerable. But it does not bear close examination. Supposing a bird's keenness of sight is slight, what then is the point of an almost exact sameness at the end of evolution? The vaguest similarity of colour, let alone pattern, would have been enough. But supposing a piercing eye allows the bird to distinguish the smallest differences in colours or patterns, then it would be still easier for them to distinguish the first tell-tale differences, and it becomes the harder to understand how the mimicking pattern ever started to develop. In short, at the beginning of the movement when the difference between the mimic and the model was considerable, there was only a slight difference between individuals of the mimicking species. The bird would not have spared those who showed just a trace of the future imitation and who, still near the evolutionary departure point, were almost as different as the others from the protected model. One cannot see how the transformation could ever have got under way. The dilemma is clear: if birds have good eyes then the process cannot be understood at its starting point, and if they have bad ones, then it is unintelligible at the end of the period. One must suppose that birds have good eyes, and, all of a sudden, with no intermediate stages, a change made the mimick-

ing butterflies more like the stranger species than their own. It is very likely that this was the case. But we must say so clearly and abandon the idea of a slow, cunning change by means of imperceptible steps.

Moreover, it is not absolutely certain that the birds were caught in this trap. Certainly naturalists have easily been deceived when they have not carefully examined the wing venation of Lepidoptera. For instance, mimicking females have been described as females of *Danaus chrysippus*. Moreover the *Danaus* themselves have been deceived and have chased the females of a nymphalid, *Hypolimnas misipus*, in mistake for their own. However it has been disputed[1] that the birds were so easily deceived, because even a brief experience would be enough to enable them to recognise the mimic in flight. I set this objection aside, for it is contradicted by several observations in the opposite direction. What remains is that the hypothesis now rests on one fundamental fact, which seems to be most uncertain: do birds eat a big enough proportion of butterflies to make it essential for the survival of species that non-protected butterflies should mimic the protected ones? The reply seems quite clear: unprotected and non-mimicking species are in the majority. They survive and breed without the help of any disguise.

Of course it is easy, in fact too easy, to say that they are doomed to extinction. Besides, there is something else: the relative rarity with which the remains of butterflies' wings are found in the stomachs of birds, in spite of numerous observations made in many countries. In 1932 W. C. McAtee published the results of a big enquiry on the stomach contents of about 80,000 Nearctic birds. The examination was done systematically from 1885 onwards, under the control of the United

[1] W. Schaus, *First International Entomological Congress*, Brussels, 1912.

States Biological Survey. Traces of more than 237,000 victims were found, of which 88.77 per cent were arthropods; of these 90 per cent were insects. Many of these insects had the benefit of different sorts of protective devices of the kind that, in principle, give them this desirable immunity to attack and which less gifted species seek to obtain by the subterfuge of mimicry—a disagreeable smell, an unpleasant secretion, a venomous sting. Many other victims in the process of being digested showed cryptic or warning colours. In general terms the proportion of victims in birds' stomachs appeared to show only the relative abundance or scarcity in the country and the degree of facility in capturing them.

McAtee concluded by affirming the complete uselessness of mimicry. Birds feed at random among the prey available. G. A. Marshall raised the objection that this survey was made in a region where mimicry was rare. Others emphasized that the survey provided inadequate information about the Lepidoptera found in the stomachs. These are weak objections. In spite of the observations accumulated by the advocates of mimicry the number and success of the attacks of birds on adult Lepidoptera—protected or not—are far from being established.[1] I wonder at times if more is not presumed than is verified; so important is it to justify mimicry, which seems ridiculous the moment that it appears to be useless.

Now if it is useless, hence inexplicable by the struggle for existence, what can be done? The theoreticians are then tempted to postulate that it does not exist, as for example did a Brother Heikertinger. They maintain that the mimicry only deceives the human eye, or rather human imagination, always ready to find strange resemb-

[1] It must also be noted that predators can adapt themselves to a one-time unpleasant diet. For instance, the European cuckoo feeds mainly on caterpillars with urticating hairs: it regurgitates these in little balls.

lances, as it does in the shape of clouds, patterns of bark, cracks in walls. This new position is a strong one; here all one needs to do is to be firm and inflexible. All resemblance is either denied or attributed to chance, to an arbitrary interpretation, to an inevitable converging of the breeding lines due to identical environmental conditions.

It is worth while looking at the question again from this point of view. It so happens that genetics offers some strong evidence in the case of the so-called polymorphic butterflies; here several kinds of females, thought for a long time to be distinct species one from the other, had only one kind of male among them. These females, wearing liveries differing greatly one from the other, mimicked other species and even other families. The classic case is that of the African *Papilio dardanus*, known since 1776. The male was described by Cramer in the following year under the name of *Merope*. In 1867, during a visit to London, Roland Trimen was struck by the fact that in all the collections he had ever catalogued all the *Merope* were males and all the nearly related butterflies, described as distinct species by the experts, were female: for instance: — *Niavius* Cramer, *Cenea* Stoll, *Trophonius* Westwood, *Dionysos* Doubleday, *Hippocoon* Fabricius. In a remarkable paper, published in 1869,[1] he concluded that they were polymorphic female forms of *Merope*. The report was laughed at. W. C. Hewitson wrote: "one needs a powerful imagination to admit that, on the African continent, this male, always identical in appearance, is accompanied by a harem of completely different females."[2] He was not content with this sarcasm and produced a female *Merope* from Madagascar exactly like the male.

[1] *On some remarkable mimetic analogies among African Butterflies, Trans. Linn. Soc. Zool.*, XXVI, pp. 397-522.

[2] L. Chopard, *op. cit.*, p. 211.

In 1874, Mansel Weale raised some caterpillars from a single batch of eggs. He obtained 7 male *Merope*, 4 female *Cenea*, 1 female *Trophonius* and 1 female *Hippocoon*. The experiment was confirmed by numerous other breedings from single egg batches. Many kinds of females of *Papilio dardanus* were found, the majority of them mimics. In Madagascar there is one just like the male, the one found by Hewitson. These mimics copy not only the livery of the model but also their style of flight.

In the sub-species *Merope* the form *Trophonius* mimics *Danaus chrysippus* and the form *Planemoides* the danaid *Planema poggi*; in the sub-species *Cenea* the forms *Cenea* and *Hippocoon* respectively mimic *Amauris echeria* and *A. niavius*. There are many intermediate sub-species which are the results of crosses. What is more, a mimetic form can be found in many sub-species: for instance the *Trophonius* form, which is found in all, or the *Cenea* form, frequently found in the sub-species in East Africa. On the other hand, the *Planemoides* form is only found in the sub-species *Merope*.[1]

Thus the females of one butterfly species imitate several different butterflies belonging to different species, and these mimics are not distributed according to the geographical differences which lead to the development of distinct local races. Undoubtedly mimicry exists and exists in its own right as an autonomous mechanism.

The study of regional variations of species provides another proof. Certain butterflies have differing forms according to the region in which they live. And the mimics adapt themselves to these different forms. Thus the numerous variations of *Heliconius* in the Upper Amazon (*H. pardalinus, H. aurora*) or in the Lower Amazon (*H. sylvana, H. egina*), in Nicaragua (*H. zuleika, H. formosa*), in Guatemala (*H. telchinia*), in New

[1] L. Chopard, *op. cit.*, pp. 210-15. A. B. Klots, *Vie et Moeurs des Papillons*, Paris, 1957, p. 121 *et seq.*

Granada (*H. ismerius, H. messene*), and in Peru (*H. aristonia*) are all imitated by corresponding variations of *Melinaea*. Cases of this impressive and impeccable parallelism also occur in Africa. Once more it is impossible to think of local conditions leading to such a series of converging homologues. In effect, when different mimics start to resemble one model the resemblance is obtained by different processes, which would seem to exclude a single determining factor, that of the environment on the different imitators. Several butterflies living in the interior of Brazil have a livery which makes them almost invisible. They seem to mimic the danaid *Ituna ilione*, which has translucent wings. A reduced number and narrower scales give the same transparence to the wings of an ithomiid (*Thyridia confusa*); smaller or less numerous scales lead to the same result with other species, for instance in the case of the pierid *Dismorphia orise*. With *Castnia* the scales have lost their pigmentation and are tilted to let the light pass through them; those of *Anthomyza* are normal but transparent.[1] Needless to say, the shapes and patterns of the wings are remarkably alike.

There seems to be no doubt about these transformations, these disguises, and one could quote many more examples.[2] Why, then, are there these resemblances, these imitations, which seem to have no survival value and for which neither the environment nor plant food seems to be in any way responsible? Everything seems to happen as if they were following a *fashion*, to which each species adapts its livery by the means at its disposal: it is a slow-moving fashion, one where the changes take thousands of years, not a season, and which is concerned with whole species and not with individuals.

[1] L. Chopard, *op. cit.*, pp. 206-208. A. B. Klots, *op. cit.*, p. 122.

[2] L. Chopard considers the most convincing demonstration to be the ten plates in H. Eltringham's "*African Mimetic Butterflies*", Oxford, 1910. See also Klots, *op. cit.*, plate 55, p. 161, addenda p. 97.

But in the case of man, fashion is also a phenomenon of mimicry, of an obscure contagion of fascination with a model which is imitated for no real reason. It is then rapid and freakish. It changes clothes, the arts, literature, all the external and free things which are capable of constant modification. With insects, it must again be stressed, the variation is incorporated in the organism itself, is not the result of any initiative and, once acquired, is immutably perpetuated through ages of time that the human can only grasp with difficulty. I know that almost everything leads one to protest that the word fashion merely introduces a metaphor, almost a play on words, that it uses a poor subterfuge to hide the essential mystery. I know the idea comes as a shock at first and that nothing can be admitted until the matter has been thoroughly studied and proved. But first of all it is necessary to get rid of prejudices and to break up the pernicious and sterile alliance that unites mimicry and biological utility in the minds of the specialists: most of the time they cannot think of one without the other. My aim is above all to put research on to a new track.

If I dwell overmuch on the matter of these butterflies with polymorphic females, creatures that imitate in so striking a manner so many different prototypes, if I dwell on the inexplicable convergence which, in one and the same area, makes butterflies of widely separated species almost indistinguishable, it is to try and establish the fact that in the world of living things there is a law of pure disguise: that there is a leaning towards the act of passing oneself off as something or someone else, clearly seen, indisputable and in no way to be accounted for by any biological necessity connected with the struggle for existence or natural selection. How this is done, its mechanism, remains a mystery. Here the wings of butterflies are modified to become perfect imitations

in shape, pattern and colour of other wings. But in other cases, it is the whole morphology of the insect that this autoplastic energy may have been led to change. It is as if it were given to the insect to possess the strange faculty of designing its own appearance. I say "appearance" advisedly, because it is only the external appearance that is altered. The rest of the disguised animal keeps the distinctive characteristics of the species. Beetles imitate each other. The lycids, close relations of the lampyrids, have an unpleasant taste. They are imitated by many other beetles, but the larvae remain different. Only the adults copy each other. Butterflies, such as the *Sesias*, copy wasps: *Aegenia apiformis* copies both the form and the flight of the hornet *Vespa crabro*.[1] *Macroneme immanans* has the appearance of a black ichneumon and flies in its company.[2]

In general, there are numerous insects that mimic wasps, bees and ants. Beetles, butterflies, moths and Orthoptera adopt indifferently the necessary colours, shapes and behaviour.

If it is a question of being like wasps, the wings become transparent; the abdomen is joined to the thorax by a narrow waist: the body is composed of alternate black and yellow bands: the flight becomes noisy, quick, zigzag and easily vertical, unlike that of a butterfly. The false wasp easily takes one in.[3] To look like an ant other ruses are employed. White patches disposed here and there on the body seem to narrow it to the required size and simulate the waisting that makes an ant recognisable at once. In the case of Orthoptera, in order to

[1] P. Pesson, *Le Monde des Insectes*, Paris, 1958, p. 51

[2] H. B. D. Kettlewell, "Brazilian Insect Adaptation", *Endeavour*, XVIII, No. 72, Oct. 1959, p. 200, fig. 15. Compare fig. 16, the caterpillar of *Phoebetron* (*Euclidae*) is a striking mimic of a spider.

[3] Photographs in A. & E. Klots, *Living Insects of the World*, London, 1959: *Milesia virginiensis*, plate 126; *Sesia apiformis*, plate 65; *Hemaris fuciformis*, p. 160, etc.

help the deception, the insect ceases to jump and takes to the zigzag walk of the ant.[1]

This mimicry is so frequent that special names have been given to it—*spheco-morphism* for wasps and *myrmeco-morphism* for ants. It is true that the ant and the wasp are both well protected, the former by its sting and the latter by its corrosive secretion. However, numerous predators are not deterred by either, notably toads (not to mention ant-eaters) which make ants their usual food—in spite of the formic acid. Once again the protection afforded by mimicry is, to say the least, doubtful.[2]

One way or the other, useful or not, the plasticity of living organisms which makes mimicry possible is clearly demonstrated by the wings of polymorphic female butterflies. It affects the entire body of the insect when the creature passes itself off as a wasp or ant, which in truth, it is very far from being.

The metamorphosis, the adaptation, can be more complete still, yet more ambitious, leading to a perfect imitation of a leaf, a twig, a thorn, bark, moss or a stone. These things seem to absorb the creature into the environment where it lives and to hide it from sight. This is then no longer a question of disguise, but of camouflage. Such transformations may be even more disconcerting.

[1] Numerous cases in L. Chopard, *op. cit.*, pp. 217-232.

[2] C. F. Bequaert, *Bull. Am. Mus. Nat. Hist.*, 1922, p. 217; *Zool; Anz.*, 1930, p. 163. L. Chopard, *op. cit.*, p. 307.

CAMOUFLAGE

CAMOUFLAGE IS THE blending of the animal into the pattern, the environment; it is a search for invisibility. To attain this objective it is essential for the animal to lose its identity, that is to say to efface its outline, to assume one even colour or, on the contrary, to have a gaudy pattern, without which adaptation it would be conspicuous. Above all, it must remain still: every movement will give it away unless such movement is one in keeping with the surroundings. Thus the mantis which imitates a flower sways, or rather allows itself to be swayed by the breeze, just as are the neighbouring flowers and leaves, so as not to give itself away by an abnormal immobility. The living creature must not reveal its presence and many are the means adopted to secure this end: they run from the borrowing of things in the surroundings, or a simple change of colour, to the achievement of most surprising resemblances, such as stick and leaf insects, where colour and shape combine to produce a perfect illusion.

To disappear into the surroundings the animal can cover itself with such stuff as it finds around it, bits of vegetation, small stones, moss, dust. Caddis-fly larvae form tubes of all sorts of bits of debris. A spider described by Bristowe in Brazil, and by Hingston in Guiana, does not look like an ant but has its zigzag walk and above all carries above its body the dried and empty skin of a true ant, which quite conceals the spider. The observer thinks he is seeing a dead ant being carried by a live ant.[1]

[1] Hugh B. Cott, *op. cit.*, p. 409.

The above case is exceptional. In general the device is less finished, more mechanical. For instance, many scarab beetles just cover themselves with their own excrement. Others use the froth and wax they secrete or the remains of the creatures they have devoured. This kind of camouflage is particularly common among spiders.

The "assassin bug", *Reduvius redivivius*, which uses its legs to cover itself with dust, will use dull or brilliantly coloured dust indifferently: it is just trying to get covered, to lose its appearance of insect. In the same way oxyrhynchus crabs fix a tangle of all sorts of living organisms and bits of dead animals on their shells. They are not seen beneath this composite cover. If a shell is cleared they will cover it again, quite blindly, with many different kinds of things, testing with their claws the solidity of the structure. They clothe themselves with what they find to hand, even with newspaper or strikingly coloured paper. It does not matter what. The essential thing for them is not to appear to be crabs.[1]

The hermit crab captures sea anemones, which it fixes on its borrowed shell and which it carries to a new one when it changes shells. The dorippe sticks fish heads and small dead crabs on its back. The case of the gasteropods of the genus *Xenophora* is yet more curious. They have two methods of concealing themselves. The first consists of heaping up small stones in no sort of order on the shell, putting them among the spines haphazardly so that they look like a jumble of stones and chalk. At other times *Xenophora* seem to choose suitable fragments with great care, arranging them in an orderly fashion along the spiral of the shell, to take the place of the natural spines and projections of neighbouring species.[2]

[1] The experiments of Aurivillius (1889) and L. M. Jones (1938). Paul Vignon, *Introduction à la biologie expérimentale, Encycl. Biol.*, Paris, 1930, vol VIII, pp. 339-348; L. Chopard, *op. cit.*, p. 172.

[2] Cf. P. Vignon, *op. cit.*, pp. 320-329, plate V and fig. 628-632.

This last procedure shows that the use of external materials fulfils the same concealing function as do the modifications of the body which, in homotypy, transform the appearance of the animal. In fact the long spines that lengthen the shell of *Murex angulifer* or *M. tenuispina*, or of *Trochus dentatus*, are so like the long, thin spines of the polyps that they are difficult to find on the coral reefs on which they live.

In most cases the animal has no need to borrow external materials in order to become invisible. In the simplest case a change of colour to that of the environment is enough. In the most surprising cases the entire structure is modified, with an extraordinary luxury of detail, in order to achieve the deceptive appearance.

I will start with examples about which there can be little dispute and which seem to be quite "natural". But are the others any less so? They also belong to nature. Whatever may be the reason no-one is surprised to find the snow fauna white, or that of the desert sand- or stone-coloured, or the roadside grasshopper grey and the meadow grasshopper, like the Amazon parrots and the snake *Bothrops viridis*, emerald green, and so on to infinity. Today, around big towns, the wings of butterflies gradually darken. These adaptations are hardly disturbing: the animal is merely vanishing into the background. The case of the mackerel, which has to melt into two different backgrounds, is scarcely more complex: dark-blue back, the colour of deep ocean water; white belly, the colour of surface water and of the sky. It is thus invisible from whatever side it is looked at.[1]

On the other hand animals living in a forest would immediately be seen if they were of one colour only. They would show up clearly in the light and dark mosaic

[1] A phenomenon called *"reverse shade"*, discovered by Abbott H. Thayer.

of vegetation. Hence we get the striped or patchy colouring. A big-game hunter took some photographs of tigers, which he could clearly see, against a background of bamboos. When the film was developed the tigers had disappeared: the alternate black and yellow stripes were hopelessly confused with the vertical lines of dark and shade of the bamboo forest. The man, who knew in advance what a tiger was like, from pictures in books and visits to the zoo, had no difficulty in recognising the beast, but the creature was not visible to an inexperienced eye—the camera lens.[1] In the same way pythons and boa-constrictors, ingeniously coloured green, would immediately be given away by their shape among the vegetation of the virgin forest, but in fact the marbled pattern of browns and reds breaks up the too long, easily recognisable form of the snake and invites the beholder's eye to look at the various parts of the body as a different entity.[2] These colours, known as "disruptive",[3] are very common. They split up and disperse the appearance of the object: most often by means of one or more bands of a bright colour breaking up the neutral background colour. This can be seen on the skin of frogs;[4] the same thing can be found with the scales of fish and on the wings of butterflies[5] or moths (Noctuids and *Phalaenas* particularly). The bands of colour break up the characteristic contours and deceive predators, who see nothing but meaningless spots.

[1] Photographs by J. Berlioz, noted by L. Chopard, *op. cit.*, p. 57.
[2] H. B. Cott, *op. cit.*, p. 58, fig. 11; pp. 66-67, fig. 18.
[3] Studied in detail by H. B. Cott, *op. cit.*, part I, chaps. 4 & 5, pp. 48-102.
[4] For example *Megalixalus fornasinii*, H. B. Cott, *op. cit.*, pp. 68-9, fig. 19; p. 156, plate 21.
[5] For example *Xanthorhoea fluctuata* (Hampshire) H. B. Cott, *op. cit.*, p. 64, plate 10: the black spots on the wings destroy the typical triangular shape of the moth at rest; *Pachyx strataria* (Sussex), p. 80, plate 11; other invisible Lepidoptera: p. 236, plate 30; p. 252, plate 32; p. 256, plate 33.

In all cases the animal has a settled and fixed colouring which it has to make use of to the best advantage. Noctuids, *Phalaenas* and geometrids are particularly good at this and align themselves when at rest so that the axis of the body runs the same way as the lines on the bark of the tree: in this way the transverse disruptive bands of colour on the wings fit into the general pattern of the bark. In other creatures, the skin colour can vary and changes according to the habitat, as happens with the chameleon, many spiders, shrimps, frogs and the majority of flat fish.

Sometimes it is not only the colour of the creature which adapts itself to the background, but also the shape. There are some remarkable examples among the vertebrates, among others the leaf-toad, *Bufo superciliaris*, which is quite flat,[1] the leaf-fish of the Amazon, *Monocirrhus polyacanthus*, which looks like a dead leaf at the bottom of the river,[2] the fishes *Antennarius marmoratus* and *Pterephryne tumida*, which are provided with leafy appendages making them look like floating algae.[3] Perhaps the most striking case is that of a sea-horse of Australian waters, *Phyllopterix eques* or sea-dragon.[4] This creature disappears behind the branching filaments which extend its outline in every direction. Its shape is broken up into wavy fronds which sway with the current. With rock fish, mimicry of colour and shape is carried to the extreme and it is just here that it is most useless. In fact the visual perception of fish is particularly weak: they can only see light and movement. Moreover, these fish, as soon as they are threatened, take refuge in the maze of channels and cracks in the

[1] H. B. Cott, *op. cit.*, p. 304, plate 37, and *Bufo typhonius*, p. 292, plate 35.
[2] H. B. Cott, *op. cit.*, p. 312, fig. 63.
[3] H. B. Cott, *op. cit.*, p. 340, fig. 70 and 71.
[4] H. B. Cott, *op. cit.*, p. 341, fig. 72; see also L. Chopard, *op. cit.*, p. 87 and fig. 24.

rocks, narrow corridors which are perfectly safe for them.

As everyone knows it is the insect world that furnishes the most spectacular cases in this field. Stick insects are hard to distinguish from twigs. *Trychopeplus thaumasius*, with lobed body and legs, seems to be a small branch covered with lichen. Among the mantids, *Stagmatoptera deroplatys* and *Chaeradodis rhomboidea* resemble leaves,[1] *Leptocola giraffa* (of Africa) looks like dried grass;[2] *Idolum diabolicum* and *Gongylus trachelophyllus* (of India) appear to be flowers, to the extent that the natives of Midnapore call the last-named the "rose-petal insect". In the Indo-Malayan region, the mantis *Hymenopus coronatus* was studied first by Shelford and then by Jacobson: in its larval stage the insect is yellow with red bands on yellow flowers with red stamens; it is pink on a pink flower and white on a white flower.[3] A caterpillar will try and complete the leaf it is eating by stretching out its body to cover the consumed part so as to give the impression of a complete leaf, one without a caterpillar.

The butterfly *Kallima* looks like a dry, spear-shaped leaf, with a main nerve and a petiole. Female phyllid beetles mimic green or yellowing leaves.[4] The great sculpting of the wings of *Draconia rusina*, of Brazil, studied by Poulton, the transparent windows, filled with fine veins, while the scales stand out on the wing more

[1] H. B. Cott, *op. cit.*, p. 352, plate 40.

[2] L. Chopard, *op. cit.*, p. 112, fig. 42.

[3] L. Chopard, *op. cit.*, p. 116, fig. 44: see other examples in R. Caillois, *La Mante religieuse*, Paris, 1937, pp. 34-5.

[4] L. Chopard considers the lobed shape of this phyllid's legs to be excessive and "almost harmful": he says that the insect left with its elytra and without these flattened appendages would resemble a leaf still more. In fact, the lobed legs help form the general outline of a leaf, because the insect holds them against its body and not spread out as they are in insect collections. Ordinary legs would be much more visible.

strongly, give it the appearance of a mouldy leaf attacked by a fungus and gnawed at by caterpillars.[1]

The grasshoppers *Pterochroza*, studied by Paul Vignon, of which genus some sixty species, all in Central America, are known, show the same characteristics: wings with irregular notches, mimicking half-eaten, torn or diseased leaves. The shape and depth of the indentations, always symmetrical, vary with the species and even with the individual. With *Anommatoptera manifesta*, spots show the attack of a parasitic fungus. The elytra of *Pycnopalpa angusticordata* have pale transparent spots allowing a network of brown veins to be seen, as with *Draconia rusina*, as if some minute larvae had mined inside the leaf. A mycologist, to whom Vignon showed one of these grasshoppers, not only said it was attacked by a fungus but also named the species.[2]

There are innumerable examples. The *Phloeidae* of Brazil imitate and are mistaken for lichens,[3] the *Chlamys* grain, the *Umboina* spines, the Thomius spiders bird droppings.

What is more, their attitudes complete the picture. The insect instinctively adopts a position which enables it to make the best use of its resemblance. Thus a certain difficulty arises in deciding whether this is a simple illusion or whether it is a striking case, but of no real consequence, of a similarly directed adaptation by both plant and animal. Because the resemblance is *exploited*. The stick insect lets its long legs hang down; *Kallima* stretches the long tail of its wing along the stalk so as to make it look like the petiole of the leaf it is mimicking. The mantids that look like flowers sway backwards and forwards as though moved by the breeze. The butter-

[1] H. B. Cott, *op. cit.*, p. 336, plate 39 1; L. Chopard, *op. cit.*, p. 142.
[2] L. Chopard, *op. cit.*, pp. 136-141, fig. 57-59.
[3] P.-P. Grassé, *Traité de Zoologie*, Paris, 1951, vol. X, part 2, *Hétéroptères*, p. 1750, plate VI; p. 1795, fig. 1585.

fly *Meticulodes spongiata* rolls up its front wings so as to give the impression of a twisted leaf. Some looper caterpillars hold themselves stiff and erect, like the twigs they are imitating, so that at times gardeners cut them with their pruning secateurs. *Clolia*, in Brazil, arrange themselves in a line on a stalk so that they appear to be a string of blossom.[1] *Euglyphis braganza* Schaus is a perfect example of the subtle use of a body pattern. H. B. D. Kettlewell describes it well.[2] "When dead and mounted this very ordinary-looking moth is remarkable for one thing only, namely for having a white pattern on the costa of the hind-wing, an unusual position for patterning. This becomes intelligible only when the insect is seen alive at rest. In common with others of the same genus, this moth has a habit of passing the day motionless on tree trunks, with the anterior border of the hind-wings projecting beneath, and in front of, the forewings. The adaptive significance of this hind-wing pattern now becomes apparent: it blends with the white markings of the fore-wings and the advantage of this is that the protruding hind-wings tend to break down the outline of the moth and to merge it into the patches of white lichen on which it sits."

[1] I quote this as an example in order to complete the story, but in principle I am not considering collective mimicry. Here the resemblance is obtained by the association of several members of a species, which individually would bear no perceptible resemblance to the model. For instance, the caterpillars of *Hypsa monycha*, hardly visible singly, range themselves in parallel around a stalk and so look like a tasty berry. An unfortunate trick, because a bird, which would have left them alone as individuals, is drawn to the fruit they appear to be when in a mass. In the same way the seven-spotted ladybird, in the neighbourhood of Ostend, forms groups of forty to fifty individuals pressed close together, which are easily mistaken for the yellowish fruits of the thorn sallow which supports them. Once again this can only be harmful to the insect. For my part I do not see in these phenomena, which are, moreover, aberrant, the slightest indication of mimicry but rather a spectacular and curious case of gregariousness (with perhaps an element of play, at least in the case of the *Hypsa monycha* caterpillars, where their acrobatic arrangement is obviously a concerted action).

[2] H. B. D. Kettlewell, *op. cit.*, p. 205.

Thus mimicry is useless, if not dangerous. The insect's enemies are stimulated by smell and movement, very rarely by the appearance of the prey. In any case there is superabundance of mimicking factors, an excess of similarity. The important thing is not, after all, the external appearance but immobility. Moreover, as Vignon well remarks about *Pterochroza* grasshoppers, a whole leaf is no less a leaf than a damaged leaf. What is the point then of the refinement of mimicking scars, moulds, or the transparent windows of dried or half-rotten leaves?

The phenomenon remains mysterious. Specialists tried first to explain it as a measure of protection against possible predators, then, replacing final causes by efficient causes, as a chance assembly of characteristics, odd enough no doubt to interest the observer, but quite commonly found and with nothing remarkable about them if considered separately. The trouble with this explanation is that it is not simply a question of a group of unrelated characteristics, strange but insignificant in many other cases, it is the only pattern (of characteristics) able to create the deception, and moreover the illusion is completed by the posture and behaviour of the creature, which is completely appropriate to the model it is imitating.

Above, under "disguise", I postulated a fascination with the Other, suggesting this as the reason for mimicry and the adoption, for no practical reason, of the appearance and behaviour of other creatures, an attitude which corresponds in man to his irrepressible love of disguise. I now postulate another tendency common to men and animals, the desire for a deceptive invisibility. This trick, this concealment of oneself, obviously has advantages in practice: one can escape from a predator or lull the fears of one's prey. However, the means used so much exceed the amount of mimicry needed that we have had to introduce a new concept, that of "hyperthely", to

explain the kind of aimless delirium of perfection in mimicry, of which insects provide such striking examples.[1]

The essential characteristic is the attempt to achieve invisibility for its own sake. This, together with the strange privilege which we must suppose that insects have of being able, at times, to modify their own structure, has given the incomprehensible results which today baffle the ingenuity of theorists.

With man too, invisibility is an ever recurring desire. It can be useful, in time of war, for example. Man has invented no better methods of camouflage to conceal himself, his machines and his installations than those of snakes and stick insects, namely contrasting colours and the use of foliage. Cloths painted with broad patches of contrasting colours break up an outline and make it disappear. At other times leafy branches are used as cover. But, as always, it is in man's mind, in the human imagination, that one must look for the true equivalent of the phantasm fixed in the anatomy or behaviour of an insect. Folklore all over the world abounds in cloaks and caps of invisibility. They are one of the commonest magic objects of legend. Children's games also show that to be undiscovered is a fundamental preoccupation. Moral invisibility, if I may call it that, is no less appreciated. In stories the hero is always the one who is not noticed, and the wonderful lamp appears to be quite ordinary. Romantic literature, above all popular literature, pays homage to the same obsession with invisibility, when it treats of people who, though all-powerful, are acting in secret. Masked by their feigned insignificance,

[1] Hyperthely is the excessive development of an organ. Instead of performing its original purpose it becomes at times useless, even dangerous. Thus, when of normal size, the defence organs of certain pachyderms, the tusks, are a fearsome weapon and their size contributes to their effectiveness. But during the ice age the tusks of some mammoths were excessively long: they rolled up in a spiral and were thus inoffensive and cumbersome.

or completely masked, they are above suspicion until the moment comes to reveal themselves. Then surprise is added to terror. The adversary is paralysed and defeated in advance.

Insects do the same thing: with them also camouflage prepares the way for intimidation and the invisibility is only there to secure the success of a frightening and sudden appearance.

INTIMIDATION

In the same way that a careful examination of the problem leads to a separation, to some extent, of the phenomenon of mimicry from biological utility, I ask myself if it is not equally opportune to separate them a little from the too strict notion of resemblance, which would seem to be the first essential in the correct use of the word.

In any case it is clear that resemblance plays only a minor part in intimidation, a subject traditionally studied as a special case of mimicry. It is, in effect, admitted that the insect, by its intimidating action, seeks to be mistaken for something larger, more powerful or to be feared. Then, to the extent that one assumes that the creature is making every effort to deceive, it is natural to class it as mimicry.

I have no doubt that there is resemblance here, but it is not the essential factor, any more than in the cases of disguise and camouflage biological utility is the essential characteristic. I suspect even that the resemblance is only the consequence of intimidation: it occurs because the means of intimidating are not infinite and probably are less numerous than the patterns, shapes and behaviour possible. It thus follows that certain forms or actions designed to intimidate will resemble each other without any copying necessarily having taken place.

1. Ocelli (Eye-spots)

Let us start with the simplest case, which happens also to be the clearest, that of the ocelli which, in fact, resemble eyes, but which, in my opinion, do not inspire fear on that account. Indeed, if pressed, I might almost say that, on the contrary, eyes are frightening because they resemble ocelli. The important thing is that the fixed and bright circular shape is a typical object of fascination.

The lower side of the wings of the butterfly *Caligo prometheus*, with two well-placed, broad brown ocelli, is often quoted as a remarkable example of mimicry. There are some convincing descriptions of it in the literature. And in fact the mounted butterfly, placed head downwards, gives a perfect impression of the characteristic features of an owl. The insect's body becomes the beak. The trouble is that, when at rest in real life, the wings of *Caligo* are folded one against the other, so that it is only in the collector's cabinet that the creature appears to be this noctural hunter. In nature, where the ocelli are never seen together by one and the same observer, it does not look in the least like an owl. Living, it is rather *Ophthalmophona claudaria* Schaus that unquestionably resembles an owl.

Moreover, a day-time butterfly such as *Caligo* would secure no advantage by resembling a night-time predator. In fact, when the owl does venture out during the day-time it is quickly mobbed by the small birds, and they would be agreeably surprised were they to find a prey, a butterfly, instead of an enemy, an owl.

It seems that the ocelli of *Caligo* frighten away small birds, and if the eye-spots are excised with scissors the birds are not frightened and the unfortunate insect is

eaten.[1] The phenomenon is doubly instructive, as it shows both the care that must be exercised in reaching conclusions and the field there is for experiment. The living insect must always be studied in its own environment. The observation shows that the ocelli of *Caligo* are of themselves frightening, without the butterfly's in any way resembling an owl. It is not true, as has been asserted, that *Caligo* frightens because it is impossible to believe that an insect would have such eyes. It is not a question of eyes, but of something shining, big, motionless, and circular, carried by a living creature and which, in effect, seems to be watching even though it is not an eye.

Ocelli are common. They are called *primaries* when they are visible all the time and *secondaries* when the insect only uncovers them to inspire fear. They are frequently found on the wings of butterflies and moths, particularly on sphingids and saturnids.[2] They are also found beneath the elytra of beetles, hidden when at rest, and on the wings of numerous acridians and mantids. They are likewise displayed on the segments of some caterpillars, where they play an especially important role. They are drawn on the carapace of coleoptera: a cassid, *Pseudomesomphalia contubernalis*, thin and

[1] Experiments made by Fassl. See M. Hering, *Biologie der Schmetterlinge*, Berlin, 1906; P. Vignon, *Introduction à la biologie expérimentale*, *Encycl. Biol.*, Paris, 1930, vol. VIII, p. 355. D. Blest (*Behaviour*, 1957, XI, p. 209) has shown experimentally that the rejection or acceptance of *Automeris* of South America by birds depends on the perfection of the ocelli on the hind wings. H. B. D. Kettlewell has also remarked that, when a bird, before eating a butterfly, lets it fall to the ground and the latter uncovers its ocelli, " the bird is startled and the butterfly escapes " (*op. cit.*, p. 208).

[2] H. B. D. Kettlewell (*op. cit.*, p. 208) considers that the ocellus occurs as a result of the normal working of natural selection. It starts as a dark spot, such as is found in *Syssphynx molina* Cram. A single gene transforms this into a dark area surrounded by a black circle (for example *Arctia caja*). A second gene gives a ring of contrasting colour and a third brings the white mark which, it is said, imitates the reflection of light on the pupil of an eye (as in *Saturnia pavonia* L.).

flat, can suddenly open its wings and uncover two ocelli, bright yellow in colour with a black centre. In *Heilipus ocellatus* they are of dark velvet, surrounded by light yellow. Two Elateridae, *Tetralobus gigas* and *Elater coquebertii*, sport them on their cylindrical helmet-shaped carapace. In the case of the *Cucujo* of Central America (*Alaus oculatus*) the two ocelli on the prothorax are also the light-giving centres.

Because of the symmetry of insects, ocelli are nearly always found in pairs, so that they seem to be eyes, not only because of their pattern and shape, but also because of their placing.

Nevertheless it may occasionally happen that the ocellus is single and central, like the eye of the Cyclops. It then produces its effect by its appearance alone. This is the case with the cassid beetles of the genus *Coptocycla* (Brazil). A single ring, which passes through the elytra and the thorax, covers the whole dorsal shield and, carried over three-quarters of the dark background, provides one big and bright circular spot.[1]

Ocelli are useful for frightening other creatures. Thus when the mantis, in order to stupify its victim, adopts its spectral attitude, standing up with its wings and legs extended, it displays two black ocelli on its wicked legs, legs which are soon going to seize a prey. Poulton studied the caterpillar of the sphingid *Pergesa* (*Choerocampa*) *elpenor*, which can draw in its first three segments and expand the fourth, on which there are two ocelli ringed with black. G. A. K. Marshall was able to frighten two baboons with a similar caterpillar, that of *Hippotion* (*Choerocampa*) *osiris*. It has the same colour as a poisonous snake, which also has two ocellus-like patches. The monkeys were overcome with "abject terror" and fled

[1] P. Vignon, *op. cit.*, p. 460. See also *Coptocycla arcuata* Swederus, *Plagiometriona praecincta* Boheman and *Metrionazona* Fab., *ibid.*, fig. 703-710, p. 461.

on to a roof.[1] According to Neave even certain natives would be impressed by the display of unexpected circles.[2] At rest the caterpillar of *Leuconampha ornatus* mimics a piece of wood. If attacked it turns on its back so as to display the ventral surface, which imitates the back of a snake. The thorax expands. On the fourth segment ocelli are found, suddenly bringing into view what looks like the triangular head of a snake, with black-edged yellow scales. Meanwhile the caterpillar grasps its twig with its anal clasper and sways as though it were a snake about to strike. The danger past, the creature resumes its normal attitude and appearance. The caterpillar of *Madoryx pluto*, also found in the north of Brazil, uses the same technique, except that its mask is not that of a serpent but one of a screech-owl: round the ocelli the colouring is that of the ring of feathers which in the bird give the appearance of a jewelled setting or a reflector surrounding the eye.[3]

Phenomena of this kind have been known for a long time. Bates reported them as early as 1863. Later Shelford, then the curator of the Sarawak museum, tells how he was deceived by a caterpillar of *Choerocampa mydon*, which he took for the tree snake *Dendrophis picta*. Chopard, who deals with the incident, thinks it well worth recording that the caterpillar's ocelli are exactly the size of the snake's eyes and "not, as in some cases quoted, out of proportion to the whole".[4] In this case there is too much realism. The whole point of ocelli and a condition for their success is precisely for them to appear to be enormous—out of proportion. It is not a question of looking exactly like the model but of creating an aura of terror.

[1] *Trans. Ent. Soc. Lond.*, 1902, pp. 397-398.
[2] H. B. Cott, *Adaptive Coloration in Animals*, London, 1940, p. 307.
[3] Miles Moss, "Sphingidae of Para", *Novitates Zoologicae*, 1920, XXVII, pp. 333-424; P. Vignon, *op. cit.*, pp. 368-373 and plate VIII.
[4] L. Chophard, *Le Mimétisme*, Paris, 1949, p. 242.

This can be seen in the case of the lobster-moth caterpillar (*Stauropus fagi*), where the same Chopard admits that it resembles nothing and suggests instead "an imaginary animal".[1] In fact the shock produced is all the greater if its source is strange and apocalyptical. From this point of view the caterpillar of *Papilio troilus* is remarkably successful. It too resembles nothing. Two immense ocelli, black on a white ground, simply make it monstrous. A minute, thin, light patch crossing the ocellus, and shaped like a crescent, gives the impression of the reflection of light on a wet pupil. From the head a bifurcated appendage shoots up, which seems to give the creature horns and which has, at the same time, a repulsive smell. There is thus a combination of visual and olfactory repulsion.

At rest, with its antennae down, only its forewings visible, the sphinx moth *Smerinthus ocellatus*, hanging from a twig, looks like a few dried up willow leaves. Suddenly the antennae rise up, the thorax expands and the abdomen is arched. The creature quickly unmasks on its back wings two big blue "eyes" on a pink ground, which transfix the aggressor to the spot, while the body trembles and shudders in a kind of spasm. It never flies away. If a too violent movement makes it fall to the ground, it continues to shudder in the same way.[2] Standfuss (1909) found that this frightened even birds—tits, robins and common nightingales.

I will mention one more example, because it has given rise to an ingenious theory. The chrysalis of the Ceylonese geometrid *Dysphania* (*Euschema*) *palmyra* carries two big black ocelli circled with yellow, among which a series of dark marks show as a narrow snout. According to G. M. Henry, who has described it, this appearance

[1] L. Chopard, *op. cit.*, Paris, 1949, p. 243.

[2] A. Japha, "Die Trutzstellung des Abendpfavenauges" (*Smerinthus ocellata* L.), *Zool. Jahrbücher Syst.*, XXVII, pp. 321-326; P. Vignon: *op. cit.*

can hardly be taken for a snake or a lizard, but it may very well remind an attacking bird of the fright aroused in it by the small lizard *Stenops gracilis*. In other words, the author maintains, the bird does not regard the chrysalis as its enemy reduced to minute proportions. Instead, the sight releases the fear reaction. In the same way, G. M. Henry goes on, the monkey does not think it is seeing a dwarf crocodile when it sees the strange protuberance of the Surinam lantern-fly.[1] But it is similar enough to a crocodile's snout to remind the monkey of a crocodile. I will give my own view of this later.

For the moment I content myself with recording the efficiency of ocelli. It has been attested by many naturalists, and certain of them, such as R. W. G. Hingston, have even stressed its importance, but always from the point of view of the insect's mimicking the appearance of some vertebrate predator, a cat, snake, owl or diurnal bird of prey. This was the reason, it seemed to Hingston, for the circular nature of the ocellus, which copied the pattern of the so much feared eye. Hingston lays stress on the characteristics which gave the imitation maximum visibility: good placing and a choice of colours in which black circled by yellow predominated.[2]

The same observer says that, of the almost bewildering variety of natural objects whose appearance is simulated by different animals, for purposes of protection—by concealment, by warning, by bluff or by disguise—it is not surprising to find that the eye, of all possible patterns, should have been especially singled out for caricature on the "masks worn in Nature's carnival of make-believe".[3]

[1] G. M. Henry, "The terrifying appearance of the pupa of *Dysphania* (*Euschema*) *palmyra* Cram." *Proc. Ent. Soc. Lond.*, 1926, 1, pp. 61-62.

[2] Experiments made with posters show that those having this combination attracted most attention. Hingston himself thought of the black pupil encircled with gold of the predator.

[3] R. W. G. Hingston, *The Meaning of Animal Colour and Adornment*, London, 1933. Quoted by H. B. Cott, *op. cit.*, p. 389.

Exactly, the question is to know whether the ocellus is a device, an imitation of an eye, and if its function is to make it appear that a vertebrate, not an insect, is present. It is well to remember at this point that every motionless circle is by nature hypnotic. To look at it for some time is troubling, paralysing and induces sleep. That a bright clear ring round a dark and apparently empty centre might moreover resemble an eye is assuredly an additional source of trouble and fright, a possible means of increasing fascination and vertigo. This ambiguity is added to the purely optical effect, and, in man, sets the imagination working.

It does not seem to me to be impossible to show that the ocellus is not a diagrammatic image of the eye, and that the similarity is only in the circular shape and pattern. The best proof, however, that we are dealing with two different things, of which one is not a reminder or image of the other, is that they can be combined. Among birds, owls are almost alone in having the eyes placed not on either side of the head, but on a flat disc-like surface, and both looking in the same direction. Moreover the owl's pupils are dilated and fixed in orbit. They remain central and motionless. The bird must turn its head if it wants to look to the side. Finally, each eye is surrounded by a golden ring and is placed in a circle of downy feathers which extends the ring to the edge of the face. The eyes of these birds of prey are thus turned into ocelli: huge concentric circles, motionless and shining. What is more, like the mantids and the sphingids, the owls also know a trance-like state, where they open their wings, ruffle out their feathers and raise their comb. As with the mantids and sphingids this spectral attitude immediately follows a condition of absolute camouflage, for the browns and greys of its plumage, as skilfully executed as in a grisaille painting, blend the bird and the bark perfectly. The immaculate white of

the great white owl does the same with snow. One only sees the immense eyes, which are no longer just eyes, that is, simple and ordinary organs of vision, but supernatural apparitions, as if come from another world, huge, blind, motionless and phosphorescent, with the fixed and strange perfection of geometrical shapes. Moreover, mythology supports the suggestion for there, almost without exception, owls are birds of ill omen.[1]

As I said, it is mostly an optical phenomenon. But in man the hypnotism is not complete. He feels the damaging influence without being paralysed by it. His imagination intervenes and develops, once the animal atavism is overcome, a belief in the evil eye. This belief is widely spread. The evil eye, that is to say the ocellus, projects bad luck, it carries a curse. One must fly from its baleful regard and protect oneself from it by a suitable countermagic. The best way is to turn it against itself and to interpose between the adversary and oneself the same fearful power of an eye charged with the same evil influence. Man thus paints enormous eyes on the bows of his ships or on his shields, to assure the defeat of his enemy and his own preservation.[2] Often he does not depict them as they are in life, that is, long or olive-shaped, with the arch of the eyebrow above. He quite frankly paints ocelli: concentric rings of contrasting colours, pure and abstract, foci of hypnotism and terror.[3]

2. *Medusa*

Once again, by working out the subject and examining the usual contrasts and contradictions, we find that insect behaviour explains man's mythology. It illuminates not only man's belief in the evil eye, but also the in-

[1] Athene is the exception, her owl being the emblem of wisdom.
[2] S. Seligmann, *Der böse Blick und Verwandtes*, Berlin, 1910, vol. II, pp. 145-150, fig. 105-116.
[3] S. Seligmann, *ibid.*, vol. II, fig. 91, 92, 104.

vention of creatures with looks that paralyse or kill, such as the Gorgon, catoblepas, basilisk and many others. It is worth while looking a little closer at this. According to Hesiod the Gorgons were three monstrous sisters (Homer mentions but one). Only Medusa was famous. They were the daughters of the Old Man of the Sea, Phorcys, and of Ceto. They lived in the Far West, beyond the river Oceanus which confined the world, near the Kingdom of the Dead and the country of eternal spring —the Garden of the Hesperides. Their arms were made of iron and they had powerful wings. Their bodies and garments were black. Their faces were circular, swollen with fury, frightening. Their hair was of snakes. They had flat noses and their huge open mouths showed a double row of savage teeth. Their eyes were big and flashing, really ocelli. They paralysed or changed to stone anyone who looked at them, or whom they looked at.

Polydectes, king of Seriphos, sought to seduce Danaë, the mother of Perseus. To get rid of her too vigilant son he ordered him to go out and cut off the head of Medusa, the only mortal Gorgon. Here we recognize a plot often found in popular stories and moreover the story of Perseus continues exactly like one of them. Hermes and Athene brought the hero to the three Fates, sisters of the Gorgons, who had only one eye and one tooth between them, which they used in turn. Perseus intercepted this single and common eye. He was thus able to force them to point out the place where the Gorgons lived. In addition they gave him some winged sandals, a bag and the helmet of Hades, which could make him invisible, that is to say the usual magic objects without which such an impossible task could not be performed. To these presents Hermes added a sickle and Athene a mirror. Perseus found the Gorgons asleep in a cave. Averting his eyes and using the mirror, he

cut off Medusa's head without looking at her. (I suspect rather that he used the mirror to reflect back her own fatal visage.)

The severed head still retained its power. Perseus kept his trophy in the bag the Grey Sisters had given him. With this invincible weapon he changed Atlas into a mountain, and Polydectes, as well as some others, into stone. He partly turned to stone the monster that guarded Andromeda, chained to a rock in the middle of the sea: the seaweed on which the bloody head of the Gorgon fell was turned to coral.

The story is quite transparent. It is merely an account of an initiation ceremony. The youth, given advice by his teachers and fitted out with all the necessary accoutrements, travels to the Other World, that is, he goes into the bush, or to the surroundings where the sorcerer is to carry out the ceremony. He has to submit to the test and win through in order to become a man and have the right to wear the mask which will make him a member of the class of male adults or of a secret society. Not till then can he carry the disguise and paralyse his enemies with fright.

The Gorgon's head is nothing more than a mask. It is not irrelevant to see in its intervention the belief in the evil eye, the hypnotising power of ocelli, clearly related to the wearing of masks in primitive communities, where often even the chance sight of a ceremonial mask by a non-initiate is a sacrilege bringing death, or at least the partial paralysis or the consumption of the bold or unfortunate person. And those in power will see to it that these expected results do indeed happen. At times they need do nothing, the thought alone will be sufficient.

According to some, Perseus buried Medusa's head beneath the agora of Argos, but others have it that he offered it to Athene, who asked Hephaestos to place it

on her shield. It is also said that Athene got the head as a prize of battle, or that Zeus, the only legitimate owner, lent it to Athene, and to other gods of sufficient rank, so that they might petrify their enemies. This fatal trophy is, like the eye, frequently found on shields.[1]

In classical times Athene carried it in the shape of a pectoral on the aegis. In fact the aegis is the double of the *gorgoneion*. It is the skin of the goat Aegis, so fearsome that the sight of it made the bravest tremble: even the Titans asked Gaia, its mother, to hide it. Consequently she shut it up in the grotto where Amalthea came to get its milk for the young Zeus. Later on Zeus used the skin to cover his shield.

Another fable represents Aegis as an enormous monster who created the earth by his own means. His mouth spouted fire. He burnt up Phrygia entirely and the Caucasian forests as far as India. Athene killed him and used his skin as a breast-plate.

The aegis was not always a close-fitting breast-plate made of scales on which shone the terrible head of Medusa. It could also be a large animal skin covering the torso at least as far as the loins. Put over the head, it hides the face and replaces it with the hideous mask of the Gorgon, with huge eyes, the tongue hanging between savage teeth and the hair a mass of writhing snakes. A painting from a piece of an Amasis vase[2] leaves no doubt on this point and makes one think that originally the aegis was the complete disguise and the *gorgoneion* the mask. From the beginning (for instance in Homer's *Iliad*, v. 737) this disguise and its accessory are at one and the same time offensive and defensive, spell-binding, paralysing, like the evil eye, like the ocelli of caterpillars, butterflies and moths.

[1] S. Seligmann, *op. cit.*, vol. II, pp. 130 *et seq.*, and fig. 218-220.

[2] Reproduced in Helbig, *Archäologische Zeitschrift*, 1844, table XV. Cf. S. Seligmann, *op. cit.*, I, p. 95, fig. 6.

On the Acropolis of Pericles and Phidias, the ancient mask has become no more than a calm, harmonious face, adorning the breast of the tutelary goddess. But the belief has only been shifted. Chased out of the sacred world, the head of Medusa has entered into folklore and her qualities have become attributes of the animal kingdom. Alexander of Myndos, cited by Athenaeus (v. 64), knew Gorgo not as the monster beheaded by Perseus but an animal in Libya resembling a wild sheep. It had such a heavy mane that it could scarcely shake it from in front of its eyes. But when it did succeed in doing so its look was mortal. Some of Marius' soldiers once saw it and, taking it for a wild ram, tried to capture it. The creature was able to raise its mane from its eyes and annihilated the soldiers with a single look.

The catoblepas, which Pliny placed in western Ethiopia, was equally formidable. Happily its head was so heavy that it dragged on the ground, so that its murderous glances were not too unfortunate for the human race.

Again, as with the Gorgon, the basilisk must be confronted with a mirror. Mentioned by Pliny and Galien, this fabulous reptile kept its place in bestiaries until the seventeenth century; for instance it appears in Aldrovandi. It can be killed by its own reflection. The surface of calm water is quite fatal to it.

Almost everywhere we see in man this tenacious, almost ineradicable, fear of the eye whose gaze paralyses, roots him to the spot, suddenly deprives him of thought, movement and will. He is afraid of finding himself in front of this circular device, which can bring unconsciousness or death, which can kill or turn to stone. He is terrified by it, but at the same time tries to use this instrument of terror so as to be master of it in his turn. He invents fabulous creatures with the sole object of wringing from them this paralysing power, against which

he feels defenceless, but which he hopes to take and use for his own ends.

To give rein to this urge, which he cannot understand and which the insects themselves obey, man concocts the idea of painting eyes, circles and masks, at once protective and aggressive. The insect, as usual, acquires them as part of the morphology of the species and carries them as an indelible part of its organism. Man puts them on his arms, ships, chariots and houses. Clumsily he tries to reverse the position. He devises elaborate superstitions in order to tame and use this mysterious force so that he too may substitute for his failing strength a power, imaginary but immeasurable, from which there can be no appeal precisely because it is illusory and mythical: in short, an invincible hypnosis. Once again the parallel is repeated, the ocellus is equivalent to the Gorgon's death-dealing look, the spasm and shudder of the caterpillar or butterfly to the trance and frenzy of the sorcerer. This time, after examining the evidence, the similarity is remarkably exact. Moreover, whether one wishes it or not, when the full details are examined, they all lead inevitably to the problem of the mask.

SORCERY

Sorcery, or—what amounts to the same thing—a belief in sorcery, cannot be explained unless it is based on a characteristic going beyond the limits of the species and which also precedes the species.

I DO NOT know if many entomologists have noticed that insects having ocelli are nearly always mimics and, if so, whether they have drawn the logical conclusion from this observation. Caterpillars looking like snakes or owls, or rather, those that disclose a mask, seem at first to be just bits of wood. They have to turn over before they resemble snakes. *Smerinthus ocellatus* at first looks like a few dry leaves. The mantid's colour is the same as its background. The big pterochroze grasshoppers, we remember, carry mimicry to a degree that is quite useless: their elytra perfectly imitate dead leaves attacked by a disease, with all the spots, galls and necrotic and transparent areas of decaying leaves. Now these elytra often conceal ocelli: for instance in the *Pterochroza* there are the genera *Tanusia* and *Ommatoptera*, with a significant name. The Surinam lantern-fly, we shall see, is also a mimic and carries ocelli.

Under these conditions the relationship between mimicry and ocelli cannot be due to chance. There is a connection between the two phenomena which is worth while exploring. For my part I find it in the mechanism used for the display of the hypnotic ocelli. It is not enough that they just exist: it is essential that they *appear*. Invisible at one moment, they burst forth into

view the next. Mimicry not only hides them but at the same time effectively conceals the insect. It fades into the background and cannot be discerned. Then all at once, where there was nothing, from a kind of absence or at least a neutral presence, difficult to place exactly, there suddenly appear two huge vivid circles, whose very stillness fascinates.

The disappearance into the background, the imitation of bark, of lichen, of leaves, around which most of the controversy on mimicry rages, are then not, or not always, the main functions of mimicry. They are only the preliminaries which serve to multiply the terrifying effect being prepared, one destined to produce panic. The insect uses the principle of the shutter-mask: it replaces one appearance by another, designed to frighten. Better still: where there was nothing there is suddenly a horror.

The insect knows how to frighten; what is more it gives rise to a particular kind of fear, an imaginary terror not corresponding to any real danger, a threat pure and simple, working through the strange and fantastic. And just because it seems supernatural, unrelated to the real world, coming from the beyond, it confounds the victim and seems to prevent any reaction on its part but paralysis or confusion.

The insect uses a consummate technique: the suddenness of its transformation and the accompanying mimicry with which it emphasizes the display of the ocelli. I have already described the frenzied trance of *Smerinthus.* Another sphingid, with cryptic and disruptive colours, *Amphypterus ganascus,* when attacked displays its red back wings. It has spines on its feet with which it wounds its rash attacker. The frightening attitude of the mantis is no less characteristic. The creature suddenly rears up as though moved by an electric shock: the elytra and the wings are opened and display their double spread: the abdomen is curved inwards and opened out in quick

shaking movements, with a sound of escaping air: the outspread predatory legs disclose black ocelli with white centres, described by the ever poetic Fabre as *"joyaux de guerre tenus secrets en temps habituel"*. A motionless bogy, the mantis, paralyses the liveliest jumpers there are. A cricket could, with a single leap, spring well clear of the monster's grasp, but it stays still, or it may even slowly approach the fatal apparition. Such events are frequent and well attested with mantids. *Pseudocreobotra wahlbergii*,[1] in its bogy attitude, turns upon itself so as always to face its enemy. *Eremiaphila braueri*, described by Roonwal, suddenly displays its brightly coloured wings, purple, edged with black, and rises on its hind legs. Roonwal walked round the insect, which turned with him, looking at him fixedly: it held this attitude for twenty minutes.[2] The Californian mantis, *Stagmomantis*, noted by Varley,[3] also turns to face its aggressor. *Idolum diabolicum*, described by Carpenter, is an essentially cryptic mantis; when it wants to frighten it pushes out its femurs, which have wide lobes marked with violently contrasting colours, and presents them perpendicularly to the enemy. At the same time the creature makes a sizzling and rattling noise by rubbing a wing against a leg. Monkeys are frightened by it.[4] According to Shelford a similar sound is produced by *Hestiasula sarawaca* of Borneo. The grasshopper *Ommatoptera pictifolia* Walker, which, in repose, looks like a dead leaf, when disturbed vibrates its elytra and dis-

[1] Observation made by L. C. Bushby in Portuguese East Africa (H. B. Cott, *op. cit.*, p. 388, fig. 81).

[2] M. L. Roonwal, "The Frightening Attitude of a Desert Mantis, *Eremiaphilo braueri* Kr. (*Orthoptera*, Mantidea)", *Proc. R. Ent. Soc. Lond.*, 1938, 13, pp. 71-72.

[3] G. C. Varley, "Frightening Attitudes and Floral Simulation in Praying Mantids", *Proc. R. Ent. Soc. Lond.*, 1939, pp. 91-96.

[4] G. D. Hale Carpenter, "Experiments on the Relative Edibility of Insects, with Special Reference to their Coloration", *Trans. Ent. Soc. Lond.*, 1920, pp. 1-105; H. B. Cott, *op. cit.*, pp. 212, 213, 216, 222.

plays vivid colours on the lower surface; it then shows the ocelli of its wings.[1]

Miming, sudden starts, hypnotism, production of strange and disquieting noises are all tricks of the sorcerer. Painted in vivid colours, or in white, decorated and masked, he may be found gesticulating on stilts, which make him larger than life (like the mantis when it rises on its hind legs), or he may dance, shake convulsively, producing a weird sound from a rattle whilst he conducts this liturgy of panic. In another work I had occasion to point out the great importance of the mask and of frenzy in the history of man. I give here a summary of the riddle, as far as I have been able to elucidate it.[2]

It is a fact that all mankind wears or has worn a mask. This enigmatic accessory, with no obvious utility, is commoner than the lever, the bow, the harpoon or the plough. Whole peoples have been ignorant of the most ordinary tools. They knew the mask. Complete civilizations, some of them most remarkable, have prospered without having conceived the idea of the wheel, or, what is worse, without using it even though it was known to them. But they were familiar with the mask. Man in general, the abstract and hypothetical man of the first ages and cultures, could say with more truth than Descartes, in any case in the literal sense, "*Je m'avance masqué*". There is no tool, no invention, no belief, custom or institution which unites mankind so much as does the habit of wearing a mask.

There is a mystery about masks: what are the reasons which everywhere have made man want to cover his face with a second one, an instrument of change, of ecstasy, of possession by the gods, which is also an instrument of intimidation and political power? Ethnology is full of

[1] H. B. D. Kettlewell, *op. cit.*, p. 203, fig. 17.
[2] R. Caillois, *Les Jeux et les Hommes*, Paris, 1958, pp. 136-154.

masks, spasms, trances, hypnosis and the panics which are the almost inevitable consequence of them. At this point I dare to put forward a new hypothesis: peoples belong to history and civilization the moment they give up the mask, when they reject it as a vehicle of personal or collective panic and strip it of its political function. But even thus debased to a simple accessory at a carnival or a fancy-dress dance, it is still disturbing and fascinating. Its power is held in check, on a rein, but it has not gone. At present all I wish to emphasize is that the question of masks is neither episodic nor localized: it affects the whole species.

At the height of its power the mask, in every case, seems to be a face at once adventitious, terrible and monstrous, that at one and the same time conceals and frightens; it unites and combines the two functions of mimicry and ocelli. Let us look at the masks from Africa and Oceania. They frighten because of the outsize horns that rise above them, by the huge and menacing snouts, by the eyes, black holes often set off by projecting circular stumps with a cavity in the centre, like the kerb stone of a well. I quite understand that the wearer of such a mask wants to acquire the qualities and force of his animal ancestors, to see himself as an animal, to leap, tear and bellow. The end he has in view is to frighten and cause panic. I will now leave on one side the mythology which sustains the practice of wearing masks. In principle it is essentially human: perhaps it is man's only real invention. But with regard to the subject of masks I must point out the alignment there is between behaviour and appearance, for instance, the sudden display, spasms, mimicry and the changes produced in many insects which have the double capacity of at first concealing themselves and then suddenly assuming a frightening appearance. But now to ocelli I add the useless, so-called decorative antlers of the stag-beetle, the horns

of numerous scarabaeoid beetles, the complicated and redundant head structures of *Sphongophorus, Cyphonia, Heteronotus* and the mask of the lantern-fly. It is time to consider these strange new items.

Let me summarize the main elements of the problem for the last time: certain insects display ocelli, which they use to fascinate their prey or an enemy. This is because, if a creature is forced to look at a fixed circle for some time, it becomes rooted to the spot and hypnotised. To this power of the feeble to frighten the strong, or of the slow to halt the swift, is sometimes added a frenzy which itself exercises a spell-binding power. Man and animal are both equally affected by these optical and rhythmic phenomena. On the one hand we have insects whose forewings enable them to escape notice and blend with their surroundings suddenly displaying, with a convulsive shudder, relatively enormous circles: it is then almost as if they were aware of the magical effect produced. On the other hand we have men wearing masks, who no longer seem to be men, suddenly appearing from the bush and behaving like wild animals or spectres from another world. They too can fall into convulsive trances. They feel themselves possessed by strange and all-powerful forces: their actions and cries are all dictated by the Being possessing them, or whom they embody. Thus transformed, they pursue and terrify their dupes, who do not know who they, the masked ones, are and who lose all power of defence or action. In his panic the fugitive is no longer capable of seeing the obvious truth, the presence of a man behind the Apparition.

In human masks only the eyes are left in the hidden and transformed face; looking—de-humanised—from behind black holes circled with colour, or the only protuberances on a frighteningly flat surface. But these masks, while exercising fascination, are also mimetic.

All sorts of different accessories help to make them as different as possible from the human face. They must be different. Hence the many structures that crown them: horns, ears, haloes, a thousand different devices are found, some identifiable, others enigmatic.

Insects also know these bulky accessories. The stag-beetle carries a big set of antlers, jointed like a huge jaw, but functionless. The oryctus has two strong horns on its thorax which have given it its common name of rhinoceros beetle. The Jupiter scarab and the Hercules dynastid are made longer by a species of pincers which double their length. One arm springs from the head and the other, which is above it, issues from the thorax. The two parts fit together in front of the insect, which thus seems to be preceded by a formidable weapon.[1] Nevertheless, all this impressive armoury is useless. It is the decoration of males only, in the same way that it is only men who have the right to wear masks. Sometimes the disturbing effect is increased by dissymmetry, as for instance in the case of the protuberances found on the underside of the left mandibule of *Lathrus korschinskii*.[2]

Membracids have dorsal humps, beneath which they cannot be seen. One of them, *Umbonia orozimbo*, of Central America and Brazil, has what looks like a large green thorn with stripes and patches of brick-red: this creature, like the butterfly *Caligo*, has frequently been discussed in the literature of mimicry, with as little justification. For this thorn-like insect lives on legumes which have no thorns, so that its disguise can only help to make it more conspicuous. In fact this is where the answer to the problem may be found: concealment is not the only purpose of disguise. One may just as well

[1] See also the lucanid *Cladognathus giraffa* of Sikkim (P.-P. Grassé, *Traité de Zoologie*, 1949, vol. IX, p. 884, fig. 577) and the enormous, long, fine scissors of *Chiasognathus grantii* in the south of Chile.

[2] P.-P. Grassé, *ibid*, p. 1014, fig. 707.

use it to attract attention, to appear, in borrowed plumes, spectacular and striking, confusing or deceptive. Once again I condemn a pre-judgement of utility: man thinks it advantageous for the insect to hide itself. He does not imagine that it might, on the contrary, be advantageous to attract notice. Once more he is sacrificing an apparently anthropomorphic attitude to a deeper anthropomorphism, one equally undesirable.

Whatever the case may be, there are some species closely related to *Umbonia* which carry such extraordinary superstructures that they could be part of a nightmare; for instance, *Heteronotus nigriscans, H. vulnerans* and others of this genus, *Sphongophorus latifrons, S. inflatus* and others, and *Ciphonia* provide examples. *Ernestopehlkia spinosa* has a long appendage at the back which stretches forward the length of its body. The hump of *Amitrochates rectus* is sculpted to look like a stylised ant. *Bocydium globulare*, drawn as early as 1788 by C. Stoll, raises a long stalk, ending with four globes, which looks like a television aerial.[1] With *Smerdalea horescens* of Guatemala geometric shapes give place to torn ones: the insect hides itself under a leaf-like appendage which reminds one of the indented rostrum of a lobster.[2]

What on earth is the use of the strange superstructures which shelter these Homoptera as though with fantastic parasols? It is doubtful if they have the least protective value. *Heteronotus trinodosus*, of Central America, is completely shaded by a number of balls: attempts have been made to find in them an imitation of the ant. *Parantonae dipteroides*, described by Fowler,

[1] *Représentation des cigales*, plate 28, fig. 163; P. Vignon, *op. cit.*, p. 410, fig. 675.

[2] See P.-P. Grassé, *Traité de Zoologie*, Paris, 1951, vol. X, part 2, pp. 1518-1520, fig. 1353-1356. *General Catalog of the Hemiptera*, I, Membracidae, Smith Coll., Northampton, U.S.A., 1927, part I; A. da Costa, Lima, *Insetos do Brazil*, vol. 3: *Homopteros*, 1942, *Esc. Nat. Agr.*, ser. did., no. 4.

might be thought to mimic a fly. Nothing is more doubtful than these interpretations, more arbitrary than the similarities thought to have been found to this or that part of a plant. Even when these branching and cumbersome appendages remind one of something they do not really resemble anything, and in any case their only function is considerably to hinder the insect's flight.[1] They are purely "ornamental" excrescences, aerials, branching at random and absurdly but, at the same time, keeping some balance and symmetry. They make one think of the erasures on a Rabindranath Tagore manuscript, skilfully made good, or the pattern of old medieval keys, beautifully worked, or the curves and windings of the old Scythian or Sarmathian animal art. They also remind one of the structures which top certain ceremonial masks from Oceania and America. Paul Pesson has underlined this point in a recent book.[2] However, I hesitate to use an analogy which runs so much the way of my argument.

It seems to me best to be wary of too exact resemblances. I am not looking for exact copies of morphology, but of function and behaviour. Here the sorcerer may rather be compared to the bearer of ocelli than to the wearer of a mask.

[1] H. B. Cott, *op. cit.*, p. 409; P.-P. Grassé, *op. cit.*, p. 1520; here P. Pesson advances the theory of "hyperthelic orthogenesis".

[2] *Le Monde des Insectes*, Paris, 1958, p. 41: "Les portraits d'insectes présentés dans les planches de cet ouvrage font quelquefois penser à des creatures de l'Apocalypse, *à des masques peints de guerriers ou de sorciers*, ou à des robots monstrueux, et ces quelques exemples, parmi des milliers, suffisent à confondre la plus prodigieuse des imaginations."

LANTERN-FLIES

THE HOMOPTERA DESCRIBED do not, in the exact sense of the word, carry masks, that is, false faces placed over their real ones. Among the insects, only the Surinam fulgorid—the so-called "lantern-fly"—seems really to be masked. Naturalists distinguish (or rather they used to distinguish in the year X,[1] since such classifications are evanescent): the lantern-fly of Brazil and Guiana, the candle-fly of China, the evening-fly of Guinea, the phosphorescent fly and the day-blind fly of Surinam, the glow-worm fly of Cayenne and finally the European fire-fly of Italy and Sicily. With the exception of the last one, which is geographic, all the descriptive words have to do with the supposed attributes and connections of the insects with light. There was a deeply rooted belief concerning the chief of these insects, *Fulgora laternaria,* the Surinam lantern-fly. At the beginning of the eighteenth century Mlle de Mérian started the story that it emitted enough light to read a paper by. I give here, *in extenso,* the very fanciful report which accompanies Plate XLIX of her book: "The Indians tried to persuade me these flies became the *Lantarendragers* or *Latern-flies,*[2] and on this plate I show the male and female in flight and at rest. The head, or rather the long hood, shines at night like a lantern: during the day it is transparent like a bladder and striped with

[1] Translator's note; Year X of the French Revolution. Year 1 was 1791.

[2] This fly makes a noise something like the sound of a hurdy gurdy and can be heard from afar. For this reason the Dutch call it *Lierman,* that is to say *hurdy-gurdy player.* (*Mlle de Mérian's note.*)

red and green. The light given out by this bladder at night is like that of a lantern, so much so that it would not be difficult to read a book printed with the same type as that used for the *Gazette de Hollande*. I have one of these flies, just about to change, and it has retained its shape of a fly, not even having changed its wings, but this bladder of which I have spoken has grown on its head; the Indians call this fly the mother of the Lantern-fly, just as they called the Scarab the mother of these flies. The fly on a pomegranate flower I have drawn below is a *Lierman* ready to become a *Lantern-fly*; these two names are given in order to distinguish them because they both make this hurdy-gurdy noise, apparently with the proboscis, which both of them have and keep throughout all their moults. Some Indians once brought me a number of these lantern-flies, and, not knowing they were luminous, I put them into a big box. On hearing a noise during the night I, jumped out of bed and called for a candle. I soon found the noise came from the box, and I hurriedly opened it, but I was frightened to see a flame come out of it, or rather as many flames as there were insects and I let it fall: but when I recovered from my astonishment, or rather my fright, I picked up all my insects and greatly admired their strange property."[1]

The head of this particular fulgorid *Laternaria phosphorea* L. is extended by a growth almost as big as the creature's body and empty. It was thought to be a lantern, hence the name of the insect. In sober truth, though, the "lantern-fly" is not luminous. It is the empty protuberance that sowed doubt on this point: the lantern lacked a candle. However these naïve beliefs are no longer held, though there are some scientists who are willing to restore a little luminosity to the poor

[1] *Dissertation sur la genération et la transformation des Insectes de Surinam*, The Hague, Pieter Gosse, 1726, p. 49.

thing: its "lantern" does glow under infra-red light. It has also been admitted that it carries phosphorescent bacteria. In the latest reference book on biological characteristics,[1] Table 295, dealing with luminosity, allows the lantern-fly a white light, with a question mark as to the nature of the light emitted. In any case there is no question of the bright light which allowed Marie-Sibille de Mérian to read with ease print in type "such as that used for the *Gazette de Hollande*".

W. E. China[2] has unearthed the history of this belief. It goes back to 1681 when Nehemiah Grew published his *Museum Regalis Societis*. He bestowed on a mysterious *Lantern-fly* of Peru, of which he said he could nowhere find a description, the luminous properties of *Pyrophorus noctilucus*, described fifty years previously by Thos. Moufet in respect of a very different species.[3] At the end of his account Grew says: "The most remarkable thing about this insect, apart from the shape of the head, is its luminosity. It shines at night like a little lantern, to such an extent that it is enough to fix two or three to a stick or some such device in order to get enough light to work or walk at night."[4] The transference of the luminous qualities of Moufet's beetle to the "lantern-fly" was obviously an arbitrary action of Grew's, most likely suggested by the empty protuberance of the former insect. Marie-Sibille de Mérian, who had probably read Grew, falls into step with him. As she was on the spot her mistake is rather surprising. I do not agree with W. E. China, who thinks that the confusion is caused by a mix-up of her notes and drawings by the

[1] W. S. Spector, *Handbook of Biological Data*, Philadelphia, and London, 1956, p. 329. A minus sign is shown in the column dealing with histology.

[2] *Proc. Ent. Soc. Lond.*, 1924, pp. XLIX-L.

[3] *Theatrum Insectorum*, London, 1634, p. 112. It was the cucujo.

[4] N. Grew, *op. cit.*, p. 158.

European editors. The caption fits the drawing too well for this. I have another explanation.

An art critic, a good one I think, has remarked that the strange fascination of Mona Lisa's smile does not depend on the form of the lips, but the fact that she is painted without eyebrows or eyelashes. By a kind of transference it is the smile which is noticed. I think this observation can be widely applied. When one is surprised by something one is inclined to look for the cause not in the true reason right under one's nose, but in some characteristic which fits in with a preconceived notion, or which for all sorts of other reasons, conforms to one's expectations. In the case of the Mona Lisa the surprise caused by the absence of eyebrows and eyelashes is attributed to the enigmatic smile, found in most of Leonardo's people. In the same way, the strangeness of the fulgorid lantern-fly is not its supposed phosphorescence. I think that Mlle de Mérian, astonished by its appearance, explained it by that luminosity which gave her such cause for wonder with the usual fireflies.

In any case, her account was accepted until the end of the eighteenth century, when, due to the persistent absence of any luminous fulgorid, doubts began to arise. A long discussion started. It was stated that only one sex was luminous, and that it was luminous only when alive, or at certain periods. All sorts of reasons of this nature were brought forward, each one a retreat for the pro-luminosity party, until the present moment when all they can claim is the faint and modest light of parasitic bacteria. In fact, the polemics had all stopped by the end of the nineteenth century.[1] But some of the most widely distributed dictionaries continue to describe this fulgorid as a "luminous insect of hot countries".

[1] See the bibliography in W. E. China, *loc. cit.*, pp. L-LII.

The fulgorid, no less than the mantis, is a subject of interest to man. But as its geographical location is much less extensive than that of the mantis it has given rise to far fewer stories and to far less mythology. It is found only in Surinam and north Brazil, though it extends as far south as Minas Gerais. In this area it is, like the mantis elsewhere, the subject of many superstitious beliefs. One of the more notable is that it is a vehicle for the evil eye. It is both sought and avoided for this reason.

The Indians call it *jacarenam-boya*, that is "*jacare*-head" (*jacare* means alligator in Guarani), and believe that it can inflict terrible wounds. They think it very poisonous and fear it most at dusk, when it flies around in large circles.[1] They tell of one such insect that came out of the forest and attacked a canoe holding nine people. Eight of them died. The leader saved himself by jumping into the river.[2] Presumably he thought himself safer with live alligators than with their flying and buzzing spirits.

In Europe, where there are only a few specimens of the insect, all in collections or in the hands of dealers, the length of the controversy over the luminosity of the creature shows the abnormal interest it aroused. It is significant that Victor Hugo makes a sort of symbol of it in *Ce que dit la Bouche d'Ombre*:

> Qui sait ce que, le soir, éclaire le fulgore,
> Être en qui la laideur devient une clarté?

What is more he associates it with the demoniacal mandrake. The allusion is all the more remarkable in that, outside a few scientists directly interested in the

[1] Francis Walker, *Entomological Magazine*, 1836, III, p. 107.

[2] H. W. Bates, *Proc. Ent. Soc. Lond.*, 1864, p. 14. Quoted by E. B. Poulton, "The terrifying appearance of *Laternaria* (*Fulgoridae*) founded on the most prominent features of the alligator", *Proc. Ent. Soc. Lond.*, 1924, pp. XLIII-XLIX.

matter, the very existence of this distant insect can have been known to very few people. It must be that the animal, by some special characteristic, makes an immediate impression on the layman.

This is in fact the case. The head lobe of the lantern-fly imitates an alligator's head exactly. Colour and relief combine to simulate the savage teeth of a powerful jaw. A large boss seems to protect a globular eye, where, according to Cott, a white splash simulates the reflection of light. W. J. Burchell, who described one of these creatures on the 16th April 1828, shows that the prominence of the eyes and nostril-openings reproduces the features which allow the alligator to see and breathe when completely submerged.[1] Behind this false head, dwarf and giant at the same time, where all the characteristics are exaggerated, almost caricatured, but nevertheless perfectly executed, one can just see the tiny head of the insect and two bright, black, almost microscopic points—the eyes. The empty snout is superfluous. Nevertheless one does not think of some kind of mimicry. Why should a hemipterous insect, living among trees, flying from branch to branch, encumber itself with an alligator's head a centimetre long?

There are two possible replies to the question. The first is to deny that the frontal lobe of the lantern-fly really looks like an alligator's head. This is the contention of L. Chopard, who is indignant that "this curious and chance combination of marks is still cited, even in serious books, as causing terror due to the sudden evocation of a past experience".[2] He sees it as a simple illusion due to the working of human imagination. Certain details, no doubt strange, facilitate the mania we have for interpretation, but their assembly by pure chance represents nothing—objectively. Let everyone just look at the photo-

[1] E. B. Poulton, *loc. cit.*, p. XLIV.
[2] L. Chopard, *op. cit.*, p. 245.

graph of the fulgorid lantern-fly.[1] It seems to me that we are attributing too much to imagination. The factors making up the resemblance are only so because of their reciprocal distribution. If they were isolated or distributed in another fashion it would indeed be mere fantasy to claim we saw eyes or teeth; such resemblances would be no more significant than the forms and shapes we see in clouds. But, in this particular case, the parts all fit together, just as in a jig-saw puzzle. I admit that the resemblance is absurd, even ridiculous, but I cannot, in order to avoid ridicule, deny the evidence.

I come to the second answer to the question. The fulgorid lantern-flies, apart from their resemblance to alligators, are undoubtedly mimetic insects. Their forewings are covered with grey patterns which cause them to blend into the background of the trunks of the *simaruba* trees, which are their favourite resting places. Long waxen threads run from the abdomen and help to make them invisible among the mosses, lichens and irregularities of the bark. Nevertheless, on the back wings they have ocelli, invisible when they are at rest. The creature is ready to frighten the enemy, using the usual tactics. As with certain caterpillars and sphingids, the creature only hides in order to frighten more effectively later.

An additional element is the crocodile snout, which

[1] In the *Illustrated London News*, 5th April 1924, photograph by the American naturalist P. G. Hawes; in the article quoted by E. B. Poulton: *Proc. Ent. Soc. Lond.*, 1924, fig. 1-4: *Laternaria servillei*, an exaggerated and deformed alligator; fig. 5-8: *L. lucifera*, smaller but a perfect resemblance, not a caricature; in the *Nouvelle Revue Française*, Oct. 1957, No. 58, Prof. Séguy's photographs used to illustrate my article "The Mask" (pp. 625-642); in *Endeavour*, Oct. 1959, vol. XVIII, No. 72, p. 203, fig. 18, colour photograph, but not very clear, by Prof. J. Haywood (Oxford) illustrating the article by H. B. D. Kettlewell, who noted that this was "probably the insect with the largest repertoire of defensive mechanisms". It had: (*a*) a cryptic appearance; (*b*) horror mask; (*c*) secretion of repellent wax; (*d*) secondary ocelli (p. 208).

completes the effect of the ocelli. Its small size is no reason for denying that it is an instrument of terror. It is even highly probable that it releases a fear reaction in monkeys, as they are afraid of crocodiles, to which they frequently fall victim. It will be recalled that this is the hypothesis of G. M. Henry on the chrysalis of *Dysphania palmyra*, but also advanced by him in the case of the lantern-fly.

The hypothesis is supported by E. B. Poulton, who cites the caterpillar snakes, such as that of *Choerocampa elpenor*, G. A. K. Marshall's experiments and the theory put forward by Henry.[1] The difficulty (one of the difficulties) is the difference in scale: Shelford points out that potentially insectivorous monkeys are frequently eaten by crocodiles, but from there to the point where the monkeys mistake a kind of plant bug for a crocodile is a big step. To overcome this objection Poulton tried, rather ineffectively, to show that animals are more affected by appearance than size and quoted the case of his own dog who would become excited by a little porcelain poodle only a few inches high.[2]

Even if we admit that disproportionate sizes are of less importance than we imagine, the difficulty remains. No one, as far as I know, has really made the test to see if monkeys, are, or are not, frightened by the lantern-fly, although Vignon pressed for the experiment to be made in order to prove or disprove Henry's theory. For my part I very much doubt if this much-desired fright actually occurs. If it did occur, the mystery would be deepened; one would have to imagine that, long long ago, at the time when insect morphology became fixed, a brilliant foresight, or a blind organic chemical activity, inspired the creatures destined to become lantern-flies to mimic the snout of a crocodile, with the object of

[1] See *supra*, p. 95.
[2] E. B. Poulton, *loc. cit.*, pp. XLVII-XLVIII.

putting the eventual monkeys to flight. The idea is one of delirium.

I now put forward another idea, hardly less daring. In the same way that the habits of the mantis correspond to human mythology, that the structures of the Radiolaria are Platonic, so too the *repertoire of frightening appearances* is limited and applicable to all creatures. The lantern-fly's snout does not imitate a crocodile's. It is just a variant on a smaller scale, that of insects, as useless and as amazing as the horns of the *Oryctes*, the jaws of *Lucanus* and the pincers of the Hercules beetle. It is not a question of a copy but of an original as old as the head of the crocodile. To man the crocodile seems to be the model only because he has known it longer and it is more familiar to him, also perhaps because it is so much bigger. If scientists had known the lantern-fly before the crocodile, if the fly was common and the crocodile scarce, if the lantern-fly was enormous and the crocodile small, the problem would have been reversed. People would have wondered what improbable reason there could be for the crocodile to imitate the lantern-fly. There remains the similarity of appearance. It is at this point that my theory seems to me to be extravagant, at least in the present state of knowledge. I suppose that the two appearances are independent and yet are homologues, that they really coincide and yet neither owes anything to the other. I imply that both are at one and the same time autonomous and yet brothers. I suggest that nature's moulds, or prototypes, are finite in number, that there is a certain inertia or avarice present, and that if no cause of interference crops up it automatically limits the number of models produced, among them the number of terror-inspiring masks.

I have made up my mind. If there were only the lantern-fly's snout, if there were only the extraordinary

humps of certain Homoptera, if there were only the illusory defences of the scarab beetles, if there were no ocelli, I should content myself with the theory, however unsatisfactory, that they are simple caprices of nature. But there are ocelli and the skilled use of ocelli. There are shams and the use of shams. And, moreover, effective use. The insect definitely behaves like a spell-binder, a sorcerer, the wearer of a mask who knows how to use it. Fear is an emotion so well known in nature that I do not hesitate to find in it the reason for so many alleged ornaments and so much mimicry.

Therefore I have stopped believing in chance and coincidences. My choice is made. I speak firmly of the lantern-fly's *mask*. For the last time I maintain that there is an opposition between the insect's world and man's: on the one hand the "mask", immovable, formed for all time in the morphology of the species, and on the other the fragile, external and movable simulacrum used by the officiant to cover his face at the celebration. But the effect sought for is the same, and the method of getting it too.

Hugh Cott, towards the end of his book, has a paragraph entitled "Concealment of the Body behind a Mask"[1] He quotes several examples of myrmecomorphism, among them that of *Heteronotus trinidosus*,[2] which is probably illusory. He lays especial emphasis on the spider described by Bristowe and Hingston, which hides beneath the body of an ant and, at the same time, imitates its jerky walk.[3] One could certainly quote this as a good example of the use of a mask by an insect. Nevertheless I set aside, without hesitation, an argument which at first seems so valuable to me. For the purpose of my theory I require the mask to be organic, to be

[1] H. B. Cott, *op. cit.*, p. 409.
[2] *Supra*, p. 110.
[3] *Supra*, p. 79.

integral to the insect (in any case the spider is not an insect), to be a part of its body, not, as with man, a mere portable accessory that can be put on or off at pleasure. Under these conditions only, and just because of this contrast, the agreement between the two is exact.

CONCLUSION

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WHETHER IT BE a question of the bizarre habits of the praying mantis, the beauty of butterfly wings, the hyperthelic camouflage of stick insects and of acridians, ocelli (and the spasmodic movements which add to their effect), or the lantern-fly's mask, the problem is always the same. Each of these characteristics corresponds to something similar in man—to some obsession, some myth, some irrational but compelling belief or course of action.

It is worth remembering that man and insects (certain insects) are the two kinds of beings that have the strange privilege of living in societies. And these societies show in their turn the same inevitable contrast between automatic reactions and freedom, between monotonous repetition and inventiveness, the evolution of human history. In the case of the insects, every worth-while adaptation, every modification which has value over thousands of centuries, is incorporated and preserved in the organism. Witness the perfection of every part, of the antennae, of the feelers, of the compound eyes, quite apart from the somnambulistic infallibility of its instincts. Man, on the other hand, had the ability to create tools (at first crude), weapons (at first inadequate) cumbersome clothing which is not a part of his body (in contrast with the carapace or fleece which is immovable armour or clothing for the wearer); then came machines to make weapons, tools or clothes, finally complex machines to make simpler machines. This faculty, capable of unlimited development, implies groping,

progress by trial and error. At the same time it paves the way for a decisive freedom. Man's freedom implies an imprecise, ambiguous language, which invites misunderstanding, not an exact system of unequivocal signals, such as make up the limited code of inexorable turns and choreography which is incorrectly labelled the "language" of the bees because of a radical misunderstanding of the confused nature of language, but also in tribute to an irrefutable similarity of function. The same unfortunate or happy circumstance also presupposes societies with such things as the class struggle, religious wars, hate and fanaticism, revolts and revolutions: not an unchangeable order, or a perfect economy in which physiology both supports and dictates social regime.

Man's liberty refuses to accept the unvarying castes of ants and termites, with their queens, soldiers and workers, all with their life's work dictated to them by their anatomy. Man's liberty allows, it calls for, mathematical speculations which invent hyperspaces and abstract volumes which cannot be represented, but which can be conceived, and which are deduced from arbitrary symbols in a game which is both refined and free. It is not content with the fixed and exclusively hexagonal geometry of the honeycomb, not even with the complex though none the less rigid forms of the Radiolaria. Liberty is responsible for a history of painting full of unevenness, marked by periods of success and failure and not by the unchanging perfection of the butterfly-wing. It means myths, illusions, horror perhaps, not preordained behaviour, a set path with no choice available. It implies that eventually the individual is not only more free but more productive than the species. Consciousness, which is creative in the external world, not in the organism which contains it, has no doubt lost much through not being infallible and unhesitating. Awareness indeed takes faltering steps. This is perhaps the

price that has to be paid for its coming into existence. Certainly it continues no less to explain the stubborn and mysterious guiding lines which direct the mass of articulate people. However, within the limits which consciousness is learning to recognize, or perhaps to shrink from, imagination, however imperfect, is free, and it is creative.

I stop my narrative here and leave this adventurous, this chimerical theory. I turn back to precise and exact research, to facts. But full of dreams and nostalgia I want to compare for a moment longer, in imagination, the sorcerer's mask, out there in the bush, with the long frontal protuberance of the lantern-fly, almost as big as itself, carried by this creature with the strange hollow crocodile's head, both dwarf and bloated, with huge globular, yet false, eyes, beneath a frontal arch no less false, a jaw that can bite nothing, a head hollow but huge nevertheless, carried unknowingly by an absurd Hemipteron in front of its true face since the dark night of geological time.

There is still only one Nature. The success of man, or his misfortune perhaps, is to have introduced an element of play into the rigid machinery.

(Continued from front flap)

The author further asks whether there is a relationship between natural aesthetics and human art, and whether mimicry in insects—disguises, camouflage, and methods of intimidation—also has a counterpart in some human action. The author sees the physiology and behavior of insects as strangely paralleled in the mythology of man. Legends in which the hero is changed or disguised correspond to the mimicry of insects; stories of caps and cloaks of invisibility may be related to the camouflage of insects; the fear of the evil eye or of Medusa's glare, or the use of frightening masks, have their counterpart in the use of wing-spots (*ocelli*) in insects and the fear produced by the sudden assumption of a terrifying appearance.

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