

### The familiar path

The best way to find that no two human *Umwelten* are the same is to have yourself led through unknown territory by someone familiar with it. Your guide unerringly follows a path that you cannot see. Among the rocks and trees in the environment there are some which, strung together in sequence, stand out as landmarks from all the others, although they are not apparent to a stranger.

The familiar path is entirely dependent on the individual subject. It therefore a typical *Umwelt* problem. The familiar pathway is a spatial problem, and draws both on the subject's visual and functional space. This is evident from the way in which a familiar path is described: something like this: turn right behind the red house, then straight ahead for a hundred paces, and on to the left. Three kinds of sensory cues are used to describe a route: (1) visual cues, (2) the direction planes of the coordinate system, (3) directional steps. In this case we do not use the elementary directional pace, i.e., the smallest possible motor unit, but the customary summation of elementary impulses required to take one walking step.

The walking pace, that is, the regular motion of a leg forward and backward, is fixed so definitely and is of the same approximate length for so many people, that until quite recently it served as a common length measure. If I tell someone to walk a hundred paces, I mean that he is to give his leg the same motor impulse a hundred times. The result will always be the same approximate distance traversed. If we travel over certain stretch repeatedly, the impulses given while walking remain in our memory as directional signs, so that we automatically stop at the same place, even if we have paid no attention to visual cues. Thus the orientational signs are of great importance for the familiar path.

It would be highly interesting to determine how the problem of the familiar path is worked out in the *Umwelten* of animals. Scent cues and tactile cues are surely decisive factors in building up the familiar path in many of their *Umwelten*. Thousands of experimental series have been made in the past decades by numerous American scientists who tried to determine how soon an animal was able to learn a certain pathway through requiring widely varied animals to orient themselves in a maze. They have not seen the point: the problem of the familiar path. They have neither investigated the visual, tactile or scent cues, nor given thought to the application of the coordinate system by the animal — the right and left is a problem in itself, has never struck them. Nor have they ever debated the question of the number of paces, because they did not see that in animals, too, the pace may serve as the measure of distance.

In short, the problem of the familiar path must be attacked all over again, despite the prodigious amount of observations available. Beside its theoretical interest, the way a dog retraces the familiar path in his *Umwelt*, for example, also has eminent practical value in view of the tasks which face the seeing-eye dogs of the blind.

Figure 29 shows a blind man led by his dog. The blind man's world is a very limited one: it extends only as far as he can feel his way with his feet and cane. As far as he is concerned, the street through which he passes is plunged in darkness. His dog, however, must guide him home over a certain path. The difficulty of training the dog lies in introducing into the dog's *Umwelt* specific perceptual cues which serve the blind man's interests, not the dog's. Thus the route along which the dog leads the blind man must be plotted along a curve around obstacles against which the man might stumble. It is especially hard to teach a dog the meaning of a mailbox or an open window — to give it perceptual cues for things which it would normally pass by unheeded. The edge of the curb, over

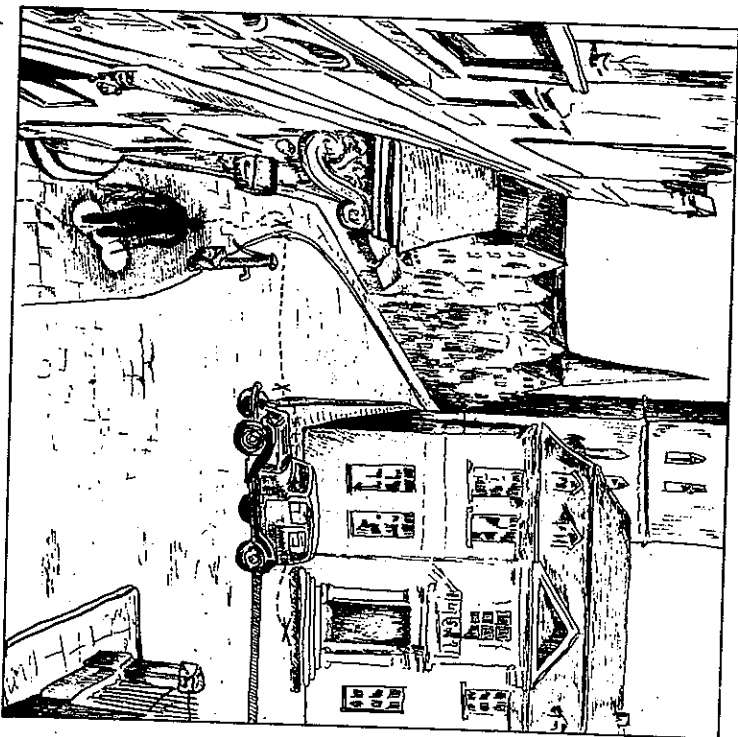


Figure 29. Blind man and his dog

which the blind man might stumble, is equally hard to introduce into the dog's world, since under ordinary circumstances a freely running dog scarcely notices it.

Figure 30 portrays an observation made with young jackdaws. As may be seen, the jackdaw flies around the whole house, but then wheels and retraces its former, familiar course for the return flight to its starting point, which the jackdaw did not know again when it approached it from the other side.

It has recently been found that rats long continue to use an accustomed detour, even when the direct path is open to them.

Now the problem of the familiar path has been taken up anew with fighting fish, and the following results were obtained: in the first place, it was found that the unfamiliar has a repellent influence on these fish. A glass plate with two round holes, through which the fish could glide with ease, was placed in the aquarium. If the food was presented behind the hole, the fish took quite a while to glide hesitantly through the hole and snatch the food. Next the bait was shown laterally from the window — the fish soon followed after. Finally, the lure was presented behind the second window. Nevertheless, the fish invariably swam through the familiar hole and avoided using the unfamiliar.

Then, as shown in Figure 31, a partition was built into the food side

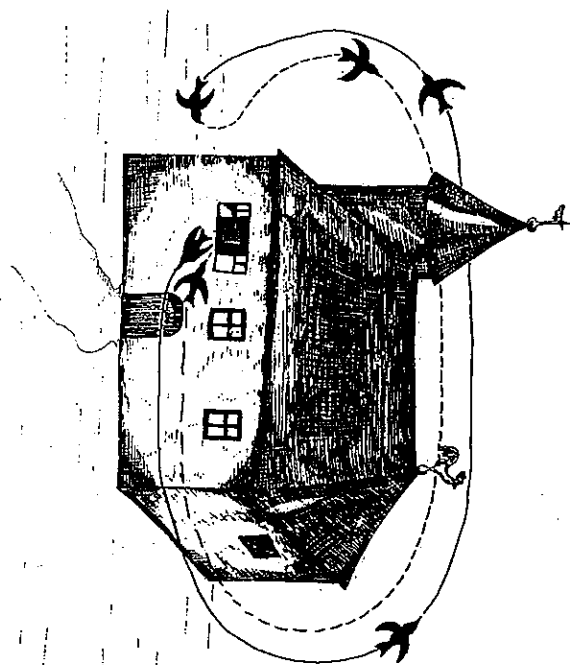


Figure 30. The jackdaw's familiar path

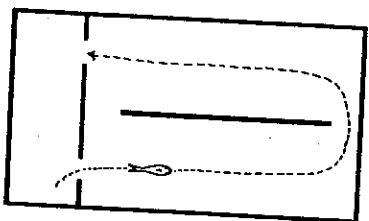


Figure 31. The familiar path of the fighting fish

of the tank at right angles to the glass plate, and the fish lurled around the partition by means of the food. If the food was now shown on the other side of the partition, the fish swam straightway around it, still following the long familiar path, even if it could have reached the bait by swimming toward it in front of the partition. The familiar route here involved visual and orientational cues, and possibly directional steps as well.

On the whole, we may say that the familiar path works as a stretch of lightly fluid medium within a refractory mass.

#### Home and territory — *Heim und Heimat*

The problem of home and territory is closely related to the familiar pathway.

As a starting point, it will be best to choose the experiments with sticklebacks. The male stickleback builds himself a nest, whose entrance he likes to mark by a colored thread — a visual path cue for the young? The young grow up in the nest under the father's care. This nest is his home. But his territory reaches beyond the nest. Figure 32 shows an aquarium, in opposite corners of which two sticklebacks have built their nests. An invisible borderline crosses the aquarium and divides it into two regions, each of which belongs to one nest. This area, which belongs with the nest, is the stickleback's territory, which he defends vigorously and successfully even against bigger sticklebacks. In his own territory the stickleback always wins.

Territory is a pure *Umwelt* problem. It is an entirely subjective product,

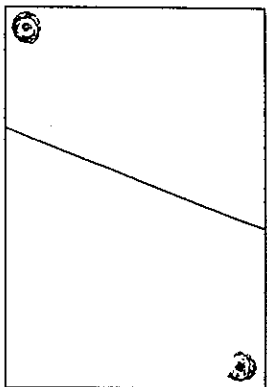


Figure 32. Nest and territory of the stickleback

for even the closest knowledge of the environment does not give a slightest clue as to its existence.

The question now is, which animals possess a territory and which do not? A housefly, which, in flying back and forth, covers a certain section of space around the chandelier, does not, by virtue of this, necessarily have a domicile.

A spider, on the other hand, which builds a cobweb in which it is constantly active, possesses a home that is at the same time its territory. The same is true of the mole. It, too, has built itself a home and a territory. An orderly system of caves is spread out underground like a cobweb. But, in addition to the single tunnels themselves, its domain also comprises the whole section of earth encompassed by them. In capturing it plots its tunnels so that they resemble a cobweb. We were able to demonstrate that the mole, thanks to its highly developed scent organ, not only finds its food easily within the tunnel, but that it can also swim food in the solid earth beyond the tunnel, up to a distance of some 6 cm. In a close-knit system of passages, such as the mole builds in captivity, the entire area of soil extending between the passages would be controlled by its senses. In nature, where the mole draws its tunnels farther apart, it can control the earth within a certain radius around a tunnel by scent cues. Like the spider, the mole travels repeatedly through this network of passages and gathers up everything in the way of food that has strayed there. In the midst of this network of tunnels, the mole builds itself a cave padded with dry leaves — its home proper, where it spends its leisure hours. The underground passages are all familiar pathways to the mole; it runs forward and backward along them with equal speed and skill. Its field of prey extends as far as its passages reach. The whole field is at the same time the mole's territory, which it defends by death against all neighboring moles.

The faculty with which the mole, a blind animal, finds its way unerringly in a medium which to us seems completely homogeneous, is astonishing.

If trained to a certain place where the mole gets its food, it will find this place again, even after the passages leading to it are totally destroyed. The mole cannot possibly be guided by olfactory cues in so doing. Its space is a purely operational space. One must assume that, by reproducing its orientational steps, a mole is able to retrace a pathway that it has once traveled. As in all blind animals, tactile cues connected with the directional steps must here play an important part. It may be assumed that orientational cues and directional steps unite to form the basis of a spatial schema. If the mole's network of passages, or part thereof, is destroyed, it is able, with the aid of a projected schema, to re-create a new network resembling the old.

Bees also build themselves a home, but the area all around the hive, where they seek their food, while being their field of prey, is not a territory which they would defend against intruders. In magpies, on the other hand, we may speak of home and territory, for their nest is built within a region inside of which they tolerate no other magpies.

Eventually, we shall probably find that countless animals defend their field of prey against members of their own species, thereby making it their territory. Any tract of land, if the territories were drawn into it, would resemble a political map for each species, their borderlines determined by attack and defense. It would also appear that there is no free and left, but that everywhere territory touches territory.

It is most interesting to observe that between the nests of many birds of prey and their hunting grounds, a neutral zone is inserted, where they strike no prey at all. Ornithologists are probably right in supposing that this arrangement was made by nature to prevent birds of prey from striking their own brood. When, so to speak, the nestling has become a branchling and spends its day around the parental nest, hopping from limb to limb, it might easily incur the danger of being struck by its own parents by mistake. As it is, the nestling spends its days unmenaced in the neutral zone of the protected territory. This protected territory is brought out by many songbirds as a nesting and brooding site, where they can bring up their young in safety under the great robber's protection.

Special consideration should be given to the ways and means by which dogs mark their territory for members of their own species. In a park there are certain spots where two large hounds urinated in their daily outings. The places which they marked with their scent cues were always spots particularly conspicuous to the human eye also. Whenever both dogs were walked at the same time, a urinating competition ensued.

As soon as a high-spirited dog meets a strange dog, the former invariably shows a tendency to furnish the nearest conspicuous object with 'his sitting card'. Moreover, if a dog penetrates into the territory of another

dog, which is earmarked by that dog's scent signals, he will successively seek these out and paint them over carefully. A spiritless dog, on the other hand, will pass shyly by a strange dog's scent marks in the latter territory, and not betray his presence by any scent signals.

As shown in Figure 33, the great bears of North America also have the habit of marking their territory. Standing erect to its full height, the bear rubs off the bark of a lone, far-visible pine with its back and snout. This acts as a signal to other bears to give the pine a wide berth, and avoids the whole district where a bear of such dimensions defends its territory.

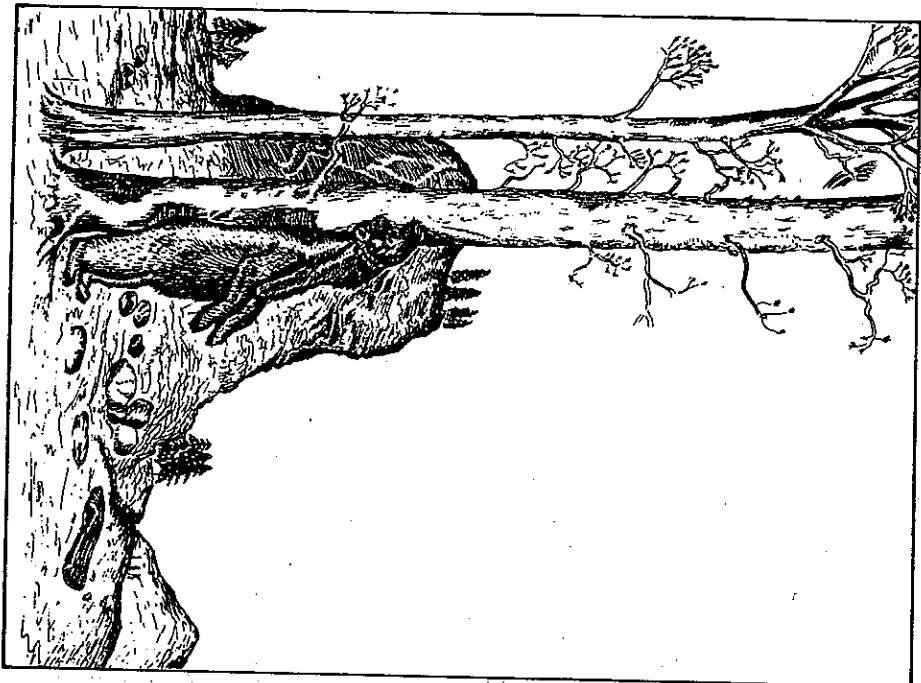


Figure 33. A bear marking his territory

### The companion

I recall vividly the picture of a rumpled duckling that had been hatched together with turkey chicks and had attached itself so closely to the turkey family that it never went into the water, and painstakingly avoided other small ducks that came from it, fresh and clean.

Soon thereafter, someone brought me a very young wild duck, which followed me about at every step and turn. When I sat down, it leaned its head on my foot. I had the impression that my black boots were the attraction, for sometimes it also ran after the black dachshund. I concluded from this that a black moving object was enough to replace the image of the mother for it, and had the young duck put out near its maternal nest, that it might find its family again.

Today I have come to question whether this ever happened, for I have been informed that goslings of the greylag goose, when just taken from the incubator, must be pocketed and taken to a grey goose family at once if they are to attach themselves willingly to members of their own species. If they remain a little longer in human company, they will reject all companionship with their own kin.

The phenomenon we are dealing with in all these cases is a confusion of perceptual images. This occurs frequently, especially in the world of birds. What we know about the receptor images of birds is as yet insufficient to draw positive conclusions.

In Figure 18 we watched the jackdaw on the hunt for grasshoppers. We got the impression that the jackdaw possesses no receptor image whatsoever for the grasshopper in repose, and that therefore the grasshopper does not exist in the jackdaw's *Umwelt*.

Figures 34a and b illustrate another observation concerning the receptor images of jackdaws. Here a jackdaw is seen in a posture of attack

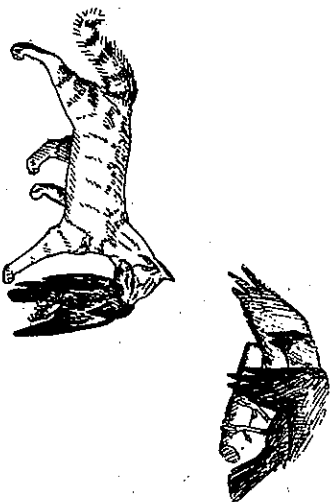


Figure 34a. Jackdaw in posture of attack against cat

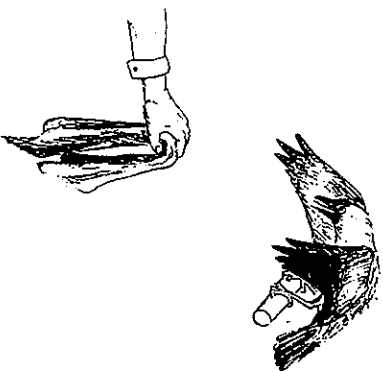


Figure 34b. Jackdaw in posture of attack against bathing trunks

against a cat carrying another jackdaw in its mouth. Jackdaws never attack a cat when it is not carrying any prey. Only when the cat's dangerous teeth are put out of action by holding the prey between them does the cat become an object of attack to the birds. This seems to be a highly judicious action by the jackdaw. As a matter of fact, however, it only conforms to a plan of nature, and runs its course independently of insight. For the bird assumed the same posture of attack when a pair of black bathing trunks was carried by. Nor was the cat attacked when it carried a white jackdaw. The receptor image of a black object being moved past the jackdaw promptly releases a posture of attack.

A receptor image held in such general terms can always give rise to mistakes. This has already been shown in the sea urchin, in whose world cloud and ship are constantly confused with the enemy fish, because the sea urchin responds in the same way to any darkening of the horizon. In birds, however, we cannot get away with such a simple explanation. As regards social birds, we have a wealth of contradictory observations involving a confusion of receptor images. Only recently have we succeeded in analyzing out the main principles in the typical case of a tame jackdaw 'Jock'.

Jackdaws living in a colony have a lifelong 'companion' with whom they carry out the most widely varied activities. If a jackdaw is raised in isolation, it by no means relinquishes the companion. If the jackdaw finds none of its own species, it will adopt 'substitute companions'. Moreover, a new substitute companion may take over for each new activity. Lorenz was kind enough to send me Figure 35, wherein the different companion relationships may be seen at a glance. In her youth, the jackdaw Jock had Lorenz himself for a mother companion. She followed him even

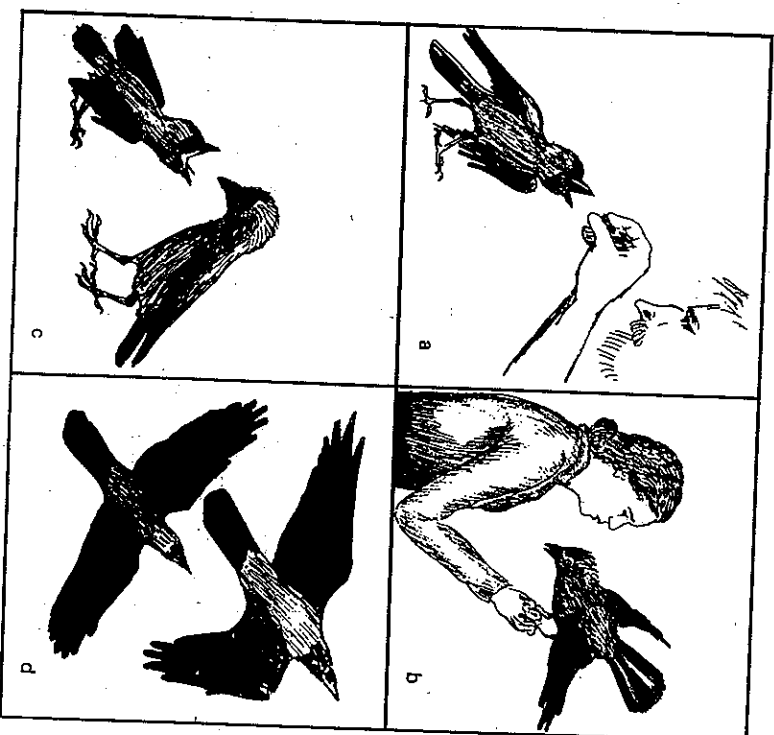


Figure 35. The jackdaw 'Jock' and her four companions

where; she called him when she wanted to be fed. After Jock had learned to get her own food, she chose the maid for her love companion and performed the characteristic courting dances in front of her. Later on Jock found a young jackdaw who became her adoptive companion and whom she fed in person. When Jock prepared for long flights, she tried, in the manner of jackdaws, to make Lorenz fly with her, by taking off close behind his back. When this attempt failed, Jock attached herself to young crows, which now became her flight companions. Clearly, there is no uniform perceptual image for the companion in the jackdaw's world, or could there be one, since the role of the companion changes all the time.

In most cases, the receptor image of the mother companion is not determined at birth as to form and color. On the other hand, the mother's voice frequently is.

'One should', Lorenz writes, 'determine, in a specific case of a mother companion, which mother signs are innate and which ones are individually acquired. The uncanny thing is that, if the fledgling is only taken from its mother a few days, or even hours after hatching (grey goose, Heinroth), the acquired mother signs are engraved so deeply that one would swear they were innate.'

The same thing happens in choosing the love companion. Here, too, the acquired signs of the substitute companion are so definitely engraved that an inconvertible perceptual image of the substitute companion is created — once the first exchange has occurred. In consequence, even animals of the same species are rejected as love companions.

This is shown very clearly by a delightful experience. In the Amsterdam Zoo there was a pair of bitterns, whose male had 'fallen in love' with the director of the Zoo. So as not to hinder their mating, the latter did not appear for a considerable length of time. The result was that the male became accustomed to the female. A happy union ensued, and when the female was sitting on her eggs, the director risked showing himself again. But what happened? No sooner had the male caught sight of his former love companion, than he chased the female away from the nest and seemed to hint with repeated bows that the director was to occupy the place due him and continue the business of brooding.

The receptor image of the child companion seems in general to be outlined more firmly. Here the gaping bills of the young are probably the most important factor. But here again, one may find that hens of pure strain, such as orpingtons, will mother young kittens and bear bunnies.

Again, as Jock shows, there is more leeway in the case of the substitute companion for free flights.

If we consider that the jackdaw treats bathing trunks in motion as enemy, that is, they obtain the functional tone 'enemy', we may say that they are a substitute foe. Since there are many enemies in the jackdaw world, the appearance of a substitute enemy, especially if it only happens occasionally, does not affect the perceptual images of the jackdaw's enemies. Not so with the companion. The latter exists only singly in *Umwelt*, and once a functional tone is lent to a substitute companion it is impossible for a true companion to make a later appearance. Once the perceptual image of the maid had acquired the sole 'love tone' in Jock's world, all other perceptual images had become ineffectual.

If we consider (a phenomenon not without analogy in primitive people) that in the world of jackdaws all living creatures, that is, moving things, are divided into jackdaws and non-jackdaws, and furthermore, that

borderline between them is drawn differently according to personal experience, it will perhaps be possible to understand that such grotesque mistakes as the ones just described should occur. It is not the perceptual image alone that decides whether one is faced with a jackdaw or non-jackdaw, but the functional image of the subject's own attitude. This alone determines what perceptual image will acquire the prevailing companion tone.

#### Search image and search tone

Again I begin with two personal experiences, which will best illustrate what is meant by the search image, a factor of great importance in the *Umwelt*. When I spent some time at the house of a friend, an earthenware water pitcher used to be placed before my seat at luncheon. One day the butter had broken the clay pitcher and put a glass water bottle in its place. When I looked for the pitcher during the meal, I failed to see the glass carafe. Only when my friend assured me that the water was standing in its usual place, did various bright lights that had lain scattered on knives and plates flock together through the air and form the water bottle. Figure 36 conveys this experience. The search image annihilates the perceptual image.

The second experience is this: One day I stepped into a store where I had a large bill to pay, and drew out a 100 Mark bill. It was quite new and slightly bent, so that it did not lie flat on the counter, but stood on its edge. I asked the cashier to give me my change. She declared I had not yet paid. I tried in vain to point out to her that the money was right under her nose. She became irritated and insisted on immediate payment. At this point I touched the bill with my forefinger, so that it fell over and came to lie the right way. The lady uttered a small cry, then took the bill and felt it, full of apprehension that it might dissolve into thin air again. In this case, too, the search image had obviously extinguished the perceptual image.

All my readers have probably had similar experiences of seeming magic. Figure 37 was published in my 'Biology'. It symbolizes the different processes that interlock in human perception. If a bell is set up before me and sounded, it appears in his environment as a source of stimulation, from which air waves penetrate to his ear (physical processes). In the ear, the air waves are transformed into nervous excitation, which is conveyed to the receptor organ of the brain (physiological processes). Now the receptor cells intervene with their receptor signs and

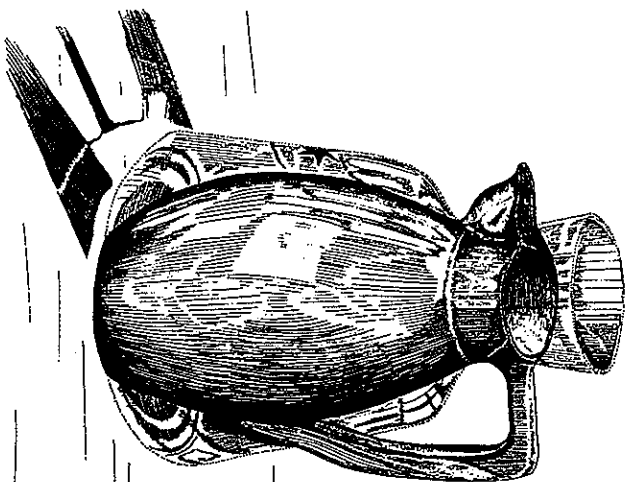


Figure 36. The object sought obscures the perception

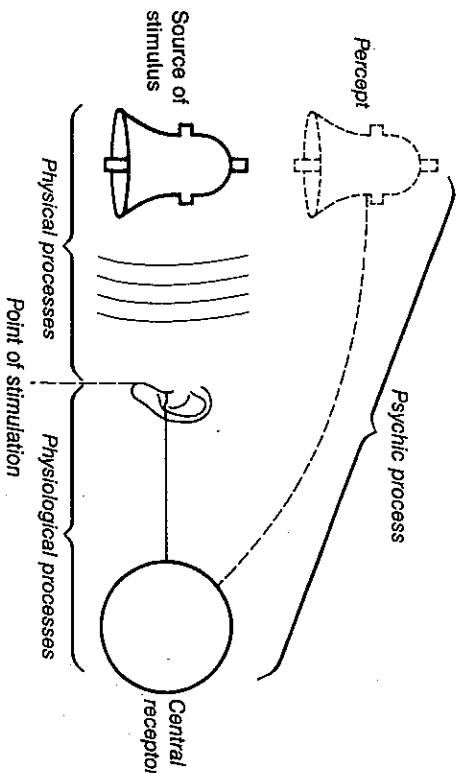


Figure 37. The processes in hearing

project a perceptual cue or meaning into the *Umwelt* (psychological process).

If besides the air waves coming to the ear, ether waves also reach the eye, which in its turn sends excitation to the receptor organ, then their receptor signs of sounds and colors are combined to form an entity which, projected into the phenomenal world, becomes a perceptual image.

The same graphic illustration can be used to explain the search image. In this case we will assume that the bell lies outside the visual field. The receptor signs of the sounds are projected directly into the *Umwelt*. But connected with it is an invisible optical receptor image, which serves as a search image. If after searching, the bell enters the visual field, then the perceptual image now resulting is fused with the search image. If they differ too widely, it may happen that the search image eliminates the perceptual image, as in the aforesaid instance.

Search images undoubtedly exist in the *Umwelt* of dogs. When the master orders his dog to retrieve a stick, the dog, as shown in Figure 38, has a quite specific search image of the stick. Here we may also examine how closely the search image corresponds to the perceptual image.

It is reported that, if a toad has consumed an earthworm after a prolonged period of starvation, the toad will immediately throw itself on a match that bears a certain resemblance in shape to the earthworm. This leads us to believe that the recently consumed earthworm acts as a search image — as indicated in Figure 39. On the other hand, if the toad has allayed its first hunger with a spider, it has a different search image, for now the toad will snap after a bit of moss or an ant, which, however, does not agree with it very well.

Now we do not always look for a definite object with a single receptor image, but far more often for one that corresponds to a specific functional image. Instead of a specific chair, we look around for something to sit on, that is, for a thing that may be connected with a certain performance tone. In this case we cannot speak of a search image, but only of a search tone.

The earlier example of the hermit crab and sea anemone demonstrates how important a part the search tone plays in the *Umwelt* of animals. What we referred to as the hermit crab's different moods there, can now be much more accurately termed the varying *search tone* with which the crab approached the same perceptual image, giving it at one time a protective tone, at another time a dwelling tone, and again an eating tone.

The hungry toad at first sets out to seek food with just a general feeding tone. Only after it has consumed an earthworm or a spider does it acquire a more specific search image.



Figure 38. The dog and his search image

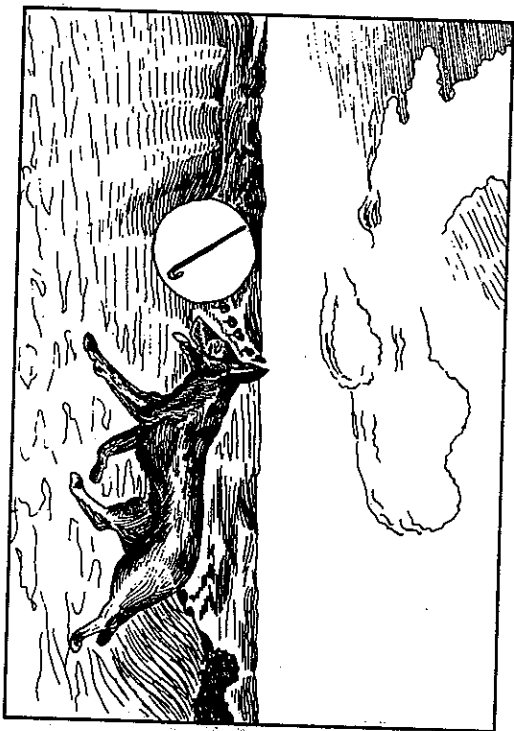


Figure 39. The toad's search image

objects of their own perception. In our study so far, these *Umwelten* have as a rule been the product of receptor signs roused to activity by external stimuli. We have already seen exceptions to this rule: the search image, the tracing of the familiar pathway, and the demarcation of the territory, which could not be attributed to external stimuli, but were free subjective products. They evolved as a result of repeated personal experiences by the subject.

If we now continue on our way, we shall enter worlds that feature very effective phenomena which, however, are visible to the subject alone and are bound to no experiences, or at most are related to one single experience. We shall call *Umwelten* of this kind *magic worlds*.

An example may illustrate how deeply many children live in magic worlds. In his *Paiderna*, Frobenius tells of a little girl who was quietly acting out for herself the fairy tale of Hansel and Gretel, the wicked witch and the gingerbread house, with a matchbox and three matches. Suddenly she cried out: 'Take away the witch, I can't bear to look at her horrid face any more.' This typically magical experience is indicated in Figure 40. Undoubtedly, the wicked witch appeared bodily in the little girl's *Umwelt*.

Explorers have often come upon experiences of this kind among primitive peoples. It is maintained that they live in a magic world, where fantastic phenomena mingle with the perceptually given things around

### The magic *Umwelten*

There can be no doubt that a fundamental contrast prevails everywhere between the environment which we see spread around animals, and the *Umwelten* that are built up by the animals themselves and filled with their

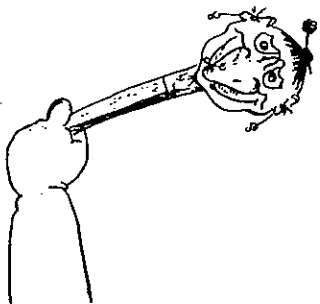


Figure 40. The magical appearance of the witch

them. If we look more closely, we shall meet the same magic formations in the *Umwelt* of many a highly cultured European.

The question now arises: do animals also live in magic *Umwelten*? Magical experiences are frequently reported in dogs. But these reports have not hitherto been sifted critically enough. On the whole, however, it will probably have to be conceded that dogs relate their experiences in a manner that is magical rather than logical. The role which the master plays in the dog's world is surely conceived magically, not broken down into cause and effect.

A zoologist friend of mine tells about an undoubtedly magic phenomenon in the *Umwelt* of a bird. He had brought up a young starling in a room. The bird never had a chance to see a fly, let alone to catch one. One day he saw the starling suddenly rush toward an invisible object, catch it in mid-air, return with the object to its perch, peck away at it with its bill as any starling will do with a captured fly, and finally swallow the invisible thing (Fig. 41). There was no doubt that the starling had had the apparition of an imaginary fly in its *Umwelt*. Evidently, the starling's whole world had been so charged with the 'feeding tone', that even without the appearance of a sensory stimulus, the functional image of fly-catching, which was in readiness, forced the perceptual image to appear, and this released the entire action chain. This experience indicates that otherwise utterly puzzling actions by various animals should be interpreted magically.

Figure 42 portrays the behavior of the pea-weevil larva, which was studied by Fabre. In good season, the larva bores a channel into the soft flesh of a young pea, all the way to the surface. This tunnel is not used until, after the larva's metamorphosis, the grown beetle crawls out of the pea, which has hardened in the meantime. It is quite sure that we are here dealing with an activity which, though conforming to a plan,

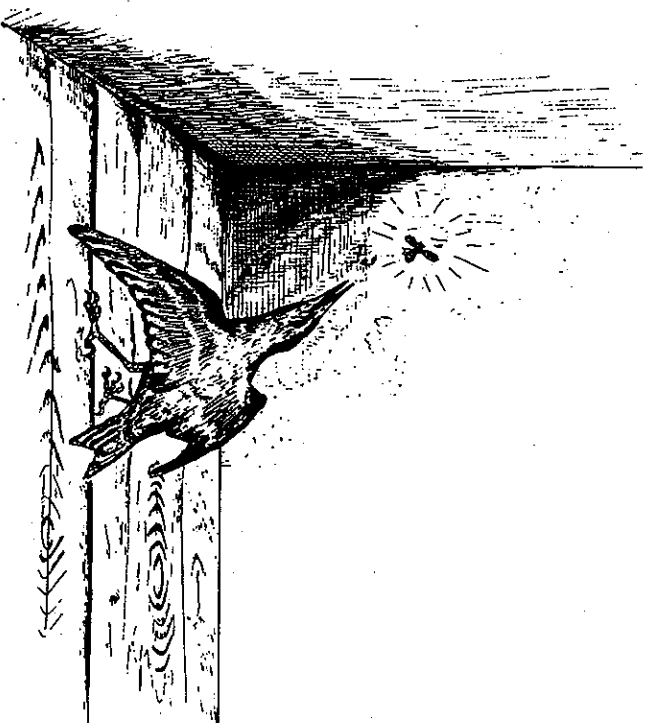


Figure 41. Starling and imaginary fly

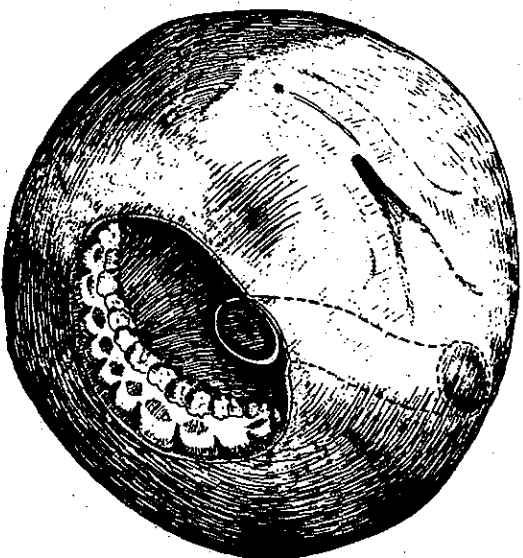


Figure 42. The magical path of the pea-weevil larva

yet utterly senseless from the weevil larva's point of view, for no sensory stimulus of the feature beetle can possibly reach its larva. No receptor sign shows the larva the path which it has never trodden and that it must nevertheless take, unless it is to perish miserably after its transformation into a beetle. The way lies before it, clearly written, as in magic characters. The familiar path, acquired through experience, is here replaced by the innate pathway.

Figures 43 and 44 show two further instances of the innate pathway. The female of the funnel-roller begins to cut an intricately curving line of prescribed form along a birch leaf at a specific point (which she may possibly recognize by its taste). This enables her afterwards to roll the leaf into a funnel, into which she will lay her eggs. Although the beetle has never followed the path and the birch leaf shows no indication of it, the path must yet lie before her perfectly clearly, as a magic phenomenon.

The same applies to the flight routes of migratory birds. The continents bear the innate route, which only birds can see. This is certainly true of young birds, who set out unaccompanied by their parents, whereas for the others the acquisition of a familiar path is not beyond the realm of possibility.

Like the familiar pathway, with which we have dealt extensively, the innate way also leads through both visual and functional space. The sole difference between the two is that in the case of the familiar path a series

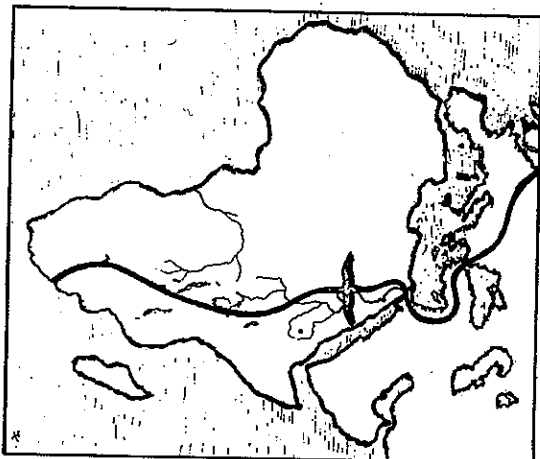


Figure 44. *The magical path of the migratory bird*

of receptor and effector signs, which have been established by previous experience, succeed one another, while in the case of the innate path the same series of signs is given directly, as a magic phenomenon. To the uninitiated observer a familiar path in a foreign *Umwelt* is just as invisible as is the innate path. And if we assume that the familiar pathway becomes manifest to the foreign subject in his own *Umwelt* — of which there is no doubt — then there is no reason to deny the phenomenon of the innate pathway; since it is composed of identical elements, the projected perceptual and functional signs. In the one case they are elicited by sensory stimuli, in the other they chime in harmonious succession, like an inborn melody.

If a certain route were innate in a man, it could be described in the same terms as a familiar path: a hundred paces to the red house, then round to the right, and so forth.

If we choose to call significant only what is given to the subject by the evidence of his senses, then, of course, only the familiar path will be called meaningful, not the innate. Even so, it remains playful to the highest degree.

A strange experience reported by a contemporary scientist indicates that magical phenomena play a far greater part in the animal world than we suspect. He had fed a hen in a certain stall, and let a guinea pig into the stall while the hen was picking up the grains. The hen was beside

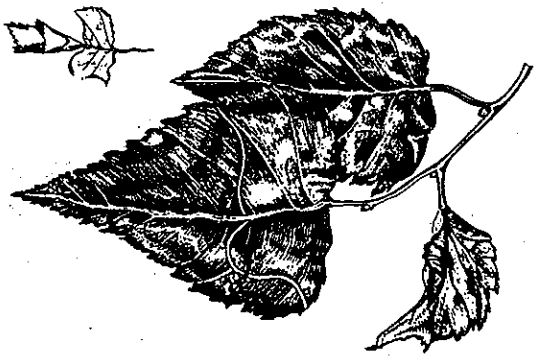


Figure 43. *The magical path of the funnel-twister*

herself and fluttered about frantically. From then on, she could never again be persuaded to consume food in this stall. She would rather have starved amid plenty of the finest grain. Evidently the apparition of the first experience hovered above the stall like a magical shadow, as Figure 45 attempts to convey it. This occurrence corroborates the surmise that when a mother hen rushes toward the peeping chick and chases away an imaginary enemy by violent bill-pecks, a magic apparition has similarly arisen in her *Umwelt*.

As we have progressed farther in our study of the *Umwelten*, the conviction has grown on us that effective factors occur in them, to which no objective reality can be ascribed. We met the first of these in the plagemosaic, which the eye imprints on the things in its *Umwelt*, and which is no more present in the environment than are the directional planes that support space in an *Umwelt*. It has been equally impossible to find an environmental factor to correspond to the subject's familiar pathway. The distinction between territory and hunting ground does not exist in the environment. No trace of the *Umwelt's* vital search image can be found in the environment. Now we have finally come upon the magical phenomenon of the innate path, which mocks all objectivity and yet gears designfully into the *Umwelt*.

There are, then, purely subjective realities in the *Umwelten*; and even the things that exist objectively in the environment never appear there as

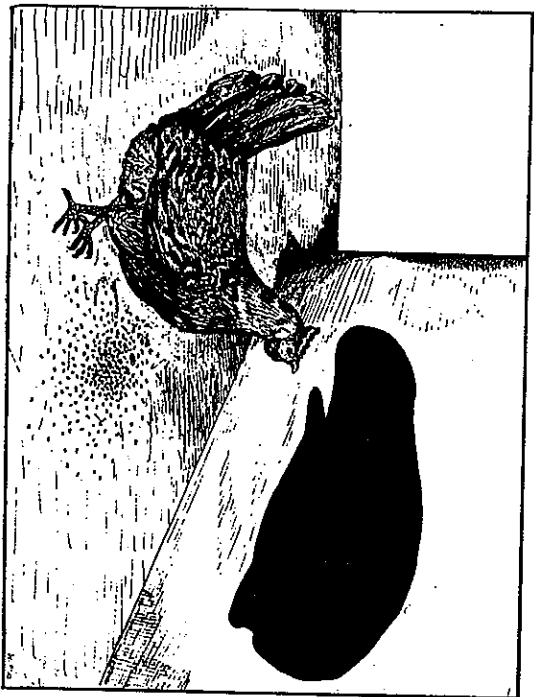


Figure 45. *The magical shadow*

their objective selves. They are always transformed into perceptual cues or perceptual images and invested with a functional tone. This alone makes them into real objects, although no element of the functional tone is actually present in the stimuli.

And finally, the simple functional cycle teaches us that both receptor and effector cues are the subject's manifestations, and that the qualities of objects included in the functional cycle can be regarded as their bearers only. Thus we ultimately reach the conclusion that each subject lives in a world composed of subjective realities alone, and that even the *Umwelten* themselves represent only subjective realities.

Whoever denies the existence of subjective realities, has failed to recognize the foundations of his own *Umwelt*.

#### The same subject as an object in different *Umwelten*

The foregoing chapters described single strolls into various regions in the unexplored territory of the *Umwelt*. They were arranged according to problems, to obtain a uniform view in each case. Even though we have dealt with some fundamental problems, no completeness has been achieved or aimed at. Many problems await conceptual formulation, while others have not yet developed beyond the stage of formulating questions. Thus we know nothing so far of the extent to which the subject's own body enters into his *Umwelt*. Even the question of the significance of one's own shadow in visual space has not been experimentally attacked.

The pursuit of single problems is indeed important for *Umwelt* research; but it is not enough if we wish to gain a comprehensive view of the relationship between different *Umwelten*. In a limited field, such an overall picture can be obtained by answering the question: How does the same subject show up as an object in different *Umwelten*, in which it plays an important part? As an example, I choose an oak tree, which harbors many animal subjects, and is destined to play a different role in the *Umwelt* of each. Since the oak also appears in various human *Umwelten*, I shall begin with them.

Figures 46 and 47 are reproductions of two drawings, which we owe to the artist Franz Huth. In the thoroughly rational world of the old forester, who must decide which trees of his forest are ready to be felled, the oak doomed to the ax is nothing more than a few cords of wood, which he seeks to measure accurately (Fig. 46). The knobby bark, which happens to resemble a human face, goes unheeded by him. Figure 47 shows the same oak in the magical world of a little girl, whose forest is

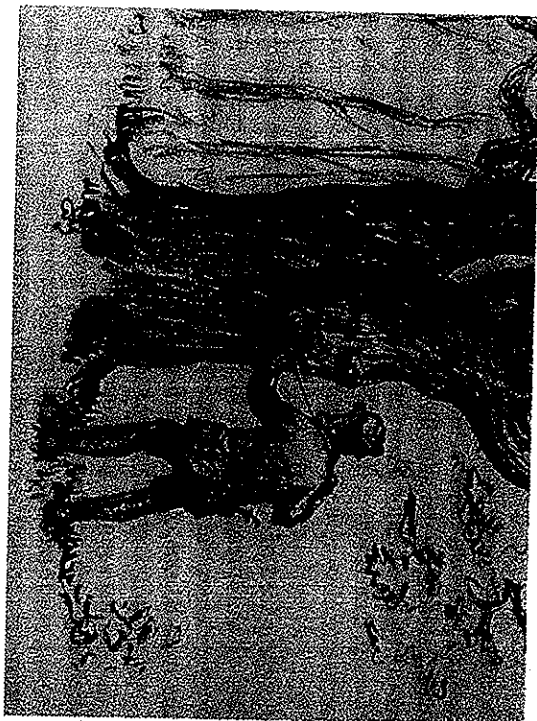


Figure 46. Forester and oak tree



Figure 47. Little girl and oak tree

still inhabited by gnomes and hobgoblins. The little girl is terribly frightened when the oak tree looks at her with its evil face. The whole oak has become a threatening demon. In the grounds of my cousin's castle in Estonia there stood an old



Figure 48. Fox and oak tree

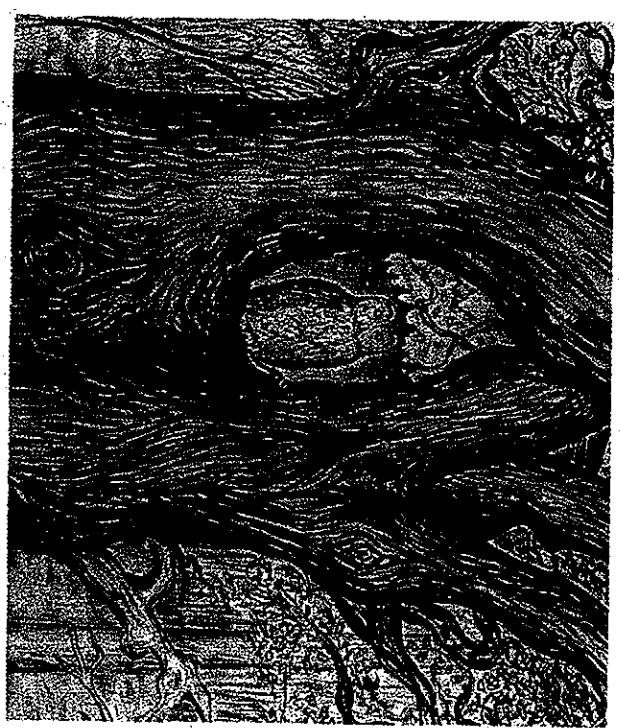


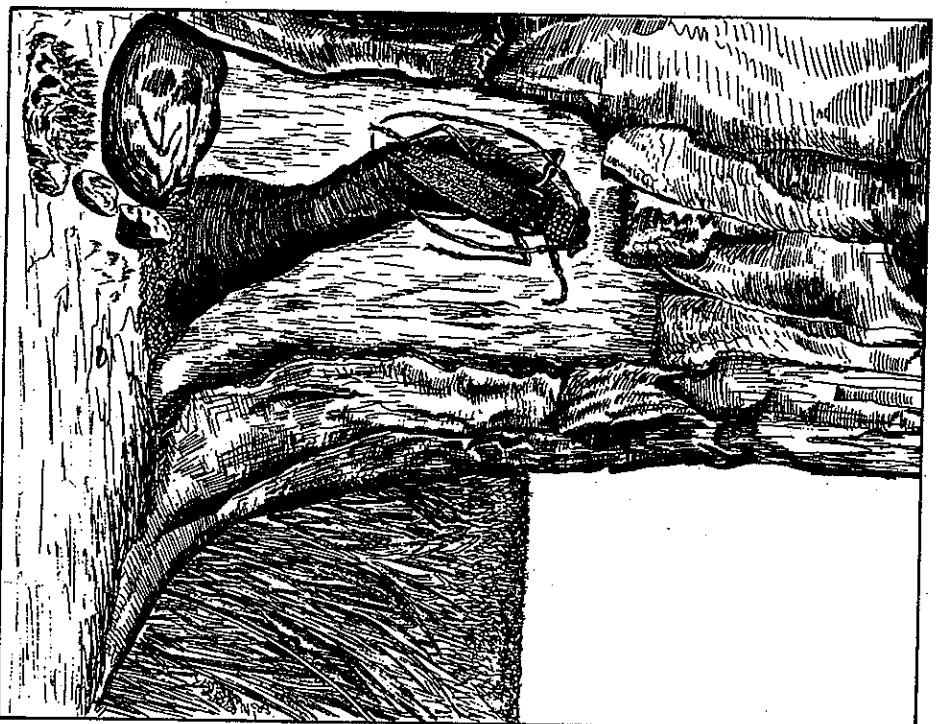
Figure 49. Owl and oak tree

Figure 50. *Ant and oak tree*

apple tree. A huge lichen had grown on it, which vaguely resembled the face of a clown, but no one had ever noticed this resemblance. One day my cousin had a dozen Russian seasonal laborers brought in, who discovered the apple tree and thereafter gathered before it daily for worship, murmuring prayers and crossing themselves. They declared that the fungus must be a wonder-working image, because it was not made by hand of man. To them, magic processes in nature appeared quite natural.

But let us return to the oak tree and its inmates. To the fox (Fig. 48), which has built its lair between the roots, the oak tree has come to mean a solid roof, which protects the fox and its family from the hazards of the weather. It has neither the utility tone of the forester's world, nor the danger tone of the little girl's, but solely a protective tone. How it is shaped beyond that, does not matter in the fox's world.

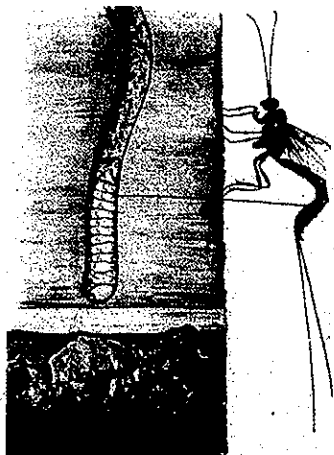
In the owl's world (Fig. 49) the oak tree also has a protective tone.

Figure 51. *Bark-boring beetle and oak tree*

Only this time it is not the roots, which lie wholly outside the owl's realm, but the mighty limbs that serve it as a protecting wall.

To the squirrel, the oak tree, with its many ramifications, providing a wealth of comfortable jumping boards, gains a climbing tone, and to the songsters which build their nests in its farthest croches and branches, it offers the supporting tone which they need.

Corresponding to the different functional tones, the perceptual images of the oak tree's numerous inmates, too, are differently shaped. Each *Umwelt* carves a specific section out of the oak, whose qualities are

Figure 52. *Ichneumon* fly and oak tree

suitable bearers for both the receptor and effector cues of their respective functional cycles. In the ant's world (Fig. 50) all the rest of the oak vanishes behind its gnarled bark, whose furrows and heights become the ant's hunting ground.

The bark-boring beetle seeks its nourishment underneath the bark which it blasts off (Fig. 51). Here it lays its eggs. Its larvae bore their passages underneath the bark. Here, safe from the perils of the outside world, they gnaw themselves farther into their food. But they are not entirely protected. For not only are they persecuted by the woodpecker, which splits off the bark with powerful thrusts of its beak; an ichneumon fly, whose fine ovipositor penetrates through the oakwood (hard in all other *Umwelten*) as if it were butter, destroys them by injecting its eggs into the larva (Fig. 52). Larvae slip out of the ichneumon eggs and feed on the flesh of their victims.

In all the hundred different *Umwelten* of its inmates, the oak tree as an object plays a highly varied role, at one time with some of its parts at another time with others. Sometimes the same parts are large, at others they are small. At times its wood is hard, at others soft. One time the tree serves for protection, then again for attack.

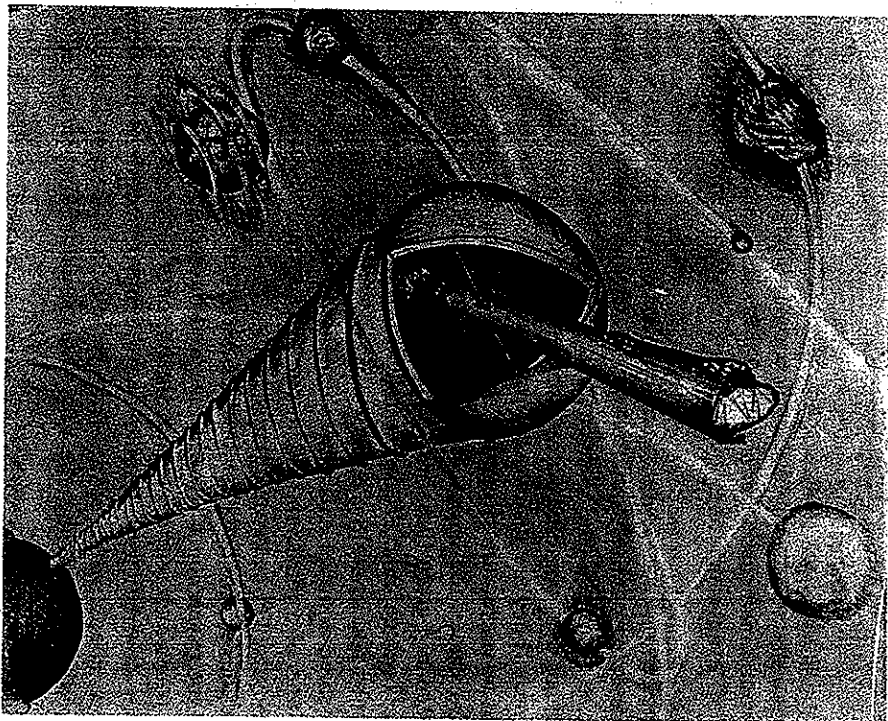
Should we attempt to epitomize all the contradictory properties which the oak tree as an object displays, only chaos would result. And yet they are all but parts of a subject firmly structured in itself, which bears and harbors all these *Umwelten* — not comprehended and never discernible to all the builders of these *Umwelten*.

### Conclusion

What we have found on a small scale in the oak tree is enacted on the life tree of nature in vast dimensions.

Out of the millions of *Umwelten*, whose abundance would result in confusion, we shall pick out only those dedicated to the investigation of nature — the *Umwelten* of different scientists.

Figure 53 shows the *Umwelt* of an astronomer, which is the easiest to portray. High on his tower, as far as possible from the earth, sits a human being. He has so transformed his eyes, with the aid of gigantic optical instruments, that they have become fit to penetrate the universe up to its most distant stars. In his *Umwelt*, suns and planets circle in festive

Figure 53. The astronomer's *Umwelt*

procession. Fleet-footed light takes millions of years to travel through his *Umwelt* space.

And yet this whole *Umwelt* is only a tiny sector of nature, tailored to the faculties of a human subject.

With slight alterations, the astronomer's image can be used to gain a conception of the deep-sea researcher's *Umwelt*. Only here, instead of constellations, the fantastic shapes of deep-sea fish wheel around his sphere with their uncanny mouths, long tentacles and radial light organs. Here again, we glance into a real world, which constitutes a small sector of nature.

The *Umwelt* of a chemist, who tries to read and write the enigmatic context of nature's substance-words with the aid of the elements, as with 92 letters, is hard to render distinctly.

We shall succeed better in representing the *Umwelt* of a nuclear physicist, for the electrons cycle around him in much the same way as the constellations wheel around the astronomer. Only here no cosmic calm reigns, but a mad rush of infinitesimal particles, from which the physicist blasts off even tinier ones by bombarding them with diminutive projectiles.

If another physicist investigates the ether waves in his own *Umwelt*, he again resorts to entirely different means, which furnish him a picture of the waves. Now he can ascertain that the light waves, which stimulate the human eye, combine with all other waves, without displaying any differences. They are just waves, nothing more.

Light waves feature altogether differently in the *Umwelt* of a physiologist who studies the senses. Here they become colors, with laws of their own. Red and green fuse into white, and shadows, thrown onto a yellow surface, become blue. Processes unheard-of in waves, and yet the colors are just as real as are the ether waves.

The same contrast exists between the *Umwelten* of a student of air waves and of a musician. In the one there are only waves, in the other only sounds. Yet both are equally real.

So it goes on. In the behaviorist's *Umwelt* the body produces the mind, and in the psychologist's world the mind builds the body.

The role which nature plays as the object of different scientists' worlds is highly contradictory. Should one attempt to combine her objective qualities, chaos would ensue. And yet all these diverse *Umwelten* are harbored and borne by the One that remains forever barred to all *Umwelten*.

Behind all the worlds created by Him, there lies concealed, eternally beyond the reach of knowledge, the subject — Nature.

#### Note

1. Illustrated by G. Kriszat.
2. Reflex originally means the intercepting and reflecting of a light ray by a mirror. Transferred to living creatures, the reflex is conceived as the reception of an external stimulus by a receptor and the stimulus-elicited response by the effectors. In the process the stimulus is converted into nervous excitation, which has to pass through several stations on its way from the receptor to the effector. The course thus described is referred to as a reflex arc.
3. The tick is built for a long period of starvation. The sperm cells harbored by the female during her waiting period remain bundled in sperm capsules until mammalian blood reaches the tick's stomach — they are then freed and fertilize the eggs, which have been reposing in the ovary. The perfect fitting of the tick to her prey-object, which she finally seizes, contrasts strikingly with the extremely low probability that this will actually ensue. Bodenheimer is quite right in speaking of a *pessimist* world in which most animals live, that is, the most unfavorable one conceivable. But this world is not their *Umwelt*; it is their environment. An *optimal Umwelt*, that is, one as favorable as possible, and a *pessimist environment* may be considered the general rule. The point is always survival of the species, no matter how many individuals perish. Because of the optimal *Umwelt*, the environment of a species must be *pessimist* or the species would gain ascendancy over all others.
4. This is corroborated by motion picture technique. When a film strip is projected, the single pictures must jerk forward successively, and then stand still. To show them distinctly, the jerky motion must be concealed by interposing a screen. The human eye does not perceive the blackout involved if the eclipse of the picture occurs within 1/18 of a second. If the time is lengthened, insufferable flickering ensues.