Any country dweller who traverses woods and bush with his dog has certainly become acquainted with a little animal who lies in wait on the branches of the bushes for his prey, be it human or animal, in order to dive onto his victim and suck himself full of its blood. In so doing, the one- to two-millimeter-large animal swells to the size of a pea (Figure 1).

Although not dangerous, the tick is certainly an unwelcome guest to humans and other mammals. Its life cycle has been studied in such detail in recent work that we can create a virtually complete picture of it.

Out of the egg crawls a not yet fully developed little animal, still missing one pair of legs as well as genital organs. Even in this state, it can already ambush cold-blooded animals such as lizards, for which it lies in wait on the tip of a blade of grass. After many moltings, it has acquired the organs it lacked and can now go on its quest for warm-blooded creatures. Once the female has copulated, she climbs with her full count of eight legs to the tip of a protruding branch of any shrub in order either to fall onto small mammals who run by underneath or to let herself be brushed off the branch by large ones. The eyeless creature finds the way to its lookout with the help of a general sensitivity to light in the skin. The blind and deaf bandit becomes aware of the approach of its prey through the sense of smell. The odor of butyric acid, which is given off by the skin glands of all mammals, gives the tick the signal to leave its watch post and leap off. If it then falls onto something warm—which its fine sense of temperature will tell it—then it has reached its prey, the warm-blooded animal, and needs only its sense of touch to find a spot as free of hair as possible in order to bore past its own head into the skin tissue of the prey. Now, the tick pumps a stream of warm blood slowly into itself.

Experiments with artificial membranes and liquids other than blood have demonstrated that the tick has no sense of taste, for, after boring through the membrane, it takes in any liquid, so long as it has the right temperature.

If, after sensing the butyric acid smell, the tick falls onto something cold, then it has missed its prey and must climb back up to its lookout post.

The tick's hearty blood meal is also its last meal, for it now has nothing more to do than fall to the ground, lay its eggs, and die.

The clearly known life processes of the tick afford us a suitable criterion in order to demonstrate the soundness of the biological point of view as opposed to the previously common physiological treatment of the subject. For the physiologist, every living thing is an object that is located in his human world. He investigates the organs of living things and the way they work together just as a technician would examine an unfamiliar machine. The biologist, on the other hand, takes into account that each and every living thing is a subject that lives in its own world, of which it is the center. It cannot, therefore, be compared to a machine, only to the machine operator who guides the machine.

We ask a simple question: Is the tick a machine or a machine operator? Is it a mere object or a subject?

Physiology declares the tick to be a machine and says
that one can differentiate receptors, i.e., sensory organs, and effectors, i.e., activity organs, in the tick. These are connected with one another through a control apparatus in the central nervous system. The whole thing is a machine, with no trace of a machine operator.

"Exactly therein lies the mistake," says the biologist. "Not one part of the tick's body has the character of a machine. There are machine operators at work all over the place."

The physiologist will continue unperturbed: "Precisely in the tick, it can be shown that all actions depend solely on reflexes, and the reflex arc forms the foundation of every animal machine (Figure 2). It begins with a receptor, i.e., with an apparatus that admits only certain external influences, such as butyric acid and heat, and disregards all others.

"The arc ends with a muscle which sets an effector into motion, whether this is the apparatus for locomotion or for boring.

"The sensory cells, which activate sensory stimulation, and the motor cells, which activate the movement impulse, are only connectors which transmit the completely physical waves of excitation, produced by the receptor in the nerves in response to an external impulse, to the muscles of the effector. The whole reflex arc works with the transfer of motion, just like any machine. No subjective factor, as one or more machine operators would be, is apparent anywhere."

"Exactly the opposite is the case," the biologist will reply. " Everywhere, it is a case of machine operators and not of machine parts, for all the individual cells of the reflex arc act by transfer of stimuli, not by transfer of movement. But a stimulus has to be noticed [gemerkt] by the subject and does not appear at all in objects."

Any machine part, for example the clapper of a bell, only operates in a machine-like manner if it is swung back and forth in a certain way. All other interventions, such as, for example, cold, heat, acids, alkalies, electrical currents, it responds to as any other piece of metal would. But we know since Johannes Müller, however, that a muscle behaves in a completely different way. It responds to all external interventions in the same way: by contracting. Any external intervention is transformed by the muscle into the same stimulus and responded to with the same impulse, by which its body of cells is made to contract. Johannes Müller showed further that all external effects that hit our optic nerve, whether these are waves in the ether, pressure, or electric currents, cause the sensation of light, i.e., our sight-sense cells answer with the same "perception sign" ("Merkzeichen").

From this, we can conclude that every living cell is a machine operator that perceives and produces and therefore possesses its own particular (specific) perceptive signs and impulses or "effect signs" ("Wirkzeichen"). The complex perception and production of effects in every animal subject can thereby be attributed to the cooperation of small cellular-machine operators, each one possessing only one perceptive and one effective sign.

In order to make an orderly cooperation possible, the organism uses brain cells (which are also elementary machine operators), grouping half of them in differently-sized groups of "perception cells" in the part of the brain that is affected by stimuli, the "perception organ." These groups correspond to external groups of stimuli, which present themselves to the animal subject in the form of questions. The organism uses the other half of the brain cells as "effect cells" or impulse cells and arranges them in groups by means of which it controls the movements of the effectors, which impart the animal subject's answers to the outside world. The groups of perception cells fill up the "perception organs" of the brain, and the groups of effect cells form the "effect organs" of the brain.
If we may, on this account, imagine a perception organ as the site of changing groups of these cell-machine operators, which are the carriers of different perceptive signs, they are still spatially separated individuals. Their perceptive signs would remain isolated if it were not possible for them to coalesce into new units outside the spatially fixed perception organ. This possibility is in fact present. The perceptive signs of a group of perception cells come together outside the perception organ, indeed outside the animal's body, in units that become qualities of the object that lie outside the animal subject. We are all quite familiar with this fact. All our human sensations, which represent our specific perception signs, join together to form the qualities of the external things which serve us as perception marks for our actions. The sensation “blue” becomes the “blueness” of the sky, the sensation “green” becomes the “greenness” of the lawn, and so forth. We recognize the sky by the feature “blue” and the lawn by the feature “green.”

Exactly the same thing takes place in the effect organ. Here, the effect cells play the role of the elementary machine operators, which in this case are arranged into well-articulated groups according to their impulse or productive sign. Here, too, it is possible to group the isolated effect signs into units that, in the form of self-contained motor impulses or rhythmically arranged melodies of impulses, produce effects in the muscles subject to them. At this, the effectors activated by the muscles impress their “effect mark” ["Wirksam"] on the objects that lie outside the subject.

The effect mark that the effectors of the subject impart to the object is immediately recognizable, just like the wound which the tick's mouthparts inflict upon the skin of the mammal on which it has landed. But only the laborious search for the features of butyric acid and warmth completes the picture of the tick as active in its environment.

Figuratively speaking, every animal subject attacks its objects in a pincer movement—with one perceptive and one effect-
tiple functional cycles, one can thereby gain insight into the fundamental principle of the science of the environment: All animal subjects, from the simplest to the most complex, are inserted into their environments to the same degree of perfection. The simple animal has a simple environment; the multiform animal has an environment just as richly articulated as it is.

Now, let us place the tick into the functional cycle as a subject and the mammal as its object. It is seen that three functional cycles take place, according to plan, one after the other. The mammal’s skin glands comprise the feature carriers of the first cycle, since the stimulus of the butyric acid sets off certain perception signs in the [tick’s] perception organ, and these signs are transposed outward as olfactory features. The processes in the perception organ bring about corresponding impulses by induction (we do not know what that is) in the [tick’s] effect organ which then bring about the releasing of the legs and falling. The falling tick imparts to the mammal’s hairs, on which it lands, the effect mark “collision,” which then activates a tactile feature which, in its turn, extinguishes the olfactory feature “butyric acid.” The new feature activates the tick’s running about, until this feature is in turn extinguished at the first bare patch of skin by the feature “warmth,” and the drilling can begin.

This is no doubt a case of three reflexes, each of which is replaced by the next and which are activated by objectively identifiable physical or chemical effects. But whoever is satisfied with that observation, and assumes he has therefore solved the problem, only proves that he has not seen the real problem at all. It is not a question of the chemical stimulus of the butyric acid any more than it is of the mechanical stimulus (activated by the hair) or of the thermal stimulus of the skin. It is only a question of the fact that, among the hundreds of effects that emanate from the mammal’s body, only three become feature carriers for the tick. Why these three and no others?

It is not a question of a contest of strength between two objects but, rather, of the connection between a living subject and its object. These take place at an entirely different level: between the subject’s perception signs and the object’s stimulus.

The tick hangs inert on the tip of a branch in a forest clearing. Its position allows it to fall onto a mammal running past. From its entire environment, no stimulus penetrates the tick. But here comes a mammal, which the tick needs for the production of offspring.

And now something miraculous happens. Of all the effects emanating from the mammal’s body, only three become stimuli, and then only in a certain sequence. From the enormous world surrounding the tick, three stimuli glow like signal lights in the darkness and serve as directional signs that lead the tick surely to its target. In order to make this possible, the tick has been given, beyond its body’s receptors and effectors, three perception signs, which it can use as features. Through these features, the progression of the tick’s actions is so strictly prescribed that the tick can only produce very determinate effect marks.

The whole rich world surrounding the tick is constricted and transformed into an impoverished structure that, most importantly of all, consists only of these features and three effect marks—the tick’s environment. However, the poverty of this environment is needful for the certainty of action, and certainty is more important than riches.

As one can see, the fundamental aspects of the structure of the environments that are valid for all animals can be derived from the example of the tick. But the tick has one more remarkable capability that allows us a greater insight into environments.

It is immediately evident that the happy occasion that brings a mammal to pass beneath the branch on which the tick sits occurs most seldom. Even the great number of ticks lying in wait in the bush does not compensate for this disadvantage in such a way as to secure the reproduction of the species. In order to increase the probability that its prey will pass by, the
tick must be capable of living a long time without nourishment. And the tick is capable of this to an unusual degree. At the Zoological Institute in Rostock, they kept ticks alive that had gone hungry for eighteen years. The tick can wait eighteen years; we humans cannot. Our human time consists of a series of moments, i.e., the shortest segments of time in which the world exhibits no changes. For a moment's duration, the world stands still. A human moment lasts one-eighteenth of a second. We shall see later that the duration of a moment is different in different animals, but, no matter what number we assign to the tick, it is simply impossible for an animal to endure an unchanging environment for eighteen years. We shall therefore assume that the tick is, during its waiting period, in a state similar to sleep, which also interrupts our human time for hours. But time stands still in the tick's waiting period not just for hours but for years, and it starts again only when the signal "butyric acid" awakens the tick to renewed activity.

What have we gained by this knowledge? Something very significant. Time, which frames all events, seemed to us to be the only objectively consistent factor, compared to the variegated changes of its contents, but now we see that the subject controls the time of its environment. While we said before, "There can be no living subject without time," now we shall have to say, "Without a living subject, there can be no time."

We shall see in the next chapter that the same is true of space: Without a living subject, there can be neither space nor time. With this observation, biology has once and for all connected with Kant's philosophy, which biology will now utilize through the natural sciences by emphasizing the decisive role of the subject.

ENVIRONMENT SPACES

Just as a gourmet picks only the raisins out of the cake, the tick only distinguishes butyric acid from among the things in its surroundings. We are not interested in what taste sensations the raisins produce in the gourmet but only in the fact that they become perception marks of his environment because they are of special biological significance for him; we also do not ask how the butyric acid tastes or smells to the tick, but rather, we only register the fact that butyric acid, as biologically significant, becomes a perception mark for the tick.

We content ourselves with the observation that perception cells must be present in the perception organ of the tick that send out their perception signs, just as we assume the same for the perception organs of the gourmet. The only difference is that the tick’s perception signs transform the butyric acid stimulus into a perception mark of its environment, whereas the gourmet’s perception signs in his environment transform the raisin stimulus into a perception mark.

The animal’s environment, which we want to investigate now, is only a piece cut out of its surroundings, which we see stretching out on all sides around the animal—and these surroundings are nothing else but our own, human environment. The first task of research on such environments consists in seeking out the animal’s perception signs and, with them, to construct the animal’s environment. The perception sign of raisins does nothing for the tick, while the perception mark of butyric acid plays an exceptional role in its environment. In the gourmet’s environment, on the other hand, the accent of significance falls not on butyric acid, but on the perception mark of raisins.

Every subject spins out, like the spider’s threads, its relations to certain qualities of things and weaves them into a solid web, which carries its existence.