

THE BEHAVIOR OF THE WALL LIZARD

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(1977)

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FOREWORD 34 YEARS AFTER

I finished writing this little book in 31 January, 1977, when I was sixteen years old. During four years, living at Seville, Spain, I spent countless hours observing the wall lizards of my neighborhood. To my surprise, this work won the 9th European Philips Contest for young scientists and inventors, celebrated in Paris in the summer of 1977.

These observations show a boy fascinated with Nature, with the eyes wide open, continuously asking the meaning of things. Many of the answers I gave were child's interpretations full of imagination and needed of scientific corroboration. 34 years later I rescue these curious pages as they were written, with the original text and drawings. I hope the reader can still enjoy with them.

Madrid, January 2011

José María Gómez Durán

INTRODUCTION

The animal which is the subject of this survey belongs to the reptile class, to the scaly order, to the saurian suborder, to the lacertilia family and to the *Podarcis hispanica* species, more commonly known as the wall lizard.

This survey was carried out –and this is highly important– in the South of the Iberian Peninsula, in the city of Seville. This will enable the first chapter in particular to be understood.

The reasons why I did this work, which is the fruit of four years of close observation, were, on the one hand, my great love of Nature and, on the other, the lack of scientific literature on the subject. I have therefore restricted myself to describing my own observations and experiences which is why the work does not have a Bibliography.

THERMOREGULATION

Wall lizards, as variable blood animals, depend in their internal temperature on the environmental temperature; however, if they only depended solely on the latter, and nothing more, perhaps the *Podarcis hispanica* species would have disappeared a long time ago.

Thus, there exist numerous adaptations depending on a balanced thermoregulation, more or less operated by the lizards themselves, based in the majority of cases on behavior. I shall hereafter describe the various forms of conduct I have managed to observe, which aid the animal to defend itself from the hostile environment surrounding it.

Lizards are not always in the same place for all the seasons; there does exist a cycle governed annually by solar and special climate circumstances which make them change to other places, even migrate in a small way. It all happens as follows:

With the first September rains, coinciding with the autumn equinox –when the sun is over the equator and days are equal to nights– lizards that live on earth and had their nests there, are forced to move. The humidity absorbed by the earth is excessive; a material that does not become soaked and that also offers a safe shelter is required. In addition, vegetation must not flourish either, since it is an authentic rain and dew accumulator. So, this shelter is obviously given by walls. They all then begin to climb the walls and search for new nests which, in general, are those from last year.

Apart from the advantage of this new material as far as the humidity factor is concerned, it also has the advantage of capturing heat. Now, in autumn, it does not matter that the earth absorbs heat slowly to release it afterwards in the same way. What is really required is a material like that of a wall, that immediately takes up heat; the night cold would, on its own, cancel out not only the heat collected by the walls during the day, but also the earth's. The latter's advantage regarding a possible slow release of heat at night is thus cancelled out with respect to the walls.

They spend winter and spring in these conditions on the walls; approximately after the laying of the eggs, coinciding with the summer solstice –when the sun is over the Tropic of Cancer, and it is the longest day and shortest night of the year– they return to the earth. The advantages of this return are absolutely logical; it suffices to reverse the aforementioned given in the case of walls and we shall find them: the extremely intense heat of summer that excessively heats up the walls and would endanger the lizard's life is dampened by the earth which accumulates heat more slowly than stone and releases it slowly at night, counteracting the cold that there is then.

Humidity, naturally, is no problem since in summer it is absolutely nil. Finally the vegetation now becomes beneficial giving shade and shelter from the sun's rays.

When, for whatever circumstance, there are no walls in the lizard's habitat, or there is no soil beneath them –both of which are rare cases– the lizard enters into lethargy, and gets into deep places, if possible, isolating itself from the environment.

As can be well understood, lizards living only on rocks and walls will fall into summer lethargy since, when summer arrives, they will have no option as regards settling in earth. However, those that only live in earth will fall into winter lethargy since, with the arrival of autumn and winter, the earth becomes damp and they are unable to move to dry place like walls; they will then go deeply into the earth.

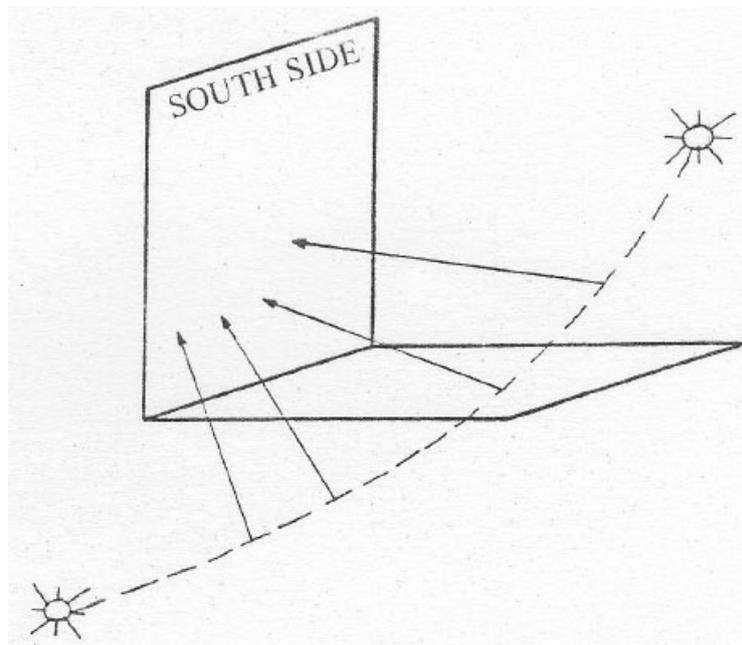
With these two examples, the extraordinary importance the materials on which the lizards live have in thermoregulation, and the migrations they go on can be understood.

However, in the south of the Iberian Peninsula –more specifically, in Seville– and under normal conditions where both non-pervious materials like stone and metal and pervious materials like earth are found together, lethargy also sets in. Nevertheless, it is reduced to a few very specific days corresponding to the very cold, rainy winter season, and the extremely hot days of summer.

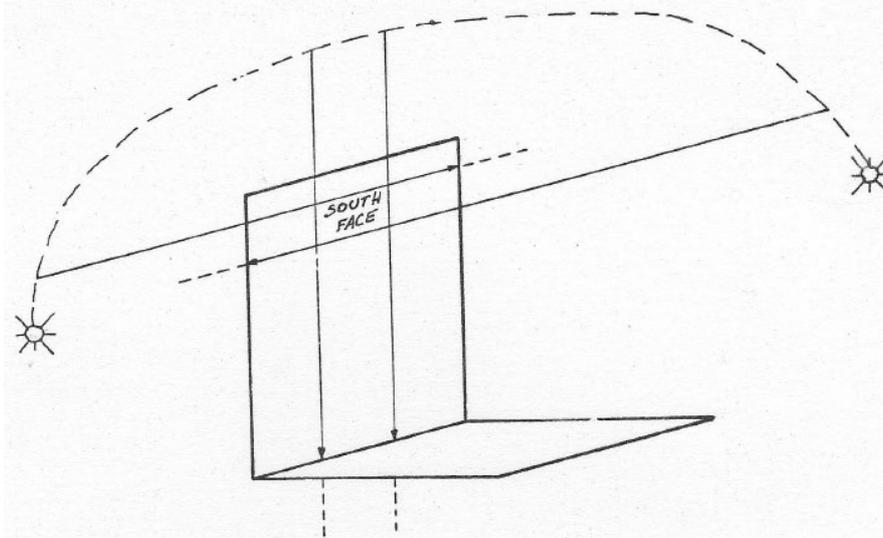
Up to now, I have only spoken of the adaptations to the different materials and of the vital role they play, but there is also an extremely important factor: sun orientation.

Lizards are not situated in the same direction regarding the sun all the year round. There is, nevertheless, an exception: the population of lizards located on the south face of walls usually remains in the same direction with no change or migration at all. Why? We can only find the reason in the sun. If we examine the orbit it describes throughout the year, we shall see that light always falls on the south side so that the lizards can always enjoy it.

Both in spring and in autumn, as well as winter, this is very beneficial because, amongst other things, the obliqueness of the solar orbit makes the rays fall perpendicularly on the south side.



It could be argued, however, that in summer this orientation would be fatal on making the *Podarcis hispanica*'s variable temperature rise too high. But this assumption is not true since, although the south face receives a maximum of direct light, it is also true that the latter's rays are the most oblique since, by then, the degree of verticality of the sun's orbit is at its maximum, so the high intensity of them is reduced to a large extent.

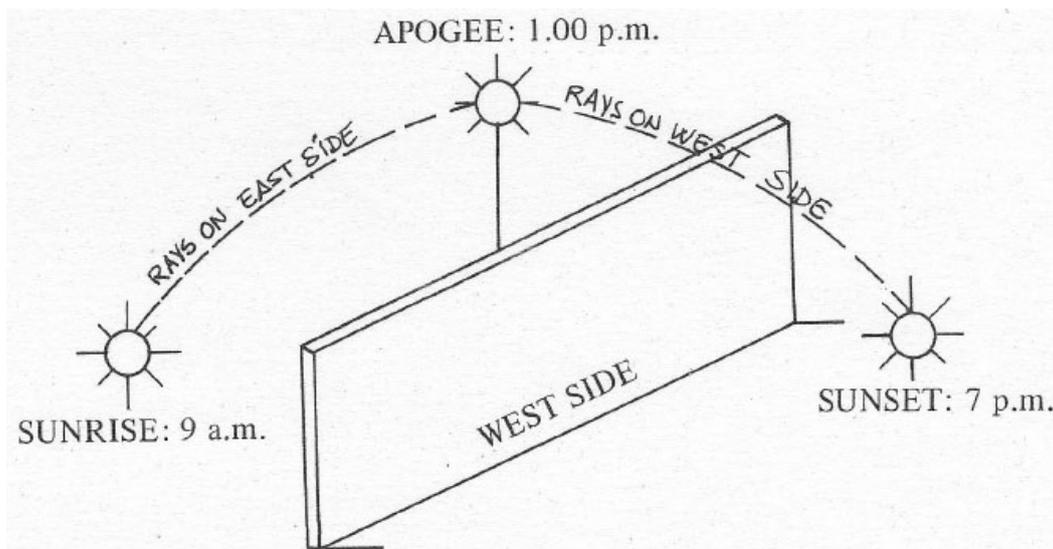


Apart from this, it must also be pointed out that lizards never live on the north side of walls as the sun never falls on them, except for brief moments before sunset in summer.

Having said these two things, I shall explain how migrations occur on the east and west side of walls.

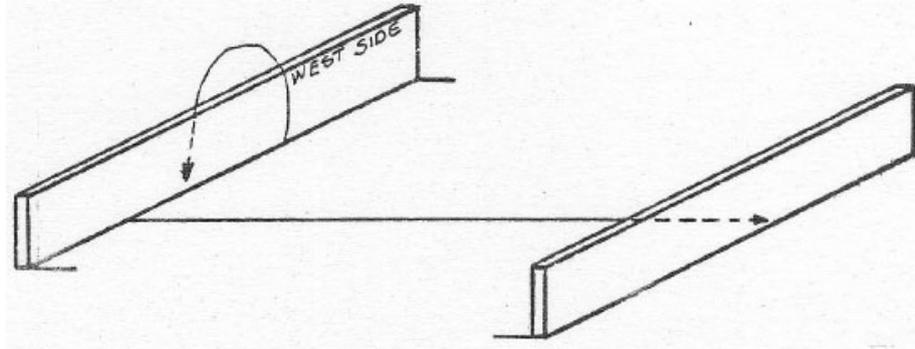
In the long season from the beginning of autumn to the end of spring, lizards are on the walls, but the matter does not end there since the orientation chosen on them is not arbitrary: they choose the side looking westwards, where the sun sets. Why? From the time the sun comes out until midday, the amount of heat produced is very little, particularly bearing in mind that we are in autumn and winter, when mornings are very cold. Therefore, the sun's rays sent out up to the zenith are not at all interesting, and it is these, in fact, which fall, not on the west side, but on the east.

The sun having reached its apogee, the rays begin to fall on the west side. But the heat by then is much greater (e.g. from 3 p.m. to 5 p.m.) and the lizards will enjoy it.



But, what happens in summer? All the aforementioned conditions are reversed, i.e., the heat given off now by the sun after its zenith is excessive, and even reaches 40°C. Therefore, the morning rays are most interesting now, much weaker and less harmful than the afternoon's. Which side receives them? The east. They have to move there then for which, if they have the chance, they go over the walls or, as I have seen, they migrate,

crossing small distances (in this case a six meter wide road) in the direction of the wall on the opposite side, and place themselves on the east side.



It must be noted that in these two cases, as in spring, autumn and winter, the lizards continue on the walls; but this only happens because the climate on the east side of the walls on summer mornings is very similar to that in the spring, autumn and winter afternoons on the west side.

However, in the majority of cases, the *Podarcis hispanica*, a slave to the environment, cannot go over the walls nor can it migrate to others. It then limits itself to descending to the earth, and hides away for most of the day in its den from where it does not emerge until the sun is almost on the horizon, and even if the temperature does rise excessively, it will suffer a little summer lethargy.

It is also worth pointing out that in summer, direct sunlight is not completely necessary, as can continue their activity without it for a certain time (the star-lizard will also carry on its activity during the night).

However, in the remaining seasons, the direct fall of the rays is fundamental and necessary, such that the activity of the different populations depends on it. Thus, when the shadow is covering walls little by little, lizards become upset and begin to twitch nervously. They sometimes try to transfer to places where the shadow has still not reached but, in general, they go one by one to their nests as though advised by a signal they all understand.

I shall finally talk of other adaptations as a function of the thermoregulation, that are also important.

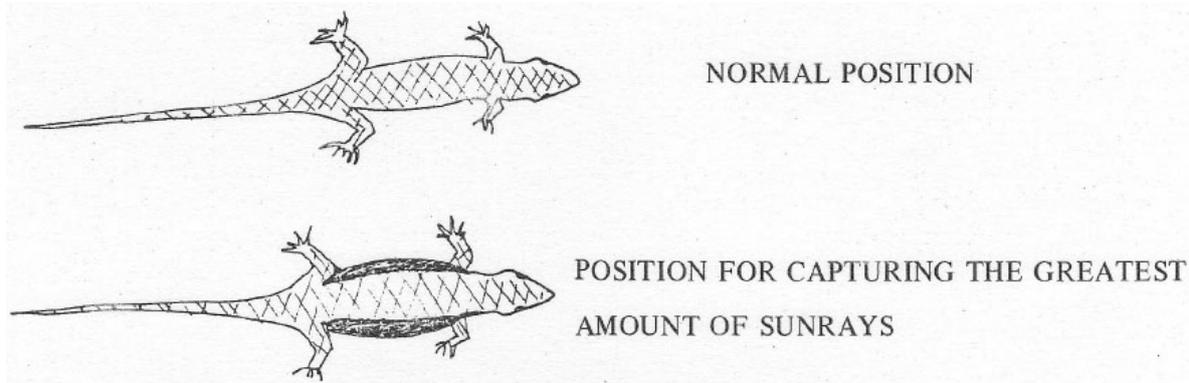
In summer, it is not rare for lizards to make use of trees and high wooden posts. Very early in the morning, they go up them (if they do not have their nests there) and in this way capture the first sun rays much easier. At midday, when the heat is suffocating, they come down to the earth and later, when the sun is setting, go up again to get the benefit of the last rays (as weak and beneficial as the morning ones).

An interesting characteristic for which trees and posts are frequently used is the facility they give for changing orientation.

It is also curious to observe, in this hot season, how lizards cut down contact of their abdomens with the material they rest on, and they even lift up their four legs, keeping them in the air since the contact surface temperature is much more important than the air's.

However, in the other seasons, particularly autumn and winter, lizards squash their bodies down onto the surface on which they are as much as possible, placing them perpendicular to the sun's rays. But what most attracts me of this behavior is that then, when they

distend their sides, bands of approximately half a centimeter wide that they have along both sides, black in color, become visible: black being the color which takes in the greatest amount of heat of all colors existing.



SOCIAL AND BREEDING BEHAVIOR

INTRODUCTION

We shall first raise the following question: Do gatherings of lizards form societies or groups? Should they form a society, there must exist therein a specific aim, a survival value that would make the meeting of lizards a necessity. There must also exist a close cooperation and a more or less complicated communication system between individual lizards, as a fundamental condition. In the case of a group, the meeting would be merely fortuitous, with no purpose and, in the majority of cases, with no personal acquaintanceship between the group's components, which obviously rejects any possible cooperation.

In what position are lizard gatherings? There are some indications that seem to point toward lizards forming groups. The most important is that the community they form has no aim or, in other words, has no survival value for the species. Thus, for example, the reason they are together in a certain place –e.g. the walls– is, in fact, because there is where the best environmental, trophic, etc. conditions occur, which makes each one go, individually, to those favorable places which, in this way, results as an unintentional gathering.

Nevertheless, we also find some points where lizards seem to form societies. At least, the high capacity for adaptation, curiosity and search for the best places to live in determines, and must have certainly determined during thousands of years, that lizards go to the same place: the best. In this way, even though fortuitously, and without meaning to, lizards meet year after year without interruption. Now, common choice on the lizards' part of the best places brings with it a problem: excessive agglomeration and bad terrain distribution. In addition, due to this confinement, hunting would be continuously disturbed, with each excessively hindering the other.

To solve this problem, lizards have had to create a repertory of signals which is fairly extensive, and a certain hierarchy, both of which seem to point towards the organization of societies. But things do not stop there; I would not be exaggerating too much when I say that lizards personally know the individuals of their species with whom they are usually found. Looked after in terraria, lizards are easily trainable and get to know their keeper, approaching him when he is near, with the intention of obtaining something to eat. Bearing in mind that under natural conditions they always frequent the same places during almost every year, it also seems clear that lizards will recognize the nearest individuals that share nearby areas. For instance, each lizard knows which is its place on the wall, respecting each other and trying not to change places. Some experiments have demonstrated this to me. On a long stone wall fence, about twenty centimeters thick, on the top side I many times frightened off a lizard towards another located about three meters away. When it had gone one meter –thus leaving two more to reach the other– it disappeared from my view. Behind the wall was a row of pine trees, and I thought it must have run up them. I still waited some time before going away. Just as I was going, however, I saw that the lizard had not climbed the trees but was right behind me. Without doubt it went over the wall and along the other side until it got behind me, and then went up to the top again.

I repeated this for several days, and the result was always the same, although on these occasions I observed with greater attention. I frightened it off again and when it had gone a little more than a meter, it stopped. Its attitude was really attentive: it didn't "know"

what to do; it looked ahead, then turned its neck round looking backwards, all the while twitching nervously. In front, quite some distance away, was the same lizard as the other day, whom it must have undoubtedly recognized. Approaching its territory would have caused it to attack more than once. Only for this reason could a lizard do what this one did. I had my body supported on the fence, and my head protruded over it so that I could see what was happening on the top side in detail. The lizard then turned round and began to crawl back passing before my eyes, not without a certain care being taken, a decimeter away, to position itself behind me. This type of thing happened many times to me and it is difficult to understand if a personal recognition between the individuals is not accepted. In this case, we cannot talk about any special kind of communication or signaling on the part of the owner of the territory; amongst other things, most times it does not perceive another individual approaching, and its attitude is calm. Furthermore, the lizard approaching can hardly see the owner of the territory and sometimes does not even see it because it is not there. Finally, it would appear that they recognize the different territories in their habitat and even associate each of them with the different degrees of danger that invading them bring with it.

I would also indicate that gatherings of lizards have a fairly important benefit, even though they are not formed intentionally: they enormously facilitate the mating of males with females. Copulation –the process of which I shall explain later– requires both sexes to be near. Confinement to the best places will greatly help this act.

In summary, I would say that lizards are unsociable animals, i.e., they do not tend towards sociability or to form societies. However, different exterior conditions cause lizards to come together. This fact, perhaps coming from very primitive times, has made lizards develop a number of characteristics and a range of communications and signals so large that, in this sense, they may be considered social. In other words, lizards do not show any tendency to form a society, but common ecological interests have made them sociable.

I shall now talk of social and breeding behavior, according to different attitudes.

LANGUAGE AND MEANING OF COLORS

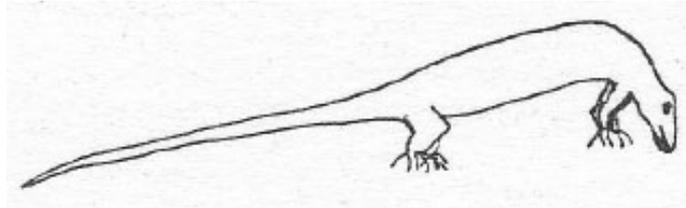
As I have said before, due to their fortuitous meetings, lizards have had to develop different kinds of communication that in some way organize the society formed, throughout their evolution. From all the ways to exchange information that I have managed to observe in lizards, I have made up the following language code:

- “aggressive attitude”
- “impressive attitude”
- “language of the sides”
- “language of stamping”
- “language of presence”
- “language of the tail”
- “language of odors”

Of these seven categories, there are three –the aggressive attitude, the impressive attitude and the language of the sides– in which the body’s color is highly important. It is not so in the other four.

I shall begin, then, with these three forms of language which are associated with colors.

When the aggressive impulse of a lizard is very high and it intends to attack, it takes up the “aggressive attitude”. This consists in lifting the body off the ground, supporting it with the legs, arching the tail and trunk and inclining the head downwards.



It is fundamental to point out that this posture is very rarely followed by an actual attack on the fellow lizard. Rather is it a model of ritualized conduct. Indeed, it is curious to note that when a lizard wishes to attack (fundamentally at the base of the tail) or rather to bite, it usually does so, whilst shaking the head up and down if it wishes to make a strong impact. For this, it has to lift up at least a little, as well as to arch the trunk. Well, this same attitude has been exaggerated and stereotyped to become a ritual.

When the animal carries it out, it walks very slowly and even stops; the muscles tense up to the maximum and the body becomes very rigid. Lizards seeing this posture, understand it perfectly and flee away.

The advantage of its having become ritualized is then clear, since in this way many fights that, had they taken place, would have been unnecessary, would be avoided. And I say unnecessary because the lizard taking up this singular attitude is highly aggressive at that moment, which means, in other words, that it is “prepared” for any fight. This preparedness gives it, on its own, a big advantage and certainty with respect to the fellow lizards, however superior they may be in strength and age. The latter, as I said, understand and flee.

However, in the “mating season”, which lasts from March to June approximately, aggressiveness increases noticeably. It now transpires that, for territorial reasons, fights abound and it is not then rare to see how, with regard to the aggressive attitude, response is not the same and flight is replaced by attack. It could be asked why there are attacks in this certain season. The reply is the same for all animals that include fights in their mating: the best one physically, the strongest, will win the fight and, therefore, the best characteristics of the species, represented by the winner, will be those that are perpetuated at mating time. This is the ultimate purpose of these territorial fights.

A question arises: Which sex takes up this posture? Perhaps both? Yes, both the male and female do it. But here the important role of colors comes in. The male is green on the top of its body. On the contrary, the female has brown-blackish livery. The male’s green has two purposes: the first, aggressiveness with the other males, and the second, inhibition of the females. With this, I would like to indicate that there are two contrasting reactions of the males with respect to the green color: flight or fight (especially in the mating season); in females, however, there is only flight in last case.

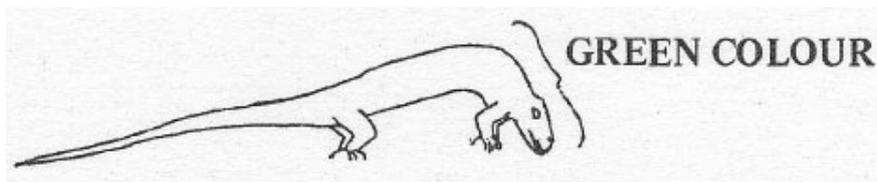
The females’ brown-blackish color also has two exactly equal functions, but in reverse. That is to say, the brown-blackish color strongly acts as an inhibitive factor for the aggressiveness in males and, at the same time, acts aggressively towards the other

females. This color appears not only on top but, more intensely, on the sides. In this way, it is always visible even when in a normal or horizontal position.



This has its function: the females are much weaker than the males and must, therefore, always, in any position, have a color that will repel the latter. On the other hand, this hardly applies to the males, since they are stronger and bigger than the females.

They will only have to use their green color against their fellow lizards of the same sex. So, the green color remains practically hidden whilst the male is in a normal or horizontal position, as it only appears on the top whilst the sides have a black band. When it wants to show this, it takes up the aggressive attitude which, when arching the back and dipping the head, leaves the green livery visible.



Having arrived at this point, which factor is most important; the attitude or the color? This is a difficult question to answer but a casual observation indicated to me that the attitude is probably more important. A lizard, fearful of the approach of another, ran away forwards; but the ten centimeter wide path was cut off by a star-lizard (*Tarentola mauritanica*) which lay across the whole width. The lizard's passing would disturb it excessively. What did it do to stop it? Surprisingly, it adopted the "aggressive attitude" in an exaggerated way. I later saw that this exaggeration is the common rule, and consists in arching the trunk at a 90° angle and even at a more closed one. But the most interesting thing was that the lizard understood this signal which had been sent by the star-lizard, an individual from a different species, from which it ran away. However, it must be remembered that the star-lizard is totally lacking in coloring. From this we can deduce two things; first: the posture must have arisen before the color, since it is understood in the absence of the latter; second: in the absence of color, the attitude is disproportionately exaggerated to make up for this absence. Nevertheless, in the marvelous network forming stimuli, any characteristic, however subtle it may be, may have real autonomy and release important impulses by itself. In the foregoing example of the star-lizard I am completely ignorant of the factors that acted on the lizard and so these two conclusions lack a sufficient basis.

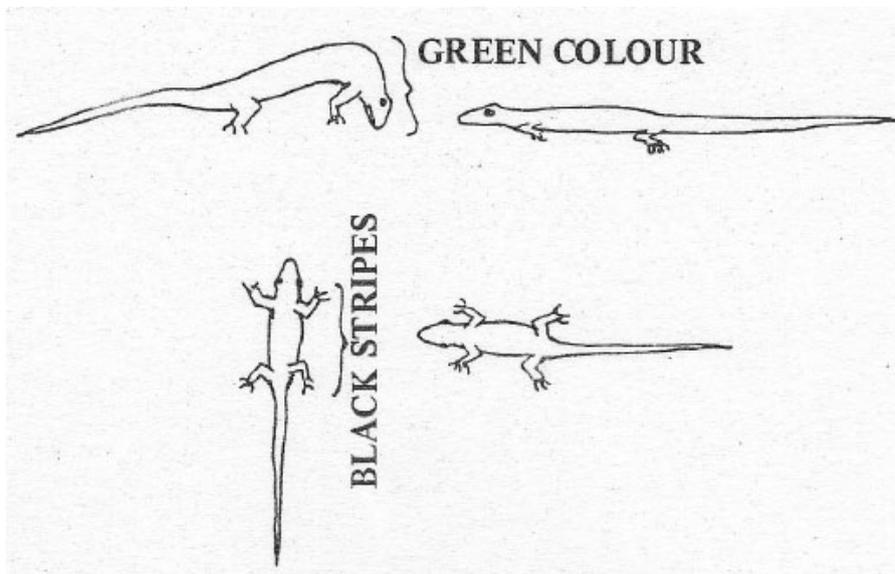
A large number of animals that have special, aggressive or mating marks possess the peculiarity of hiding or dissimulating them whilst they are not required. The simplest case is found in the beautiful tail of the peacock. But what does the male *Podarcis hispanica* do to hide them? He first endeavors not to make any movement, specially arching the trunk, so that the green on top is not visible. In addition, as I have already said, the side is lined with a black stripe so that in a normal position, it is the only thing visible.

But it does not end here, since what I call the "language of the sides" comes into action.

I spoke earlier of the fact that the brown-blackish color of the females is the stimulus releasing the inhibition of aggressiveness in the males. Conclusion: the males also use this same color in the form of a stripe somewhat more than half a centimeter wide on the sides to inhibit aggressiveness mutually, under normal, peaceful conditions. I do not

know what factors or stimuli achieve the same effect amongst the females. I rather think there is none and that the solution to this problem may be found –as I shall explain later– in associations between both sexes.

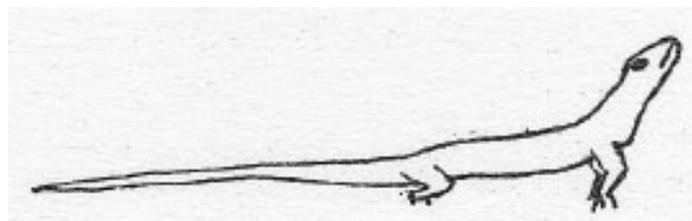
A very important difficulty arises in the aggressive attitude of the male: when it is adopted front on to the male adversary, it fulfills the mission of showing the aggressive green color. However, should it be adopted side on, the adversary will not see that color, but will only see the blackish side band whose function is not aggressive but inhibitive as we have said.



How does the male *Podarcis hispanica* solve this problem? It is really surprising: Underneath the black lengthwise bands on the sides, it has another stripe, much thinner (from one to two millimeters wide), blue colored which is not visible in the horizontal at rest position as it remains under the body. Just when the aggressive attitude is adopted and the body is raised above the ground, this blue line will be visible and this constitutes the aggressive factor.

Of the three forms of language associated with colors, the “impressive attitude” remains to be dealt with.

This consists in lifting the neck, whilst keeping the trunk horizontal and on the ground, forming an angle whose maximum reaches 90° with it. Most of the time the lizard is supported on the two front legs so that it lifts the body somewhat.



The function of this mode of conduct is, in its widest sense, to draw the attention of its fellow lizards. The position adopted is, in itself, showy, as it means a large part of the body is exposed –and this is extremely important– on being raised above the surface of the ground. Here, another type of communication, the “language of presence” has its influence to a great extent, although it is not so specific as the “impressive attitude”, but covers it together with other forms of conduct that I shall explain as they arise. When speaking of the “language of presence”, I am not referring to any special attitude or color

but simply to the way the lizard “presents” itself to his fellow lizards, with color or attitude having no influence, only just the “way of being”.

I said that this language had influence on the “impressive attitude” because, in wall lizards’ behavior, everything that is raised above the surface on which they rest creates excitation, alarm, curiosity, attention, fear and, in conclusion, an abnormal state causing vivid upset. Normality is expressed by stillness, by the horizontal position, by the total contact with the surface on which the *Podarcis hispanica* stand so that nothing protrudes above them.

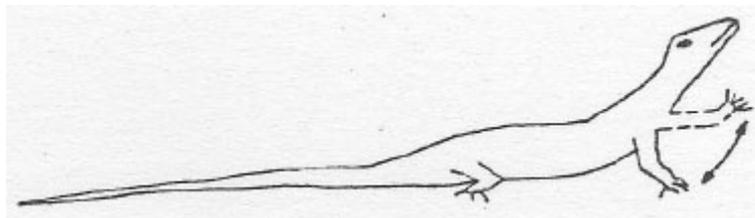
In this respect, it is interesting to note a curious experience based precisely on what has been said about normality in the life of lizards. Imagine one on a wall. We must approach it very slowly until we are approximately a meter and a half away. This is the critical limit after which it becomes highly mistrusting and flees. We then place our hand and arm on the wall, completely touching it. On dragging them little by little in the lizard’s direction, it will be very easy to touch it with our fingers, as long as we do not move our body; at least, I have managed this often and it has helped me capture them. The stillness and horizontalness factor here plays the most important role.

We thus see that the fact of raising the neck draws great attention (and body arching too, although to a lesser extent).

There is another factor making it also highly noticeable: the “language of stamping”. Lizards usually move their legs, stamp, from time to time with no purpose. When doing it like this, the stamping rate is very slow. However, when they raise their necks and rest on the front legs, they move them insistently and very rapidly. This movement is visible several meters away.

By examining the legs, I have observed that the majority of the scales covering them are very small, one millimeter and even less. They are soft and not very shiny. But on that part of the legs seen when looking head on at the lizard, exactly what it shows to his fellow lizards, the scales are abnormally large, being much longer and wider. Their consistency is harder, very shiny and highly reflective. Thus they very noticeably reflect the sun rays.

It must be pointed out that the stamping movement is done, save for a few exceptions, with the front legs, i.e., with those seen looking head on to the lizard, which indicates in a certain way that they actually have the mission of transmitting information, since otherwise they could move the back legs too (which would hardly be seen).



The attention-drawing nature of the “impressive attitude” does not end here. Now color comes into play.

Of all the colors existing, lizards have four of those that most draw attention, on the lower part of the neck: red, orange, yellow and white. Of these four, the first three (occurring in adults) are, together with pink and in accordance with chromatic physics, the colors which, over the same area, appear to be greater in size and volume.

Moreover, it is worth mentioning that these beautiful colors do not occur evenly over the whole of the lower part of the body but the maximum intensity is reached right at the neck, whilst in the rest of the body they fade a lot and even disappear. This shows us that lifting the neck must serve as something special when this part is precisely the most colored of the lower part.

It is also most interesting to point out that there is no distinction between male and female as far as the neck lifting behavior goes, as neither does the color they have. For instance, the “impressive attitude” would have the same meaning to a male when adopted by a female or by another male.

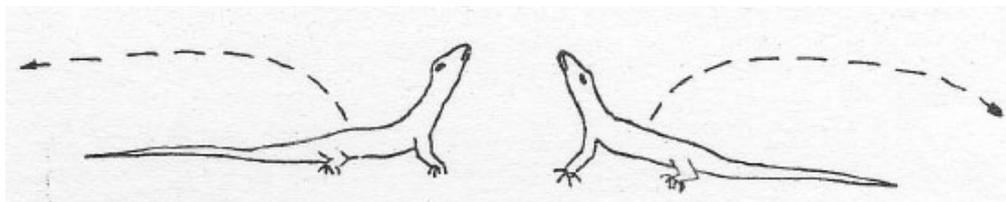
Let us think that the “impressive attitude” is the perfect negative of the “aggressive attitude”. In the latter, the neck was dropped and the trunk and tail were arched. In the former, the complete contrary occurs.

An anatomical change of such proportions must necessarily bring with it a change in the meaning of the behavior.

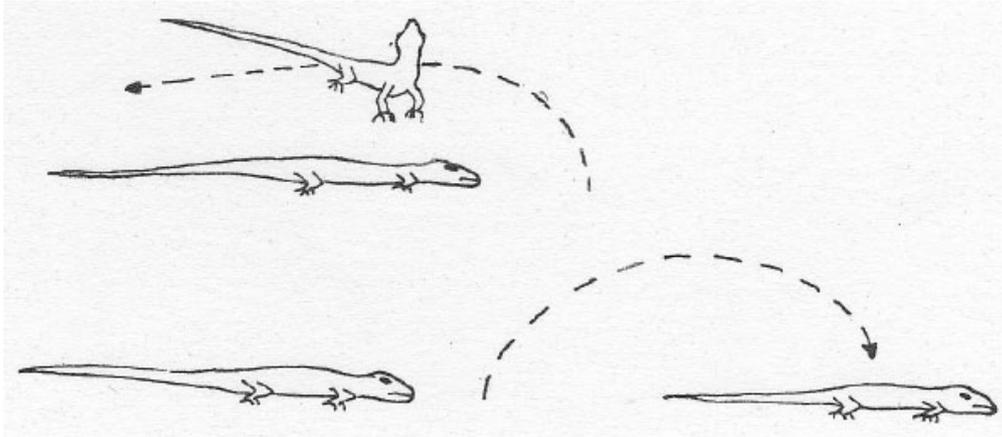
What function then has drawing the attention by means of the “impressive attitude” got? To explain it, I shall use the behavior of the peacock butterfly as well as that of certain moths.

These have very noticeable ocelli on the wings, which are hidden under normal conditions. When they are frightened by a bird approaching, for instance, they quickly open their wings and let their ocelli be seen. This quick display causes surprise and even fear in the predator and makes it flee. Delving into the roots of this behavior, we can see that initially it originates in an impulse to flee. Afterwards, as a result, an action is created that has no other purpose than aggressiveness, to give fear.

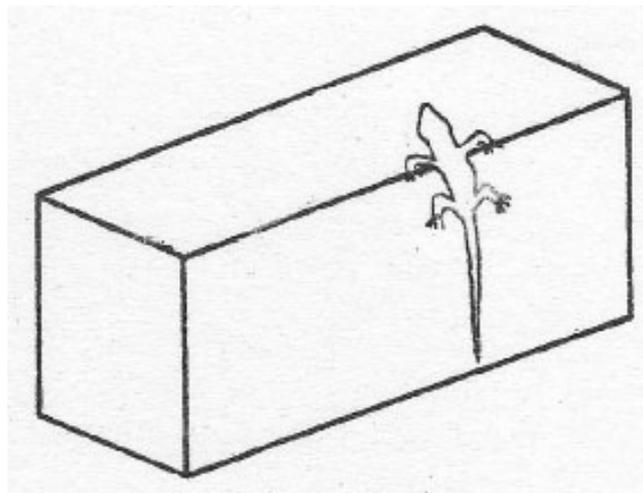
Something similar happens with the “impressive attitude”, which is used when a lizard is going to adopt the “aggressive attitude”, when a strong, dominant individual approaches or when an alien territory has been invaded. In these cases, an endeavor is made to make an impression on the dangerous adversary by drawing attention in the best way possible. It transpires at times, very few, that the one who has received the display flees. Other times, however, they provoke the release in the adversary of another “impressive attitude”. It is then curious to see the two lizards, one head on to the other, “impressing” each other mutually. In this very equalized situation, neither one decides to attack, and they usually end up both fleeing away at the same time.



Finally, it may happen that the adversary does not move but remains static (language of presence) or takes up the “aggressive attitude”, all signs of security, to which the one who showed his neck quickly flees, since, if he does not, he will be attacked. This is the most frequent case. When the time comes to flee, he does not do it just in any old way. There are two options: the first is to go by running round the adversary always displaying the neck and go away little by little until it runs off. The second consists simply in showing the other its back a certain distance away but without running. This last mode of conduct is the “language of presence” type and means “non-aggression”.



But we must say that although the aggressive result of the “impressive attitude” is not positive, distracting the adversary followed by a rapid flight is always achieved: there is no doubt that the brief display always gives rise to a paralyzing effect. This effect is that which most commonly occurs, with no further pretensions. Therefore, during almost the whole year, we can talk here of submissive behavior since the only thing sought after is to appease the adversary’s aggressiveness. This is easy to see in a very common behavior in the life of lizards; when one of them climbs from the ground up a wall to put itself on the top, it always raises its neck for some time before going on to it.



It does so because it is very possible that it is a territory already occupied. It must, therefore, make sure and adopt the “impressive attitude”. If a while passes, and there is no sign of a fellow lizard, it dips the neck and completes its climb. This observation can only be made on those flat horizontal places which are frequently visited by lizards. Where this condition does not occur it can never be seen, which shows in part that lizards know there are inhabited territories and where not.

However, in the mating season (March to June), the simple submissive nature of the “impressive attitude” changes. In this season, the colors of the bottom part of the neck are much more intense. In addition, it must be remembered that this intensity depends on age: the babies have white color, young ones yellow, adults orangey-yellow and older adults between orange and red.

This scale must have a reason. In fact, the purely “impressive” nature of other seasons turns into an aggressive factor. There is nothing better to warn of the presence of an individual or of territory than through a signal as noticeable as a “traffic light”. In this respect, it is very interesting to observe on horizontal surfaces, as from March on, how

many lizards there are with their neck craning for a long time. In this mating period, territories are fundamental, not only for obtaining food, but also, above all –as will be seen later on– for obtaining females to copulate with. Aggressiveness then increases enormously in all aspects and this, naturally, also has its influence on the “impressive attitude”. In other words, what exerted a function of submissive and appeasing display during the rest of the year, is now aggressive signaling which, if not respected, will turn into a fight. The strongest and most adult will advise of their condition by means of a more intense color; the weak, the worst equipped for procreation, will have less intense colors (which are white and yellow).

THE ANNUAL SOCIAL CONDUCT CYCLE

When I spoke of thermoregulation, I mentioned specific dates related to the sun’s position, which coincided with various changes in the thermoregulatory conduct. These changes have to be very possibly connected with the alteration of internal factors or hormone secretion. The stimulus seems to be the different duration of light according to the position and angle of the sun’s orbit, although its intensity may be a more important factor. Two highly important changes governed by this same stimulus also occur in the social behavior. The first occurs approximately at the spring equinox, when the sun is over the equator and days are the same in length as nights. Moulting then occurs which favors the skin acquiring a special coloring and glossiness. Aggressiveness is now dominant in the social conduct. There will be well defined territories which, in general, will be occupied by the same lizards day after day (the increase in insects in this season will also act as a stimulus); finally, the different forms of language, colors and attitudes will reach their maximum vigor and meaning.

The second change happens around the autumn equinox (the sun is also over the equator and days are the same as nights). The skin changes again, this time baring the lizards of their glossy colors and making them go much paler. A question can now be asked. If these colors are now too weak and pale and therefore do not fulfill their aggressive or inhibiting function, how can social relations be kept in balance? We have to seek the answers in the atmospheric conditions. The two seasons now approaching, autumn and winter, bring with them a cold, wet climate, apart from a lack of food. So, on cold, damp, windy, rainy days and on those when they come out to sunbathe (something which, because it is autumn and winter, is necessary almost every day), lizards have no social structure and there is no kind of hierarchy or territory; the reason is very simple: there is no need, since they cannot carry on any activity, including eating, which makes the territories and social language necessary. This has its advantages: they can choose the best places for keeping themselves from the cold and wet or for taking the sun without fear of being attacked even though the agglomeration in these places may be excessive. It is truly a fine thing to see how, on cold afternoons, they are all together, sticking close to one another, in the best crack in a wall and how, on the few sunny days, they come together, even in groups of twenty individuals, three or four centimeters (or less) from each other in the best strip of wall. With good weather and the coming of insects in spring, lizards begin to distribute themselves and form territories during the day. Even so, nights are still cold and there are few little holes in the walls offering good shelter and little humidity (the earth would collect a lot).

The same thing now happens as in autumn and winter: when the sun sets and the shadows begin covering the lizard populations, the social structure, aggressiveness and inhibitions come to a complete standstill; it appears they return to a state of a very primitive society.

In this respect, I remember a long wall of a villa in which there was only one very narrow hole leading to a cavity. Every evening, when the shadows were covering it meter by meter, the lizards went one by one, with full acquaintanceship with the place, to this hole however far away from it they were.

In summer, things change. They are now housed in the earth, which offers them many places in which to live. Each lizard usually has its own nest and, therefore, the problem of preventing aggression and inhibitions does not exist.

To sum up, we can establish the following scheme of things:

1. With humidity and bad weather, there does not exist any kind of social behavior, even during the day (autumn and winter).
2. With the advent of mild temperatures, this stoppage of social conduct will only occur after the time to enter the common nests in the evening (spring).
3. With excessive heat, the different rules of social conduct do not stop either during the day or at the time to enter the nests, since, amongst other things, each lizard usually has its own (summer).

THE BREEDING SEASON

Of the seven types of communication that occur with the *Podarcis hispanica*, the “language of the tail” and the “language of odors” have been left for this section because both have their greatest activity in the mating season. This lasts from March to June approximately, and as I have said before, all characteristics, whether of behavior or simply anatomical, reach their greatest vigor and brightness. Territories, that usually vary between one and three meters around the lizard, are now highly important since, to the obtaining of food (abundant at this time) the obtaining of females for copulation is added.

There are several ways of forming territories, such as the actual “presence” of a strong individual, surprise attack, the use of the “aggressive attitude”, the continued display of the varied and rich neck colors. It is important to indicate that if with these two latter attitudes the lizard that sees them remains motionless, this is a signal of safety (language of presence).

But, amongst all these ways of forming territories, there is a specially interesting one, highly used, in which what I call the “language of the tail” is involved. Before explaining it, and for better comprehension, I shall talk of the importance of lizards’ tails.

Its main anatomical function is to maintain the body’s balance, by counterbalancing the long trunk situated between the two pairs of legs, so that a tailless lizard is enormously clumsy in crawling around. It also aids in changing direction.

It is somewhat prehensile, which is a most important characteristic especially as far as climbing trees is concerned. It surrounds the branches with its tail when having to climb or descend them and thus, to a large extent, prevents dangerous falls.

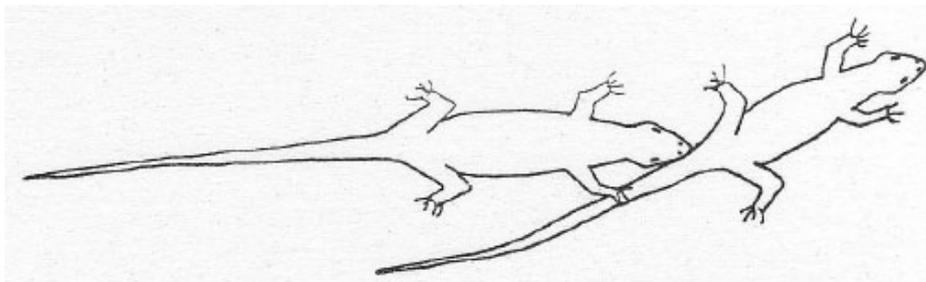
It is light, long and flexible. Now, every structure in Nature must have its explanation and its “raison d’être” how it is, and why not another way. I then wonder why the lizard’s tail is long and light instead of being short and heavy; after all, the anatomical function of the counterweight to the trunk would have the same result: to counteract the weight of one kilo on one balance dish it is all the same whether a compact iron cube of 1 kg. is placed on the other, or whether long, thin sheets of the same metal and weight.

Bearing in mind that the *Podarcis hispanica*'s tail occupies no less than two thirds of the body, what function, I repeat, must such a length have? We find the answer in a unique faculty of live beings and exclusive to Sauria: autotomy. This consists in the capacity of breaking its tail on condition that it has a point of support from where to break it for him. This point of support may be offered by the claw of birds of prey, the paw of a cat and of a multitude of mammals, the hand of a man and, in fact, the enormous amount of predators that hunt the lizard. In this way, the great length of the tail with regard to the rest of its body ensures almost that the lizard is caught more often there than by any other part, which instantly causes it to break off and, consequently, move on its own, thus attracting the predator even more than the actual lizard itself.

But the tail's autotomy is nothing like comparable to the breaking, for example, of the human tibia. Autotomy is a reflex, complicated action in which a number of muscles, the caudals, act on an area of least resistance made up of an amorphous partition passing through the muscle masses and crossing a vertebra. If this were not enough, the artery passing through the tail is provided with a circular muscle, the sphincter, which shuts off in the case of breakage and thus prevents hemorrhage.

This is obviously a whole mechanism preconceived for the animal's defense. However, it would pay too dearly for this defense, i.e., the breaking of the tail would leave it disabled, both in fighting with his fellows to obtain a territory and a mate, and in hunting and protection against predators. Once again, Nature has provided the *Podarcis hispanica* (like the majority of other Sauria) with an exceptional, marvelous faculty: they can regrow the lost tail. No characteristic can demonstrate to us in such an obvious way, how important the caudal member is to a lizard: a whole, highly complicated and unique process in life on the planet is destined, after disappearing, to come back again..., it is so necessary!

So, it is precisely on this importance and need for the tail to exist that I base the "language of the tail". This type of communication, much more used than the others mentioned earlier, is employed to form the territory, i.e., to eject the different fellow lizards found in a certain place from it. To do so, the lizard moves slowly, with no apparent aggressiveness, towards the individual it wants to chase off its territory, who must always be back on. The one at rest very rarely flees due to the nearness of the one approaching. On the contrary, they are usually calm since there are no signs of much aggressiveness. But the other keeps approaching, until the time comes when the snout reaches the base of the tail. It then begins giving the other many smooth knocks and touches. The one being attacked tries to flee, but the fear of provoking greater aggressiveness stops it running off. It just limits itself to walking very slowly at the same rate as the one immediately behind it.



This situation soon ends with the flight of the one being attacked because the aggressor stops touching it, although, to end it all, it usually deals it a good blow that never breaks the tail but after which there is no further contact.

From this description, we can see how lizards innately know that contact made with the snout on the base of the tail is extremely dangerous since it may lead to immediate breaking off. Hence the slow walk away, the flight after contact ends and, in conclusion, the language used for forming the territory.

Lizards obtain their territories through all these modes of conduct. A question then arises: the territories belonging to the males are different and private for each one but, does the same happen with the females? Naturally, what is certain is that they need to have it, as it is indispensable. Nevertheless, according to my observations, it seems that the females' territories are not different and separate from those of the males; on the contrary, they form part thereof, i.e., they are the same in the male as in the female. It turns out that copulation does not usually occur instantly at a certain moment, but rather is there first a kind of prelude or "settling in" through an association. These associations, which begin at the commencement of the mating season, and even before, are formed only by a couple in which both sexes enter. The union has been made and continued thanks to the inhibiting factors of the aggressiveness of each component of the couple: the male will allow the female to enter his territory and the female will remain there with no problem. It seems clear that the territory thus obtained will be defended on the one hand by the female against all other females, and on the other, by the male against all other males. This association, which occurs and is frequently seen during the breeding season, lasts in fact not too much time, although it does for several days. I then wonder, in view of the fact that the lizards disperse in the evening at the time to shut themselves away, how can both members of the couple recognize each other the next day? It is a real mystery. In fact, we are present at a very interesting link or middle step in the complicated formation of the couple in birds. Animals' characters do not usually occur brusquely, and conduct as important as forming pairs in birds must have come, necessarily, from a slow evolution from at least their primitive, former relations, the reptiles.

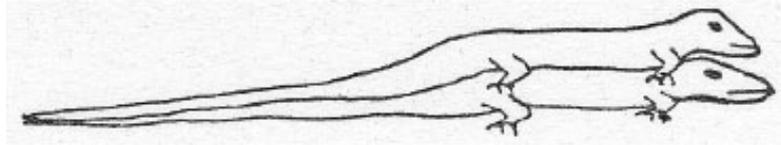
I said that the way in which they recognize each other is a mystery to me; however, I have discovered very strange conduct which only happens in the mating season and which, without doubt, must be connected with the problem of recognition, which I call "language of odors". The male lizards have glands called pores which, depending on the place where they are located, are called femoral, anal and abdominal, whose function is unknown up to now. I shall endeavor to throw new light on the matter.

To begin with, the possibility of the male's using glandular secretion as recognition of his own sex regarding all his fellow lizards is discarded, since his very conduct and distinctive colors are more than sufficient. And if this were the function of the glands, why are they not located on the outside of the body instead of being underneath, with which the secretion's access (particularly odor and, although not very probable, taste too) to outside would be much more easy and useful? In addition, why do the females not have them?

From the position of these glands, we may draw an obvious conclusion: the substance secreted (with a waxy, yellowish appearance) will have to be spread over a surface on which the male's body is resting, i.e., he will always have to be located on top of the surface onto which he wishes to secrete the product of the glands. Is it perhaps the surface of his territory, with the purpose of marking it out? I very much doubt it; the presence, the aggressive attitude, the impressive attitude. etc., serve for this.

Why, then, have such special glands? Onto where, then, is the secretion deposited? Onto the females. In fact, there is an extremely strange behavior of the males which only

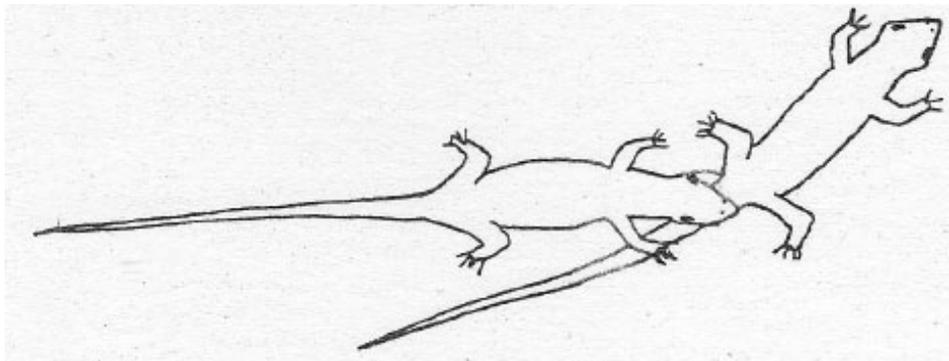
occurs in the mating season, consisting of slowly approaching the females and mounting on top of them.



This conduct has nothing to do with copulation, since the cloaca, as can be seen in the figure above, cannot come together. What do then come together are the anal, femoral and abdominal glands with the top of the female. Undoubtedly, the waxy secretion is left on her. Could the male thus recognize the female? Will this substance serve for the female to be respected by other males or perhaps by the other females? I have no idea.

To end this chapter, I shall describe the mating parade. Lizards' copulation is a really violent act, it seems more like a real attack. However, there arrives a moment when the male's sexual drive overcomes by far the aggressive inhibition the female produces for him. Very rarely does the male throw himself on her, amongst other reasons because she runs away and because, ultimately, throwing himself on her is usually fruitless.

It all happens as follows. The male slowly approaches his partner, avoiding any kind of conduct that may appear aggressive. He then uses exactly the same "language of the tail" technique used to form territories. He begins to rub the base of her tail with his nose; the female becomes alert and starts very slowly moving away followed immediately by the male. This precise moment is used by him to bite her at the cloacal slit level.



The female writhes in anxious convulsions, but it is now late; the male gets his trunk underneath, holds her with the neck on top and inserts in her cloaca one of his two erect spiky hemipenes. In a few moments, perpetuation of the species will be ensured. What has been described is practically invariable for all cases.

THE LITTERS

After about one month's gestation, the female lays from three to eight white eggs with a weak, coriaceous shell in June (about the summer solstice, when the day is the longest and the night the shortest in the year).

The orientation of these eggs is none other than that which the hunting grounds have which, as I explained earlier, are perfectly placed, according to the different seasons, to receive a maximum of sunlight. The only direction in which they are not placed –as neither to come out and hunt or sun themselves– is northwards since here in the south of the Iberian Peninsula, more specifically in Seville, the light never falls that way except in a few weeks in summer. It is curious to see how star-lizards, which need far less heat than lizards, then occupy these north walls. Thus the food is shared out much better and, moreover, the separation and spacing out of these species is aided.

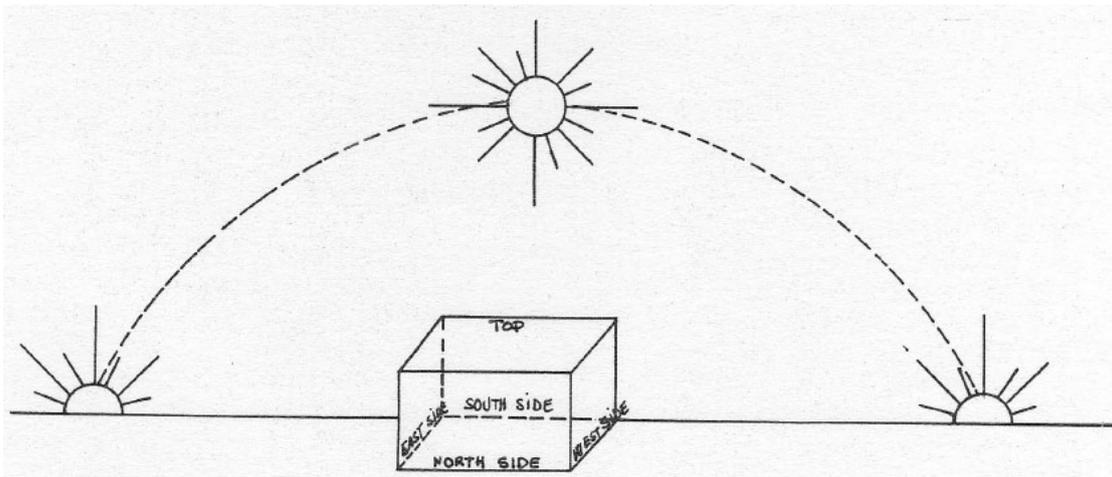
After two months, the eggs are sufficiently mature and the hatching is imminent. At the end of August and beginning of September, all the baby lizards are out.

The eggs are usually well hidden in hollows in the rocks and ground; other times, they are covered with earth which protects the eggs from excessive exposure to the sun during the day but which preserves heat for some time during the evening and part of the night. Of course, they are never laid in places where the sun hardly shines such as on the north side of walls.

Neither are they laid in places continuously exposed to sunrays, like surfaces that do not have any protective surround, whether walls, brushwood, apartments, etc.

Thus, in the figure hereafter, we can see how, on the top, with no protection at all, the sun's rays would fall almost all day, and so eggs will never be laid there.

On the other hand, the rays will never fall on the north side. They will not be laid here either.



On the other sides, south, east and west, the sun's rays are evenly distributed throughout the day, and this is then a very suitable kind of heat for the incubation of eggs.

Having taken all these precautions, hatching will take place after two months. The baby lizards just born are extremely weak and small and, bearing in mind that the rains and cold are near (autumn), it is necessary to feed plentifully in order to be able to support

them. There must, then, exist special adaptations in the babies (which the adults do not have) for this small period prior to autumn.

First, the agility of the babies is similar and even superior to that of the adults. However, the size of the mouth is very small and so it practically cannot hunt since very few insects fit into it. To overcome this difficulty, they then develop enormous curiosity. In summer, it is easy to see them all over the place –much more than the adults– sniffing away here and there, not in search of prey, but waste.

In fact, they are eminently carrion hunters, feeding off tiny pieces of flies, beetles and Lepidoptera mainly. This first food is what really makes the babies' bodies grow in rapid progression since, as adults, this growth will very noticeably become stationary.

It must be mentioned that this feature of curiosity is not only important as far as obtaining sustenance is concerned; it is also, in fact, the reason for the *Podarcis hispanica*'s expansion.

Indeed, the adults are very true to their own habitat, limiting all their curiosity solely towards it. However, the young go off further away and investigate everything, running round many places until they finally decide to stay in one. So other places are becoming inhabited and this is undoubtedly one of the reasons why excessive agglomeration in the old nests is prevented. This feature of the babies joined to non-specialization and a high capacity of adaptation is what makes wall lizards one of the most wide spread Sauria over the planet's surface, occupying Europe and a large part of Asia.

Having explained the food aspect, there is another no less important one: the social aspect. I refer here to the relationship between adults and babies. Bear in mind that adult lizards, aggressive as soon as they are disturbed in their territory, could disable the babies by breaking off the tail, and could even mortally wound them. Moreover, the value of survival held before by the baby's curiosity, could now be turned into a dangerous suicide since, full of curiosity, more than once they would approach an adult and even, as I saw, would try to clumsily snatch away the prey he had been stalking some time. The adult, with no further a do, would attack it ferociously... But this never comes about; things are too well made for such failures to happen in Nature, since, if not, the existence of the species would be in danger.

Let us explain then the extraordinary "invention" whereby the babies are not attacked either by males or females.

I already said in the chapter devoted to social behavior that the black color of the females acts as a factor inhibiting the male's aggressiveness. In the same way, the male's green stops the female attacking him. Starting from these two details, how can the baby manage not to be attacked either by the male or the female? Obviously, the baby will have to have "something" that stops the male and female's aggressiveness. What can this "something" be? Nature could not have solved it either easier or in a more useful way: she has put the inhibiting colors of aggressiveness from both sexes on the baby's body in equal part.

In fact, the baby's trunk is black-brownish whilst the tail, right from the base, is deep green. In this way, they achieve both aggression inhibitors. On the one hand the black-brownish color inhibits the male and on the other, the green inhibits the female.

The intensity of the tail's green color will reduce little by little until after the rest that comes with the first September rains, when it will have completely disappeared. After all, the critical period for feeding the baby has now passed, and so these special adaptations disappear.

HUNTING AND FEEDING

In the hottest times during summer and the coldest in winter, these lizards never hunt, amongst other things because there are hardly any insects. The seasons preferred are the mild ones, preferably spring and also autumn and winter days when the sun shines. In spring and summer, they prefer the mornings and in autumn and winter, midday.

But are lizards good hunters? In fact, not so good as is thought. I have to admit that of the many hunting sessions I have seen, not many were successful.

A comparative study with the star-lizard will give us a clearer idea. The star-lizard is the being "par excellence" that has best adapted to life on walls. The bottom of its toes is formed by little sheets that act like suckers and are capable of supporting the animal for an indefinite time, in any position and on any surface, being particularly useful on walls. I would point out that they also have nails.

The outside surface has an extraordinarily camouflaging color, and numerous protuberances in the skin help to break up the figure. In addition, they are tremendously patient and stalk their prey for hours. All these adaptations take place because the star-lizards predatory field is very small, being based practically on flying insects like flies, mosquitoes, grasshoppers, butterflies, etc.

The lizard, however, is not so specialized. To begin with, we do not find tiny sheets on the toes but sharpened nails. These nails are not capable of supporting the lizards in all positions for a long time, and they find themselves in difficulties when they have to climb a smooth wall to reach their nests.

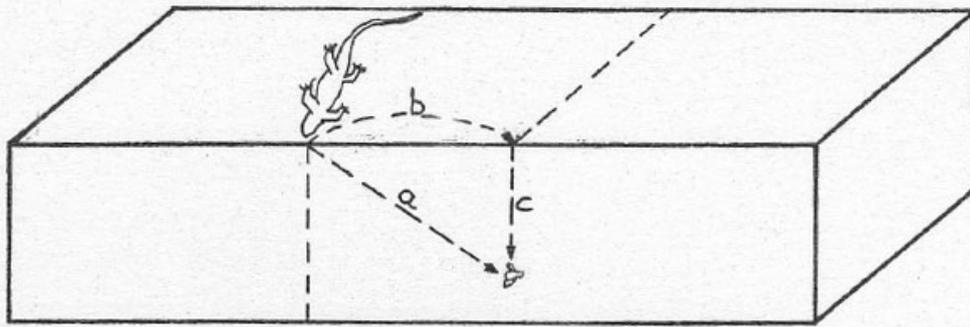
As a counterpart, they serve a little for everything like, for instance, climbing bushes and walking along the ground apart from climbing up walls, with some difficulty admittedly. Moreover, the outside surface does not camouflage with the walls. It does, however, with the ground vegetation but, having regard of the fact that they are only there from June to September (in those places where there are walls), the importance of camouflage decreases a lot.

Also, unlike the star-lizard, they are very restless and are incapable of waiting long for their possible prey. But this lack of specialization is counteracted with a wide range of hunting area. Curiosity, although not so great as in the babies, also exerts its beneficial influence. So, when there is no success hunting, they become possessed with a strange nervousness that makes them cover some distance examining every corner and tiny hole they find along the way. Now they test high pine trees difficult to get at, then they descend to the dense vegetation; then they penetrate into long pipes, now they speed along the asphalted road. They just look everywhere and at everything.

How do lizards hunt? They have several methods. On a few occasions they use a quick run, preferring a surprise attack on their prey or jumping from the wall to the ground. They often, even, leave insects alighting more than a hand-span away. Only when they are very near will they use their strength to jump and catch there.

With regard to hunting by surprise, there is a point worth mentioning. That is that lizards, if the occasion arises, usually attack flying insects just at the moment when they are going to alight, never after they have landed. The reason lies in the fact that the inertia of the insect on landing makes its possible flight more difficult than if it was already alighted, thus facilitating the lizard's hunting. I have observed a similar thing with hunting spiders that do not use a web.

With regard to jump hunting, it must be noted that they always look for the jump in the direction of gravity, i. e., vertically.



Thus, for example, in the figure above the insect is quite far from the vertical as regards the lizard. The lizard will never jump as direction “a”, but will run “b” to get above the vertical “c”, after which it will jump. The economy and usefulness of this behavior, apparently so logical and simple, has its mysteries. Why choose the “c” vertical? How can the lizard know that the gravity direction is the shortest? And, above all, how does it know that in this direction its body will drop quicker on the prey, so that rapidity and economy of effort will be maximum? I do not know.

I shall, finally, describe a really exciting method lizards use to hunt.

It is well known that excrement gives off odors that attract insects, mostly flies. So lizards take advantage of this to catch them. But what excrement do they use? Do they have to wait until it appears on the ground from some animal like, for instance, a dog? Not at all. They use, no more or less, their own excrement. To do this, after defecating, they turn round and position themselves facing the excrement, in a straight line and completely motionless; the distance from the head to the excrement is usually three to four centimeters, and the time they wait for the insect is usually as long as it takes for the excrement to dry.

I do not know if this behavior is innate or acquired, although the most likely thing is that it has its origin in learning by conditioning: lizards would observe that a short while after dropping their excrement, the insects would alight on it; later, after repetitions, the lizard would wait, now “on purpose”, for the insects to come. Thus they use a real bait, a trick to trap their prey.

How wise is Nature. Even where there is something no longer of use, there is a new source of food!

To finish this chapter, I shall speak of the main foods. The diet is basically made up of insects such as flies, Lepidoptera and beetles as well as waste and carrion. In addition, in the rainy season, they eat slugs and worms. But they must both be small sized since, because lizards cannot masticate, they cannot break up their food and swallow it if it is very large. They also eat snails at this time. In order to break their hard shells, they have to use the ground as a rudimentary tool, hitting then time after time on it. The blackbird uses the same technique with them.

Coinciding with the rains, which soften the ground so that it can be dug up by a single ant, the queens come rushing out of the ant heaps. They copulate in the air, but in order to lift themselves, they need a platform from which to throw themselves. So they use rocks and plants, if within reach, and also walls. They are then seen to climb the walls in large numbers until they reach the top and then throw themselves immediately into the air. But

there is where the lizard is waiting hungrily. Even before their wings start to move, they are in their jaws and, if possible, even further in.

Lizards practically do not drink water and the little they do is in the form of dew accumulated on plants during the night before.

In summer they have a curious food: the ant pupae, wrongly called “ants’ eggs”. More than once in this season processions of ants form on walls carrying their pupae in their jaws. They take them from the west side to the east. It must be undoubtedly because the excessive sunshine on the west side in summer afternoons could place the pupae’s life in danger. The east side, on the other hand, offers a benign shade. The thing is that the lizards engage in stealing these pupae and eating them with the greatest of pleasure. The worker, soldier and male ants are never eaten as they lack sufficient juices and have a lot of chitin.

They love sweet things and, in this respect, it is interesting to note that they take nectar. To do so, they take flowers that have fallen to the ground and put them in their jaws; they then make great efforts, turning over and even revolving round the axis of their bodies to extract the sweet drops these flowers enclose. Having finished this operation, they spit out the petals little by little.