DEATH-FEIGNING IN RANATRA.

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GENERAL CHARACTERISTICS OF THE DEATH FEINT.

The instinct of feigning death is developed in Ranatra to an unusual degree. If a Ranatra is picked out of the water it usually becomes motionless, either at once, or after a few spasmodic movements. Sometimes, however, the insect will not feign at first, but kicks about with its second and third pairs of legs, at the same time moving its anterior legs up and down so as to produce its characteristic squeaking sound by rubbing the bases of these appendages against the prothorax. When dropped on the table, even while moving, Ranatra usually becomes quiet as soon as it strikes the substratum. The attitude assumed is variable and depends to a great extent upon the position of the legs when the insect is dropped. The anterior legs are generally held close together straight in front of the body. Sometimes the two hinder pairs of legs are held straight backward close to the ventral side of the abdomen where they lie in a depression on either side of the median ventral carina. In this position the insect resembles a straight stick and may very readily be mistaken for one. Frequently both pairs of legs are bent forward and slightly dorsally. All sorts of intermediate attitudes are assumed, and the legs on the two sides are quite commonly held in different positions. This variation in the position of the appendages is in marked contrast to the definite and constant attitude which is assumed during the death feigning of many other insects.

When in the death feint, Ranatra lies motionless for a period varying from a few minutes to several hours. Under ordinary

circumstances, however, the feint does not usually last for more than an hour. There is a wide variability in the duration of the feint in different individuals under the same conditions; and different circumstances, as will be described below, influence the result to a very marked degree.

The death feint may be brought about by picking the insect up in the fingers, or, if this does not suffice, by gently stroking the body. If an individual that is picked out of the water persists in moving its legs about in an effort to escape, it may usually be quieted if its legs are bent backward alongside the abdomen and the body gently stroked or rolled about in the fingers. If when beginning to come out of its feint Ranatra is stroked or sometimes even lightly touched it will resume feigning. A breath of air blown upon the insect will frequently produce the same result. When Ranatra is walking about it often happens that, owing to the lack of adequate support by the legs, the body is allowed to touch the table. This contact frequently results in causing the insect suddenly to feign death for several minutes. The death feint may be induced in susceptible individuals by slight contact upon the thorax, legs or abdomen. Contact with the breathing tube, however, is much less likely to produce this result. In handling specimens which I do not wish to throw into the death feint I find that it is best to seize them by the tip of the breathing tube. Specimens may be moved about in this way and still kept in an active condition, whereas they would be pretty certain to feign death if they were seized by any other part of the body. If they can be induced to use their legs and walk off before their body comes in contact with the table they are much less apt to feign. This may be frequently accomplished by dragging them backward over the top of the table so that their claws catch in the wood. The walking reflexes are thus set up and the insect may often be picked up in one place and set down in another without throwing it into a quiescent state.

While in the death feint Ranatra is in a condition of tetanus. The muscles are set so that the body and limbs are in a state of extreme rigidity. All sorts of unnatural positions which the insect may happen to assume in the beginning of the feint are retained for a long period. It may be picked up by the outstretched anterior legs and held out straight, ventral side upwards, for some time without bending the legs. When the weight of the insect

finally causes the muscles to relax, the body descends very slowly and in an irregular manner. When an insect which is not feigning is held in this way the body drops down at once. If one of the hinder limbs is outstretched the insect may be seized by the tibia and held out horizontally without causing the least bend in the femoro-tibial joint. When the muscles finally give way the body sinks downward very slowly. When we reflect that the weight of the whole body in this case must be sustained by the minute extensor of a very slender limb acting with a very disadvantageous leverage, it is evident that the muscles must be in a state of extreme contraction. The attempt to bend any of the limbs in an individual that is feigning death will afford proof of the extreme muscular rigidity of the insect in this condition. Ranatras that are feigning may be placed in all sorts of unnatural attitudes which they will retain for from several minutes to over half an hour. In one case an individual which had feigned death with its hinder pairs of legs drawn up dorsally and forward was placed ventral side up so that it was supported only by the tips of its outstretched legs and the extremity of the breathing tube. The vertical distance between the tips of the anterior legs and the top of the table was indicated by a mark on a block placed close to the legs so as to gauge the rapidity of their descent. The abdomen nowhere touched the table, but its tip at the base of the breathing tube lay about a millimeter above the surface. In this position the insect remained without a perceptible movement from 7.57 P. M. to 9.10 P. M. when the tip of the abdomen touched the table. Between 9.10 and 9.20 the tips of the anterior legs sank about two millimeters. At 9.25 they had sunk another millimeter and at 9.28 the insect sank down on its back and began very slowly to move its legs. The position in which the insect was placed was one that could be maintained only through severe muscular strain—both of the leg muscles and the muscles that move the breathing tube. In another case a specimen was placed so that it stood upon its four posterior legs with its head pointing nearly directly downward. After six minutes it bent the left hind leg so as to rest on the knee, after which it remained in this very awkward position for seventeen minutes longer when it toppled partly over on its side where it remained several minutes more before getting up.

A similar condition of muscular rigidity is quite common among

insects that feign death. In certain spiders that feign death the condition is described by ROBERTSON[1] as one of "extreme tetanus." In most cases the appendages are drawn up close to the body. In some amphipods and isopods the body is strongly flexed and the legs drawn up into a compact form—a condition that can be maintained only through the exercise of a constant muscular strain. An apparently similar state occurs in the rigid form in which the asp and certain other serpents may be thrown by the proper manipulation. And it is not improbable that the cataleptic stage that sometimes occurs in hypnotized human beings may fall within the same general category of physiological phenomena.

One striking peculiarity of the death feint in Ranatra is the apparent insensibility to pain which is shown. One may perform the most severe mutilations upon an individual that is feigning death without evoking the least manifestation of feeling. This is well illustrated by the following experiment: In a Ranatra that was caused to feign death the four hinder legs were cut off one by one. Not a wince. Both anterior legs were then cut off, and after a slight jerk the insect was as immobile as before. The tip of the abdomen was cut off. No movement. Then the abdomen was cut off next to the thorax. Still no response. Then the body was cut in two across the thorax leaving a short middle piece with the stubs of two pairs of legs and the anterior end of the insect with the stubs of the anterior legs. No movement in either piece. In eight minutes the stubs of the anterior legs began to move in a lively manner. The head piece was then picked up and stroked when it was again thrown into a rigid condition.

DURATION OF SUCCESSIVE DEATH FEINTS.

In experimenting upon the duration of successive death feints in the beetle Scarites, FABRE[2] found that there was a gradual increase in the length of the feint the oftener the insect was compelled to repeat the performance. In the experiment cited the

[1] ROBERTSON, T. B. On the Sham Death Reflex in Spiders. *Jour. Physiol.*, Vol. 31, p. 410. 1904.

[2] Souvenirs Entomologiques. 7me. Sér., p. 14.

beetle feigned for seventeen, twenty, twenty-five, thirty-three and fifty minutes in successive trials; and other experiments the details of which are not given were found to yield similar results, although there was very great variability in the lengths of the responses. The insect, however, could not be induced to feign indefinitely; sooner or later all efforts failed to make it fall back into the death feint, as if it found the ruse useless and decided not to persist in it.

My own experiments upon quite a number of unrelated forms have shown that in nearly all cases the duration of the death feint diminishes instead of increases with successive trials. Details of these experiments will appear in a future paper. Ranatra forms no exception to this rule, although there is usually a very great amount of variation in the duration of the first feints. In the experiments whose results are recorded in the following table ten Ranatras were picked up, stroked to about the same degree, and laid down on the table. As soon as a specimen awoke it was immediately picked up and caused to feign again, and its time of awakening recorded. This was continued as long as any of the Ranatras would feign. All of the specimens were exposed to the same amount of light, and the temperature of the room was kept nearly constant. The experiment was begun at 9 A. M. and continued without any interruption until 5 P. M., when the last specimen refused to feign longer.

TABLE SHOWING THE DURATION IN MINUTES OF SUCCESSIVE DEATH FEINTS IN TEN SPECIMENS OF RANATRA.

A	B	C	D	E	F	G	H	I	J
5	6	14	17	26	38	38	115	117	125
13	70	34	37	37	32	56	35	22	35
24	38	30	31	31	15	19	25	43	30
16	31	6	11	19	8	43	10	9	37
41	14	32	73	52	7	11	9	15	31
8	15	6	35	29	4	9	3	2	12
26	5	9	46	79	2	12	16	16	22
29	17	6	48	61	2	9	4	10	20
4	8	24	21	9	3	9	1	15	12
12	10	41	6	15	2	1	1	10	11
2	3	11	13	4	1	16	.5	7	5

Continued on next page.

A	B	C	D	E	F	G	H	I	J
4	2	19	9	6	1	8	0	8	6
4	1	3	8	6	3	3	0	7	8
4	11	5	5	3	2	1	0	6	13
1	14	11	5	2	1	2	.5	6	5
1	4	5	3	3	0	3	0	5	2
2	2	5	2	3	0	3.5	.5	3	1
1.5	3	10	3	1.5	0	1.5	0	3	1
1.5	3	3	3	1	0	2	0	7	2
.5	8	7	3	5.5	0	1	0	2	2
1	3	4	3	4	0	.5	0	1	2
1	4	8	5	9	0	.5	0	2.5	2
1	7	3	6	3	0	.5	0	1	1
2	1	3	7	6	0	.5	0	1.5	.5
1	9	3	2	3	0	1	0	0	2.5
2	8	3.5	3	1	0	0	0	0	1
.5	1.5	2.5	1	1	0	0	0	.5	4
.5	4.5	2	1	2	0	0	0	0	3
.5	8.5	2	1	.5	0	0	0	0	4
0	1	2	2	1.5	0	0	0	0	1
0	5.5	3	4	1	0	0	0	0	.5
.5	1	5	0	2	0	0	0	0	2.5
0	0	2	0	1	—	—	—	0	3
.5	0	1.5	0	0	—	—	—	—	2
0	0	2.5	0	0	—	—	—	—	30
0	0	1	0	0	—	—	—	—	0
0	0	.5	0	0	—	—	—	—	0
0	0	.5	0	0	—	—	—	—	0
0	—	1	—	—	—	—	—	—	0
0	1	—	—	—	—	—	—	—	0
—	—	1.5	—	—	—	—	—	—	0
—	—	2.5	—	—	—	—	—	—	0
—	—	2	—	—	—	—	—	—	—
—	—	.5	—	—	—	—	—	—	—
—	—	0	—	—	—	—	—	—	—
—	—	0	—	—	—	—	—	—	—
—	—	0	—	—	—	—	—	—	—

THE EFFECT OF TEMPERATURE ON THE DURATION OF THE DEATH FEINT.

The duration of the death feint in Ranatra is decreased if the insect is exposed to a higher temperature and increased if the temperature is lowered. The duration of the feint in different

individuals is very variable, as may be seen by a glance at the accompanying tables. In all the experiments the insects were subjected as nearly as possible to the same amount of handling, and exposed to light of the same intensity. The Ranatras were picked out of the water, and, after the legs were bent back against the body, the specimens were stroked a certain number of times and laid on the bottom of a glass dish. Each dish was covered by a glass plate and kept partly immersed in water of the desired temperature which was indicated by a thermometer placed in the dish. All of the conditions except temperature to which the different lots of specimens were exposed were made practically the same.

In one experiment nine Ranatras were exposed to a temperature of 35° C., and an equal number kept at the temperature of the room which was 21° C. In the first lot the duration of feints in minutes in different specimens was as follows: 8, 8, 9, 10, 14, 18, 21, 25, and 40—giving an average duration of feint of seventeen minutes. In the lot kept at a temperature of 21° C. all of the specimens, without exception, were still feigning after an hour and five minutes when the experiment was discontinued.

In a second experiment eight specimens were kept at a temperature of 30° C. and eight others at a temperature which varied from 10° C. to 14° C. while they were kept under observation. The duration of the feints in the two cases was as follows:

Specimens Kept at 10°-C.14° C.	Specimens Kept at 30° C.
65	7
145	11
146	13
147	17
147	25
149	52
160	102
168	107
Average 137 minutes.	Average 43 minutes.

In a third experiment one lot of seven specimens was kept at the temperature of the room which was 22° C. while eight other

specimens were exposed to a temperature of 34° C. The duration of the feints was as follows:

SPECIMENS KEPT AT 22° C.	SPECIMENS KEPT AT 34° C.
30	9
30	11
34	11
40	16
49	21
83	34
88	39
	41
—	—
Average 50.57 minutes.	Average 22.75 minutes.

The experiments show that heat diminishes and cold increases the duration of the death feint to a very marked degree. This result is similar to that which FABRE obtained in experimenting on the Buprestid beetle, Capnodis tenebrionis Lin. Ordinarily this beetle feigns death for less than an hour. Exposed to cold, its feint continued for over five hours. In Scarites, on the other hand, FABRE[1] found that a slight decrease of temperature caused the death feint to become shorter, a result not improbably due to the shock effect of the transition.

Ranatras transferred from the ordinary temperature of the room to a temperature of from 0° C. to 4° C. often come out of the death feint almost as soon as they touch the cold bottom of the glass dish. The cold acts as a sudden stimulus to them and they react much as if they were laid against a hot surface. If they are kept longer at this temperature they move about very sluggishly as if benumbed, and finally settle down to a comparatively quiet state. This condition is, in great measure no doubt, due to cold rigor, and in the specimens which are not aroused by the sudden chill it is not possible to determine when the death feint terminates, since the insects lie quiet in both of these conditions. Specimens which I had kept for some time in water at 10° C. and then transferred to a glass dish at a temperature of 4° C. continued to feign death without interruption. The transition in this case was not so great and the specimens were not subjected to the sudden shock which they received in the former

[1] Souvenirs Entomologiques. 7me. Sér., p. 14.

experiment. None of these specimens showed any signs of awakening for three hours, and probably they would have remained quiet for a much longer time.

THE EFFECT OF LIGHT ON THE DURATION OF THE DEATH FEINT.

The duration of the death feint in Ranatra is diminished, as a rule, by exposure to bright light. Twelve Ranatras were exposed to the light of a sixteen candle-power electric light at an average distance of about one foot. At the same time another lot of thirteen specimens was exposed to a much dimmer light in another part of the room. The duration of the feints under these conditions was as follows:

Specimens Under Bright Light.	Specimens Under Dim Light.
14	24
23	33
41	41
46	65
70	90
71	105
81	105
88	115
93	139
101	145
1:8	180
174	210
	255
Average 75.8 minutes.	Average 116 minutes.

Ranatras are roused from their death feint much more quickly if the light is moved about near them than if it is kept stationary. In experimenting on the effects of moving light one lot of specimens was placed under a sixteen candle-power lamp six inches away, a flat dish of water being interposed to cut out the heat rays. Another lot of specimens was exposed in the same way except that the light was kept moving above them at an average distance of about six inches. The duration of the death feints under these conditions was as follows:

EXPERIMENT 1.

UNDER MOVING LIGHT.	UNDER STATIONARY LIGHT.
3	20
4	28
8	40
15	41
26	42
Average 11.2 minutes.	Average 34.2 minutes.

EXPERIMENT 2.

UNDER MOVING LIGHT.	UNDER STATIONARY LIGHT.
	13
3	14
3	15
6	21
11	24
15	38
21	39
21	78
Average 11.4 minutes.	Average 30.2 minutes.

Specimens that have been lying quiet for some time may frequently be aroused very quickly if the light is moved about near them. Each time the light approaches they respond with a twitch which increases in vigor with each repetition until finally they get up and begin to walk around.

DEATH-FEIGNING IN DECAPITATED SPECIMENS.

In cutting off the head of Ranatra close to the body only the supraesophageal ganglion is removed. The subesophageal ganglion lies considerably behind its usual position in the insects and is closely connected with the first ganglion of the thorax so that it cannot easily be destroyed without inflicting injury to the latter organ. In each case the head of the decapitated specimen was examined to make sure that the supraesophageal ganglion (which also lies quite far back) was entirely extirpated.

The shock-effects of decapitation in Ranatra are comparatively very slight. I have kept specimens for several days after this operation and probably could have kept them much longer by observing the proper precautions. In one set of experiments fifteen Ranatras were decapitated with a pair of fine scissors. When liberated most of the specimens were able to walk about in an apparently normal manner soon after the operation. They were much more restless than normal individuals and moved about ceaselessly without any apparent external cause. Those that I took up in my hand soon after decapitation either did not feign death at all or feigned for only a few seconds. Many of them when picked up would spread apart the anterior legs and move them up and down producing their characteristic squeaking sound in the usual way. When placed on their backs they would right themselves as readily as the normal insects. After five hours of restless perambulation all of the individuals operated upon became quiet. They proved, however, to be extraordinarily sensitive to stimuli. Even the disturbance of gently raising the cover of the glass dish in which they were confined caused most of the Ranatras to begin moving around. The others were roused to activity when a very slight breath of air was blown upon them. For over four hours they walked about and clambered over each other in the most restless manner. Should one settle down to rest it would soon be set going again by another individual wandering over it. The specimens paid no attention to the light of the window near which they were placed, and subsequent experiments showed that they were insensitive to much stronger illumination. Ten hours after decapitation all of the specimens were picked up, stroked gently, and then thrown down upon the table. Most of the specimens feigned death in the characteristic manner, but only for a few seconds. Some, however, continued to feign for three or four minutes. In this feint they show the same state of tetanus as normal individuals do under the same conditions. Specimens feigning with the legs drawn up dorsally were found to lie in an inverted position supported only by the tips of the outstretched legs and the caudal end of the body. This certainly gives evidence of a considerable degree of muscular rigidity. When seized by the tips of the anterior legs and held out horizontally with the ventral side upward they maintain themselves in a perfectly rigid attitude for several seconds, and then

bend downward very gradually. If a specimen not in the death feint is held out in this manner the body drops down at once.

About three hours later all of the specimens were picked up again, stroked, and dropped on the table as before. None of them feigned as long as a minute, and some started off as soon as they were free. Then the same experiment was repeated three times, and in no case did the feint last more than a minute. At 8.30 the next morning several of the headless specimens were walking restlessly about the dish. Those which were lying quietly on the bottom were roused to activity by the slight current of air caused by slowly waving an object above them. None of the specimens could be induced to feign death for more than a few seconds. In the evening they were again tried with the same result. Restless movements were kept up, with short intervals of quiet, all day, and on the following morning, although a few were dead, most of the individuals were still active. None of these would feign death for more than two minutes.

It is abundantly evident that removal of the supraesophageal ganglion causes a marked diminution of the duration of the death feint. This is, in all probability, due to the heightened irritability which normally follows when the inhibiting influence of this center is no longer exerted. When decapitated specimens are thrown into water they show the same restlessness as in air. They swim about with perfectly coördinated movements of the legs, often for hours at a time. When they come to rest they assume the same attitude as that taken by normal individuals, keeping the tip of the breathing tube exposed at the surface of the water. If two individuals meet they seize each other and struggle for some time before they become disengaged. If an object touches one of the first pair of legs it is usually grabbed at with the claws. When seized by the tip of the breathing tube the headless individual immediately makes strokes with great vigor and rapidity. If this does not enable it to get free the insect has recourse to a remarkably neat and apparently intelligent device. The hind legs are thrown as far back as possible; they are thus able to grasp the breathing tube a short distance behind the body; then by exerting a pull they bend the body ventrally. This soon brings the second pair of legs so that they can reach the offending object when all four legs are employed to push the body away. Several ineffectual attempts may be made to grasp

the tube, but as soon as this is accomplished the insect immediately ceases to free itself by swimming and follows up an entirely different series of instinctive acts. The behavior of the decapitated insect in this situation certainly affords an excellent simulation, not only of purposive action, but also of considerable ingenuity in carrying it out.

In one case a decapitated insect was kept in water for six days after being kept in the air a day to enable its wound to heal. During all this time its reactions were essentially the same as they were soon after the operation, except that the insect became gradually weaker and less active. After the fifth day it would remain quiet in the water, but when disturbed would execute the regular swimming movements and would walk in the usual manner when placed on the table, although it would right itself only with extreme difficulty. All of its responses were weak, and it soon gave signs of exhaustion.

REACTIONS OF RANATRAS WITH THE BODY CUT IN TWO ACROSS THE PROTHORAX.

A specimen feigning death was cut in two across the middle of the prothorax. It did not make the least movement when the cut was made. Both parts were placed on the table where they lay perfectly quiet. In nine minutes the forelegs on the anterior piece began to move, and in fifteen minutes when light was passed over the head their movements increased greatly in vigor and the head showed the usual lateral and vertical reflexes. Then the anterior piece was picked up and stroked; the legs became rigid. When the piece was laid down on the table again it gave no signs of movement and when the light was moved about near it the usual head reflexes failed to appear. On continuing the movements of the light for two minutes the head movements began to occur and soon became more decided. Shortly afterward the legs began to move about vigorously, swinging and clutching in all directions. Soon the anterior part of the body showed all the excitement that is manifested by a normal individual when fully aroused to activity. On picking up the anterior part of the body a second time and stroking it, it again became rigid and irresponsive to light. After moving the light around it for about a minute, the

head reflexes and leg movements began to appear again, and the part was soon as violently excited as ever. The fore legs were frequently drawn up as they are in a normal Ranatra when it prepares to fly toward the light. The part showed marked responses to light for over an hour.

The posterior portion of this specimen continued to retain its rigidity for some time after it was cut off, but it showed very little movement and died about four hours after the operation. Its original tetanic condition seemed to pass gradually into one of limpness and flaccidity.

A second specimen was cut across the hinder part of the prothorax. Just before the operation when the specimen was taken up in the fingers the fore legs were moving, although the hind part of the body was rigid. When cut across, the insect gave no response except that the fore part of the body became rigid like the rest. Eleven minutes after the operation the head would give no reflexes when the light was moved about near it for over a minute. Five minutes later it would not respond at first, but when the light was moved about over it for nearly a minute the head reflexes began to appear and these were quickly followed by movements of the legs. The part was then taken up, the legs straightened out and stroked, when they became rigid. It was then placed on the table where it remained immobile and insensible to light. When the light was moved around it for over a minute the head reflexes reappeared. The more the light was moved about, the more the excitement of the part increased, until it became very active and vigorous. For three hours and a half the head continued to show reactions to light. The posterior part of the body gradually became less rigid, but showed little independent movement; it died about four hours after it was removed. The same experiment was tried on other specimens with similar results.

The severed posterior portion of the body of Ranatra comes out of the death feint more quickly than the part containing the head. If it is picked up and stroked, it may be thrown back into the death feint again, but it remains in this state for only a comparatively short time. If the nerve cord of Ranatra is cut between the first and second thoracic ganglia, the insect may be kept alive much longer than when cut across the prothorax. The two parts of the body may then be caused to feign death

independently. The effect of cutting the nerve cord in the prothorax is greatly to lessen the spontaneous movements of the second and third pairs of legs. The posterior legs may move about when the head and anterior legs are quiet and *vice versa*. When the whole insect is caused to feign the posterior part is usually the first to recover, although it does not always give such evident signs of so doing.

DECEPTIVE QUIET.

It was only after keeping Ranatras for some time that I observed that they manifested the least awareness of my presence. So far as observed these insects never attempt to escape by swimming or walking away, although other aquatic hemiptera, such as Zaithas, water boatmen, etc., make a great ado upon one's approach and scurry away in the most lively manner. So ungainly an insect as Ranatra could seldom effect its escape by swimming, much less by walking, from any enemy large enough to overpower it. And when out of water it apparently never occurs to the poor creature to seek to get away by using its wings, although it could often easily do so. Ranatra seems to be entirely devoid of all instincts to seek safety by flight in every sense of this term. In experimenting on the reactions of these forms to light I have worked with individuals for hours, picking them up here and setting them down there, and subjecting them to a variety of treatment some of which was perhaps not particularly pleasant, yet the creatures seemed stolidly unaware of my existence except when actually handled. Pick up a Ranatra that is bent on going to the light, and if it does not feign death it will travel to the light immediately after being liberated as if impatient of the rude interruption. I have often observed individuals struggle to get to the light even before their release. If its phototactic proclivities are well aroused one may make all sorts of movements in the vicinity of a Ranatra that is seeking the light but the insect will completely ignore them.

Ranatras under natural conditions are nevertheless keenly aware of the events that take place in their neighborhood. They are attracted by small moving objects that may serve for prey, and these they lie in readiness to seize. The appearance of large objects in their field of vision causes a sudden and complete

cessation of movement. If one approaches a group of Ranatras when they are swimming about in a dish of water, it will be noticed that most of the individuals cease their movements and lie with outstretched legs. If one remain perfectly still the movements of the Ranatras are soon resumed; if now the hand is passed over the dish, the Ranatras will immediately become as quiet as so many sticks which they so closely resemble. If movements near them are continued, the Ranatras soon cease to respond so readily, and after a time they pay little or no attention to what goes on around them. Specimens that have been kept in the laboratory for several days are much less responsive than those that have been recently brought in.

The question naturally suggests itself, whether or not this state of deceptive quiet has any relation to the immobile condition that occurs in death feigning. So far as could be determined, the two phenomena have little in common beyond a certain superficial resemblance. In an insect that suddenly ceases its movements in the water one may very readily move its legs about with a piece of fine wire. The legs seem relaxed and offer almost no resistance to movement. The attitude of the legs in deceptive quiet is one which is quite constant and which would naturally be assumed if the muscles were relaxed. If a dead and limp specimen is held in the water its legs lie spread apart much as they do in deceptive quiet, although not so symmetrically. These facts indicate that deceptive quiet, instead of being associated with the muscular rigidity that characterizes the death feint, is attended by a relaxation of the muscular system.

The subject of deceptive quiet acquires an interest because of its possible relation to certain aspects of fear. What kind of feelings exist in the consciousness of a Ranatra when it suddenly becomes quiet upon the appearance of a large object is a question upon which it is perhaps not profitable to speculate. Deceptive quiet may have some relation to what is commonly, though somewhat loosely, spoken of as the paralyzing effect of fear in higher animals, but of fear in its more usual manifestations Ranatra shows no sign. Species not distantly related to Ranatra, however, swim about upon one's approach with all the appearance of violent alarm. We may say that these creatures manifest fear, since they exhibit the usual outward and visible signs of that state. Fear has undoubtedly arisen along many independent

lines of descent, and in numerous cases has been suffered to disappear again. It leads animals now to lie quiet, and now to seek safety in flight. These two aspects of the fear response are found in different relative degrees of development in different forms. Both are of service in escaping from enemies, although sometimes one is employed to greater advantage than the other. Fear as it occurs in higher animals is a sort of combination of two instinctive tendencies of a very different nature, but whose manifestations are brought about by similar situations. Often these tendencies conflict and there results a state of indecision in which neither finds its natural expression. In some animals only one of these elements usually found in fear phenomena are present; there is only one method of meeting the situation. Ranatra shows only the element of deceptive quiet in the presence of its enemies. Other insects whose reactions I have studied exhibit no trace under any circumstances of the instinct to seek safety in remaining quiet, but always make vigorous efforts to escape by flight. Which of these instinctive responses develops doubtless depends on the general mode of life of the animal and its habitual environment. Where an animal possesses both, as most higher forms do, there is opportunity for meeting different kinds of situations with a more appropriate response.