

The following results were obtained:

In the case of the *Aphænogaster barbara nigra*, when a neuter of one nest (*a*) was dipped in the juice of another nest (*b*) and was then placed among the neuters of (*b*), it was not attacked until the odor had evaporated. On the other hand, when it met a single neuter of (*b*) after being so dipped, it made an attack which was not reciprocated. Inversely, when a neuter of (*a*) was dipped in the juice of (*b*) and was then placed among the neuters of its own nest, it was instantly attacked. These attacks ceased after a time, presumably after the odor had evaporated. The results were practically the same when the ants were placed in a closed flask, although the abnormal conditions made the results less clean-cut.

In the cases of *Formica cinerea* and *Camponotus pubescens* no very definite results were obtained, either on the ground or in a flask, because these ants sought safety in flight.

A final series of experiments was carried on with the *Aphænogaster barbara nigra* and the *Formica cinerea*. The results obtained from the experiments conducted on the ground were poor, because the *Formica cinerea* avoided a struggle by fleeing before the *Aphænogaster barbara nigra* could make an attack. In a closed flask, an *Aphænogaster barbara nigra*, whether dipped or undipped in the juice of the *Formica cinerea*, was not attacked by the latter, but *Formica cinerea* was attacked by *Aphænogaster* whenever the latter could get near enough. Inversely, in the majority of cases, *Formica cinerea* dipped in *Aphænogaster* juice was not attacked by *Aphænogaster* until the odor had evaporated. *Aphænogaster* dipped in *Formica cinerea* juice was attacked by its own nest-mates. Nothing definite was obtained from the inverse case.

These meager results would probably not have been published if the author had read the classical and detailed work of Miss Adele M. Fielde on the Power of Recognition among Ants. The only excuse the reviewer offers for noticing the article is that it deals with species of ants different from those used in Miss Fielde's investigation.

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*The Reactions of Ranatra to Light.* S. J. HOLMES. Jour. Comp. Neur. & Psych., 1905, XV., 305-349.

The subject of study is phototaxis in the *Ranatra fusca*. The general purpose is to determine whether these phototactic responses as exhibited under the experimental conditions are to be explained wholly in reflex terms, or whether they can be modified by past experience

and may be partly explicable in terms of some 'pleasure-pain conception. The responses studied are certain swaying movements of different parts of the body, certain bodily postures and movements of the organism as a whole in relation to the light. The modifying conditions employed were the effects of contact, temperature, cerebral hemisection, the covering of various parts of the eyes, etc. *Ranatra* exhibits both negative and positive responses, the latter being the more normal or usual type. The type of response is experimentally controllable, the negative reaction being induced by contact, darkness, and diminished temperature. These negative responses are associated with a condition of sluggishness, or lowered phototonus, and are interpreted as due to changed conditions of the nervous system. Positive reactions may be persisted in till fatal results occur. Several experiments prove quite conclusively that past experiences may be operative in partly determining present conduct. The author is of the opinion that the method of trial and error plays only a subordinate rôle in making adjustments to novel situations.

The author claims, or rather perhaps admits, that all the responses are to be considered partly, and a great many entirely, as mechanical and reflexive in nature, and in fact the evidence abundantly confirms this position. Furthermore, he believes that certain of the reactions are partly determined or influenced by considerations of prospective pleasure or pain. The fact that positive phototaxis may lead to disastrous results is admitted to be a grave and serious objection to the view, but yet the author maintains quite fairly, I think, that this conduct under the unusual experimental conditions does not *necessarily* constitute an insuperable objection. The possibility of such modifying central conditions as it is necessary to assume is supported by the facts that light impulses must travel through the principal nervous centers, and that central influences are evidenced in the cases of learning and the change from negative to positive reactions. The positive evidence adduced in support of the contention is drawn from the experiments in which various parts of the eyes are covered without interfering markedly with the accuracy of the movements towards the light. These movements are difficult to explain by a reflex theory, are hardly the result of a progressive approximation by the trial and error method, but give the impression of an apparent felicity of effort. The author states the conclusion in a very conservative and tentative fashion, though it seems apparent by reading between the lines that he believes much more strongly in the truth of his conclusion than his words indicate, or for that matter than his facts

conclusively warrant. Probably this is a characteristic attitude of a large number of careful experimenters on animal behavior. A long course of observation on some organism leads to a pretty definite private conviction as to the existence of some degree of an intelligent type of behavior when the very phenomena inducing the belief are so vague, intangible and merely suggestive in character as to elude not only their experimental isolation, but even verbal description.

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*The Selection of Random Movements as a Factor in Phototaxis.* S. J. HOLMES. J. of Comp. Neurol. and Psychol., 1905, XV., 98-112.

The results of the experiments reported in this paper show that the act of orientation to light in the earth worm (similar experiments were made upon the leeches, the larvæ of house flies, blow flies and other insects) does not take place in accordance with the theory of 'forced orientation.' As is well known, the earth worm is negatively phototactic. "As the worm crawls it frequently moves the head from side to side as if feeling its own way along. If a strong light is held in front of the worm it at first responds by a vigorous contraction of the anterior part of the body; it then swings the head from side to side, or it draws it back and forth several times, and extends again. If in so doing it encounters a strong stimulus from the light a second time, it draws back and tries once more. If it turns away from the light and then extends the head, it may follow this up by the regular movements of locomotion. As the worm extends the head in crawling it moves it about from side to side, and if it happens to turn it towards the light it usually withdraws it and bends in a different direction. If it bends away from the light and extends, movements of locomotion follow which bring the animal farther away from the source of stimulus."

In other words, the light induces a general state of activity leading to random movements.

The first movement induced by the light may be either towards it or away from it. If towards the light it is checked, the animal draws back, and movement, usually away from the light, then follows. Since this movement does not lead to further stimulation, it is prolonged farther. The final result of these random movements will thus eventually bring the less sensitive posterior end of the animal into the direction of the rays of light.