

MOTOR REFLEXES OF CATS TO ACTIDINIA POLYGAMA (JAPAN) AND TO CATNIP (U.S.A.)

by T. HAYASHI

Department of Physiology, School of Medicine, Keio University,
Tokyo, Japan

Actidinia polygama of which effective extraction is called Matatabilactone and actidinine (1) and catnip of which effective extraction is called Nepetalactone (2) have always been the source of much interest, because of its peculiar ability to excite cats and their feline relatives.

When powder of these plants was presented to cats, they displayed a peculiar behavior, which we have taken in films and have analysed. Some of these are shown in Figure 1.

The special behavior consisted in, salivation, licking, playful rubbing, rolling, treading with hindlegs. Among these displays, salivation would come from phenylalcohol (3) which was contained in the powder, and other manifestations would come to the same behavior of rolling as shown in the figures. Yet we could not understand what it meant physiologically. Someone said that these reflexes seemed somewhat sexual, but there is no positive evidence.

RESULTS

The reflex behavior is induced by the smell, not by taste and not via the circulation. The cat must be tamed by the experimenters and must be adult: male or female are quite the same. Noise and unusual surroundings inhibit the appearance of the behavior.

Once I tried with English cats in London, and with American cats in New York, each time taking advantage of visiting my friend's laboratories, but English as well as American cats were rather cold.

Observation of the same reflexes in feline species, for example, in tigers, lions and leopards have been published recently.

We tried experiments with dogs, rabbits, mice, rats, guineapigs and also with fowls but they had no such reflexes to the plant powder.

Decortication of parietal, temporal and occipital cortex of cats seemed to promote the appearance of the behavior (3).

From these results, we presume that the reflex ability is restricted to cats and feline species in vertebrates, and its reflex centre would be situated in the subcortical, presumably limbic, structures.

Fraenkel (4) discussed the *raison d'être* of secondary plant substances and suggested that these odd chemicals arose as a means of protecting plants from insects and now guide insects to food.

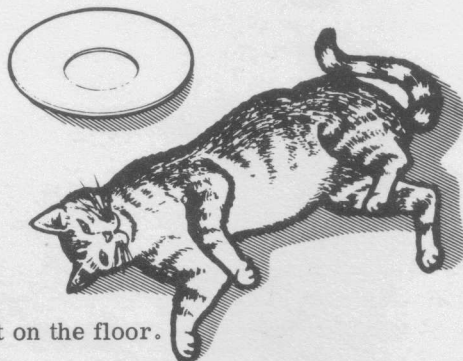


a. A male cat, weighed 3.4 kg.

b. The cat smelled and tasted powder of the plant (*Actidinia polygama*).

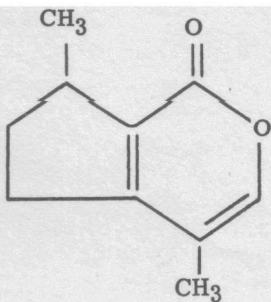


c. The cat rubbed the face against the powder and the dish.

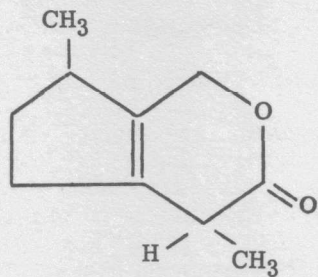


d. The cat repeatedly rolled about on the floor.

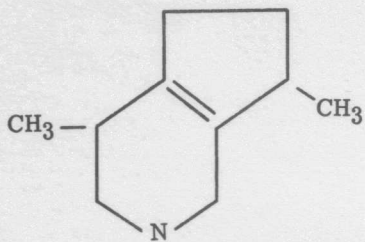
Fig. 1 The effect of catmint on cats



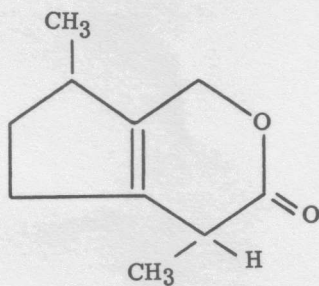
Nepetalactone (plant)



Iridomyrmecine (animal)



Actinidine (plant)



Metatabilactone (plant)

Fig.2 Molecular shapes showing the close relationship of nepetalactone (catnip) to other insect repellents

Eisner published a paper (5) stating that catnip (nepetalactone) is closely related chemically to certain cyclopentanoid monoterpenes recently taken from insects, as shown in Figure 2 for example, and to iridomyrmecin (6) from an ant named *iridomyrmex humilis* it also shares an ability to repel insects with some of these terpenes.

It was suggested that the adaptive function of catnip is to protect the plants that produce it against phytophagous insects. From the chemical structure it is easy to understand that matabilactone must be repellent to insects and any other animals to protect the plant. The cats and feline species are not phytophagous to the plants, and the fact that these substances are an attraction to cats remains mystery.

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J. R. HUGHES: Department of Neurophysiology, Northwestern University, Chicago, Illinois, U.S.A.

With regard to the point that this phenomenon seems to be restricted to the cat family, I would offer just one thought, not that this represents a definite answer. But after studying the cingular gyrus for a number of years in cats and comparing it with the cingular gyrus responses in monkeys and also gathering data from clinical literature in the human, I thought there was something very distinctive about this area in the cat and its responses to intensive electrical stimulation, particularly intensive electrical stimulation producing epileptiform activity. The clinical seizures from the cingular gyrus resemble the behavior of your cats. They do a great deal of licking, rolling around, purring and salivating and so on. Although there are certain features that you see in the monkey that are similar, one doesn't see exactly that sort of behavior. Therefore, one thought that I would have is that there may be something distinctive about the cingular gyrus in the cat and I wonder whether or not the behavior of your cats could represent a strange kind of seizure pattern from this structure.

AUTHOR:

Thank you very much for your comment. That the phenomenon is restricted to the cat family is said also in Japan. But it is not a seizure, because they have a definite pattern in their seizure, when electrically stimulated and when induced by convulsive drugs. The seizures are quite different from the behavior which I have shown you. Seizure consists in three forms in cats and other mammals, (1) epileptic (2) tonic (3) alternative movements of limbs without righting reflexes. None of these seizure patterns are similar to the actidinia behavior.

J. W. JOHNSTON Jr.: Medical School, Georgetown University, Washington, D. C., U.S.A.

This is a simple question that might be relevant to your point, Doctor. In northern Virginia, where I live, there are stands or clumps of catnip. I'm not aware of house cats visiting the catnip stands while in the living state. Do you know whether this has been reported?

AUTHOR:

No I don't think so. We have natural growths of bushes of actidinia polygama in several parts of Japan, but nobody noticed that these bushes attracted cats from the villages.

J. E. AMOORE: Western Regional Research Laboratories, Albany, California, U.S.A.

You've not observed the cats searching out the natural growing plant?

AUTHOR:

No. In the central parts of Japan we have many actidinia distributed from north to south. But I have not heard that cats gather in the stands of the plant.

Maybe the drying of the plants or burning of them is the most effective.

JOHNSTON:

That's a point that occurred to me, too! The drying out may do something to the herb which is necessary to elicit the "seizure". But I'm going to try to find out from the United States National Zoo, which is close to me, if there's some evidence of records that cats might go to it naturally. This point is important in respect to the behavior of the animal.

AUTHOR:

Thank you very much.

O. WOUTERS: Central Institute of Food Preservation Research, Göteborg, Sweden

I should only want to ask you how this powder is applied. Do they get it on a dish?

AUTHOR:

Yes, they get it on a small dish. We usually take one gram of that powder and present it to the cat. Cats will smell and later lick and eat the powder. But only the smell that comes from the dish produces the behavior.

WOUTERS:

And it does not occur if the olfactory nerve is destroyed?

AUTHOR:

No, when the receptor of the deep nose was destroyed by operation afterwards the cats did not display this behavior. But it is yet in doubt, for after the operation only two weeks had passed, and it was not completely healed.

D. G. MOULTON: Department of Biology, Clark University, Worcester, Massachusetts, U.S.A.

I believe that Lissak found that valeric acid will initiate behavior in cats comparable to that which you described, and suggests that the hypothalamus may mediate the effect.

AUTHOR:

Valeric acid? Oh I didn't know.

MOULTON:

Have you determined whether a certain critical concentration or quantity of the powder must be present before the effect will occur?

AUTHOR:

We have no experiments on the concentration but by an impression it should be inhibitive when the concentration is high, but when the powder is dissolved in water its effectiveness is quite reduced.

D. SCHNEIDER: Max-Planck Institut, Seewiesen über Starnberg, Germany

I would like to suggest that you contact Dr. Paul Leyhausen (Max-Planck-Institut für Verhaltensphysiologie, 5600 Wuppertal-Elberfeld, Boettinger Weg 37, Germany). He is a specialist in the field of feline behavior, and might have an explanation for this odd behavior, rubbing and rolling and licking and all these things. Possibly he knows an answer. Somehow it looks as if the cats don't choose this plant, but become simply "attached" to this odor, which may not play any role in nature. It may just mimic something which is important in feline behavior. If they rub and roll on their back, it looks as if this is some sort of territorial marking behavior. We know that many mammals mark their territory by rubbing; bears for instance. Finally I would like to add a personal observation which I made with a young dog, a puppy of 3 or 4 months of age. I sprayed it with insecticide and he showed exactly the same behavior as you have shown in the film. Many dogs show this when you expose them to different organic solvents, which suggests that we are dealing with an irritating effect. This would of course not contradict the assumption that this behavior plays a major role also in the normal life of these animals.

AUTHOR:

The behavior is not connected to sexual things.

R. H. WRIGHT: University of British Columbia Research Council, Vancouver Canada

I've not seen it but I've read of descriptions of delirium tremens in which the victim feels himself to be infested with various kinds of vermin which he tries to get rid of. It looked as though the cat was in many cases trying to free itself from something that was attacking it from behind in its fur or in its eyes or in its paws. There may be an analogy with the delirium tremens.

AUTHOR:

What is the origin of the scratching of the skin?

WRIGHT:

Well delirium tremens comes from acute alcoholism.

C. K. HERBERHOLD: Max-Planck Institut, Mülheim, Germany

I have only one little question. Do you observe the same reaction if the substance is injected into the bloodstream?

AUTHOR:

I have done this. But from the injection we have no display of that behavior, absolutely none.

JOHNSTON:

There is an expression used by field ornithologists called "anting" behavior, and it refers to the insects, the well-known ants, that form colonies in the ground. I understand that this behavior applies to a number of species of small mammals and birds and that it is elicited by a rather imposing list of odorous compounds. Not just ants, but this is its categorical designation

because it was the first to be reported. For instance, the grey squirrel of Eastern North America which is our most abundant species (the one you see in city parks sometimes) has seizures. Juvenile squirrels, especially, have been reported from several regions of the Eastern United States. They will visit an active ant nest and stretch out on it. Now, if you've ever put your hand on an ant nest you know what happens! Well, this happens to the squirrel, who seems to invite it. It seems to be an instinctive act. The ants crawl on the little mammal and bite it. Then the squirrel begins the rolling and then finally, since the ants are still biting, it jumps into the air. I think I have read several months ago in the Journal of Mammology that the squirrels actually do a flip-flop (backward somersault). Apparently, its an organistic kind of behavior. Now a parallel observation has been made with the flicker, which is one of our larger colorful woodpeckers with a loud voice. They are quite abundant in the U.S.A. wherever there are trees. In the first place, the flicker eats ants as a staple item of its diet. That's point one, it's an insectivorous bird like most woodpeckers. Point two, it also goes to the ant nest and scratches and so excites them and so, of course, the workers come out and attack with their mandibles. And the flicker seems to enjoy this! Apparently the odor of the ants' secretions is a principal attraction in the case of the bird. It flutters around, spreads its wings, fans them up and down, jumps about, and is not in a hurry to remove itself from the presence of the excited ants.

AUTHOR:

Thank you very much. I have received many valuable suggestions.