

Table 1. SUMMARY OF MAIN RESULTS

Ss	No. of self-stimulation responses/min			Brain stimulation applied by experimenter 45 μ amp/0.5 sec		Foot-stomping	Foot shock Duration (sec)	Histology Locus of electrode tips
	10 μ amp	20 μ amp	40 μ amp	Latency (sec)	Duration (sec)			
19	3	85	143	10	15.0	45	Substantia nigra, pars compacta; cerebral peduncle	
20	5	62	125	13	59.0	82	Substantia nigra, pars compacta	
24	1	50	53	40	140.0*	26	Medial forebrain bundle (ventral); fornix	
25	4	29	51	27	24.0	48	Cerebral peduncle; medial forebrain bundle	
23	3	36	41	> 120	0.0	0	Subiculum; temporal cortex	
21	1	2	37	> 120	0.0	50	Substantia nigra, pars reticulata	
22	2	1	28	45	0.5	65	Substantia nigra, pars reticulata; oculomotor nerve	

* Erratic.

stomping was often seen; it was greatest at the beginning of the session, and typically occurred between intrusions. These results show that there is a definite relation between the offset of rewarding brain stimulation and sexual behaviour, because foot-stomping appeared in both cases.

Third, what was the relation between foot-stomping and the gerbil's affective state? Although our initial impression from the self-stimulation data was that foot-stomping was related to a rewarding condition, our later observations of the gerbil suggested the opposite possibility; namely, that the offset of reward was aversive and that the foot-stomping was somehow a representation of this response to the aversive quality of the termination of the stimulation. That the termination of reward can produce aversive consequences is suggested by recent electrophysiological experiments of Grastyan⁵, who showed that hippocampal theta was present during rewarding stimulation of posterior hypothalamus, but changed to desynchronization at the offset of stimulation. That hippocampal desynchronization represented an aversive state was shown by another experiment in which aversive stimulation produced hippocampal desynchronization, but at the cessation of stimulation, hippocampal theta was observed. To obtain some idea of the relation between aversive stimulation and foot-stomping, each gerbil was administered foot shock through an electrified grid floor for 2-10 sec until it showed a response to electrical stimulation to the feet. In six of the seven gerbils foot shock produced foot-stomping (see Table 1). In a recently completed experiment, foot-stomping after electric shock has been obtained from nine of a group of ten unoperated gerbils. As in our brain stimulation experiments there was complete cessation of all other activity during foot-stomping. These results suggest, but certainly do not prove, that foot-stomping is associated with a high arousal, negative incentive condition.

Presumed loci of the electrode placements as seen in Nissl and myelin stained sections are presented in Table 1. We do not want to go into detail here of differences between the gerbil brain and that of the rat. While grossly similar, we have noted larger mammillary bodies relative to the rat. For the present, we wish to note that electrode placements yielding reward were rarely in what appears to be the medial forebrain bundle, although it is doubtful whether such an observation would have been made in the absence of previous data and theory on this point⁶. It appears that (1) the two placements yielding high rates of self-stimulation were in the substantia nigra, (2) there was no point where self-stimulation (10 responses/min) was not obtained, and (3) the only point producing any foot-stomping at all during stimulation was in the temporal cortex (this was the only probe that fell outside of the ventral mesodiencephalic region). Before any firm statements concerning anatomical locus of the self-reward phenomenon can be made, it will be important to determine the extent to which individual differences of bar-pressing behaviour may influence anatomical conclusions. This is particularly relevant in the case of the gerbil, for we have seen this animal perform at high rates (5-10 responses/sec) while responding for food on a fixed ratio schedule (FR 30). Finer analysis of bar-pressing behaviour

and other measures of motivation should assist in an accurate description of the gerbil reward system.

The preliminary observations of the present work give us reason to believe that brain and behaviour problems can be further elucidated. It will be of considerable interest to attempt to understand why this foot-stomping behaviour is shown after foot shock, during sexual behaviour and after rewarding brain stimulation. As a working hypothesis we have assumed that foot-stomping reflects an aversive state and that the cessation of rewarding brain stimulation, the interruption of intrusions and the "slow pain" following the foot shock are sufficient to produce this behaviour. Whatever the correct view, future experiments should further our understanding of the relation between rewarding brain stimulation and both approach and withdrawal mechanisms.

I thank Dr. Preston L. Perlman for supplying progesterone, and Dr. Irving Zucker for his helpful suggestions.

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Parasitic and Free-living Cycles in Entomogenous Nematodes of the Genus *Deladenus*

THIS Australian Unit located in England is undertaking an investigation of siricid woodwasps and their natural enemies in coniferous forests in Europe; the ultimate objective is the biological control of *Sirex noctilio* F. in Australia.

Nematode parasites of siricids were discovered by Zondag¹ in 1962 in *S. noctilio* in New Zealand. They were found in 1964-65 by Wilson and Spradbery (unpublished work) in *S. juvencus* L., *S. cyaneus* F., *Urocera gigas* L., *Xeris spectrum* L. and the parasite *Ibalia leucospoides* (Hocken.) from various European countries, and in 1965 by Hocking² in two species of *Rhyssa* (parasites of siricids) introduced into Tasmania from India and Europe. I have investigated nematodes from these and allied hosts, and various unusual features have been revealed in relation to the nematodes' life-history (Fig. 1).

It has been found that nematode larvae removed from the adults of these hosts can be cultured on species of the fungus *Amylostereum* (which is symbiotically associated with the siricids), and that they develop in 3-8 days at 24° C into adult males and two types of female. The commoner form continues to feed on the fungus and, after copulation, lays 50-500 eggs, which develop rapidly into males and both types of female. This non-parasitic cycle can continue indefinitely. The less common form is the infective female.

The two forms are remarkably different in many morphological features. The stylet shows striking functional dimorphism, being small and finely tapered in the fungus-feeding form, and very much longer and stouter in the infective form. The fungus-feeding form (as well as the male) has the diagnostic characters of *Deladenus* Thorne (Neotylenchidae), whereas the infective form would be placed in the Allantonematidae. This situation bears critically on the status of these two families, and possibly has wider taxonomic implications.

The infective female does not feed on the fungus, but, without copulating, enters a host larva, and develops in the haemocoel. Males do not enter such hosts, and so reproduction is almost certainly parthenogenetic. The mature parasitic female is viviparous, and releases 500-5,000 larvae in the haemocoel soon after the host emerges as an adult from the pupa. If the host is a female siricid, the larvae migrate into its eggs, whereas if it is a male siricid they congregate in the testes, which become hypertrophied and devoid of spermatozoa. Thus both sexes of siricid hosts are rendered sterile.

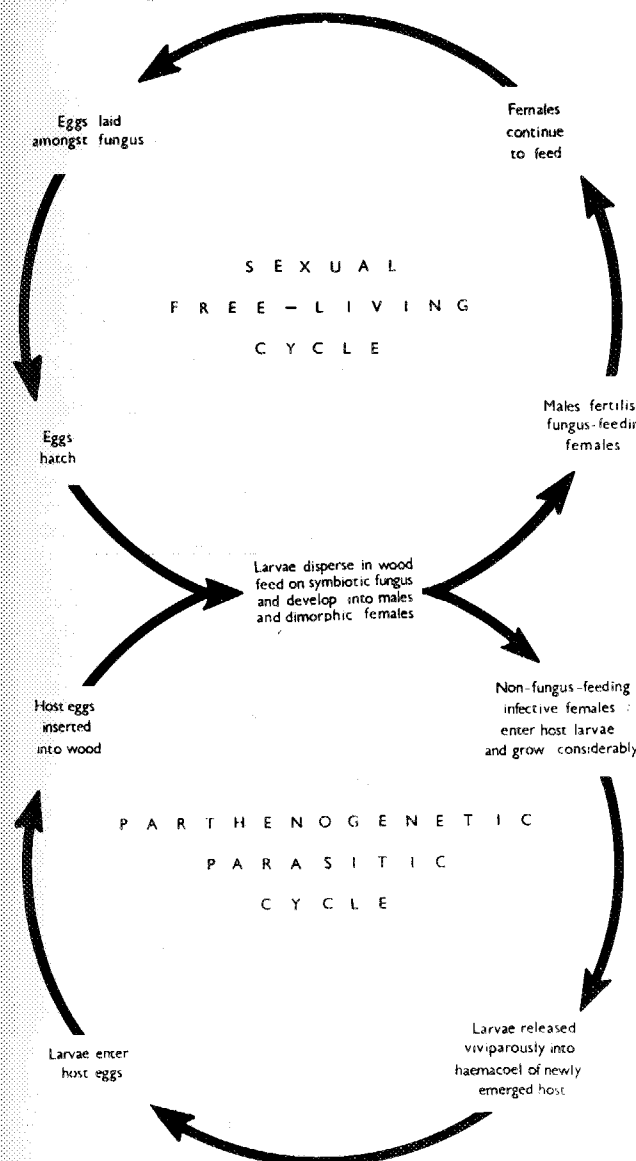


Fig. 1. Diagram of the life-history of the nematodes *Deladenus n. species*, showing the free-living fungus-feeding cycle and the parasitic cycle when female siricids are hosts. In other hosts, see text, the cycle is modified or incomplete.

The nematodes have different effects on the hymenopterous parasites. For example, in *Rhyssa persuasoria* L., parasitism does not affect the male reproductive system; however, it often totally suppresses egg production in the female (though healthy eggs are sometimes present) and large numbers of nematode larvae congregate in the accessory glands and to some extent in the ovaries, whence they often reach the ovipositor.

In parasitized siricids oviposition itself is unaffected, and the eggs (each containing 20-150 nematode larvae) are deposited, together with oidia of *Amylostereum*, in timber. The nematode larvae then disperse through the tracheids, and feed on the fungus, usually in the outer 5 cm of the wood. Parasitized *R. persuasoria* females, while drilling to locate siricids, probably also introduce nematodes into timber. Male siricids and male parasites which contain nematode larvae do not transmit them during copulation, and the larvae die within and soon after their hosts.

A considerable increase in nematode numbers can occur during the free-living cycle, and this would greatly facilitate the finding of hosts. The parasitic cycle is the mechanism by which the nematode is transferred to fresh timber infected with *Amylostereum*.

No such nematode life-history, involving female dimorphism associated with free-living and parasitic cycles, has been recorded previously. This dimorphism suggests, however, the possibility that some fungus-feeding nematodes described as neotylenchid species may have parasitic form described separately as allantonematids.

The European nematodes investigated at this Unit can be separated into at least two new species of *Deladenus*. Mr. R. Zondag kindly supplied from New Zealand infected *S. noctilio*, from which a nematode culture was established, and comparison showed this nematode to be morphologically identical with one of the two species.

Host specificity tests, using *Deladenus* from five siricid species, two *Rhyssa* species, and an associated beetle, *Serropalpus barbatus* (Schall.), from various European countries, have shown that nematodes from each of these sources will infect and develop in both siricid and *R. persuasoria* larvae.

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Received December 23, 1966.

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MICROBIOLOGY

Identity of Feline Ataxia Virus with Feline Panleucopenia Virus

Kilham and Margolis¹ investigated the cerebellar hypoplasia associated with feline ataxia (FA), a spontaneously occurring disease of kittens previously believed to be of genetic origin². They demonstrated that the condition could be reproduced by passage of affected cerebellum emulsions in neonatal kittens or ferrets, and found that the transmissible factor was a filterable agent resistant to treatment with heat and ether; this they designated feline ataxia virus (FAV). The properties of FAV led them to compare the virus with the serologically distinct Kilham rat virus (RV)³ and hamster osteolytic virus H-I⁴, of which the former can induce similar cerebellar hypoplasia in cats⁵, rats⁶, and hamsters⁷. From a different line of research, Johnson and Cruickshank⁸ concluded that the properties of feline panleucopenia (FP) virus were similar to those of RV and H-I. Subsequent correspondence between the two groups led to the present report.