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The seal louse, *Echinophthirius horridus*: an intermediate host of the seal heartworm, *Dipetalonema spirocauda* (Nematoda)

J. R. GERACI, J. F. FORTIN, D. J. ST. AUBIN, AND B. D. HICKS
Department of Pathology, Wildlife Diseases Section, Ontario Veterinary College, University of Guelph, Guelph, Ont., Canada N1G 2W1

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Heartworms, *Dipetalonema spirocauda*, are common in harbour seals, *Phoca vitulina*, that strand along the New England coast. Lice, *Echinophthirius horridus*, taken from a stranded harbour seal infected with seal heartworm carried three developmental stages of *D. spirocauda*. This is the first report of an intermediate host of the seal heartworm.

GERACI, J. R., J. F. FORTIN, D. J. ST. AUBIN et B. D. HICKS. 1981. The seal louse, *Echinophthirius horridus*: an intermediate host of the seal heartworm, *Dipetalonema spirocauda* (Nematoda). Can. J. Zool. **59**: 1457–1459.

Le nématode *Dipetalonema spirocauda* est un parasite fréquent du phoque commun *Phoca vitulina* le long des côtes de Nouvelle-Angleterre. Des poux *Echinophthirius horridus* recueillis sur un phoque échoué parasité par le nématode abritaient trois stades de développement de *D. spirocauda*. La découverte d'un hôte intermédiaire de ce nématode est inédite.

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The harbour seal, *Phoca vitulina*, commonly inhabits the Pacific and northern Atlantic coasts of Canada and the United States (Boulva and McLaren 1979). Our examination of over 600 stranded seals along the New England coast has revealed a high prevalence of heartworms, *Diptetalonema spirocauda*, and sucking lice, *Echinophthirius horridus*. Wülker (1930) first suggested that *E. horridus* played a role in the transmission of *D. spirocauda*, yet at least two studies during the next 50 years failed to confirm his speculation (Taylor *et al.* 1961; Dunn and Wolke 1976). Nevertheless, the seal louse could not be disregarded as a potential intermediate host, since it feeds on blood during all stages of its development, is intimately associated with the seal throughout its life cycle, and its transmission from seal to seal is easily accomplished under the crowded conditions of the rookery.

We obtained heparinized blood and lice from a stranded harbour seal held in captivity at the New England Aquarium, Boston, MA. One millilitre of blood was added to 10 mL of 2% formalin, centrifuged at 400 $\times$ *g* for 3 min, and the supernatant decanted. A small aliquot of the pellet was placed on a glass slide, and the microfilariae were measured. The seal had a microfilarial count (Church *et al.* 1976) of approximately 4000/mL. These were identified as *D. spirocauda* based on measurements (Table 1) and morphologic characteristics of microfilariae obtained from seals with confirmed infections. Our measurements are significantly larger than those reported by Taylor *et al.* (1961), likely due to differences in fixation technique.

Of 102 lice dissected, 70 contained at least one developmental stage of a filariid nematode. We found the larvae in the gut, haemocoel, claws, head, and most commonly, in the fat body of the louse. Forms in the gut were indistinguishable from microfilariae in the seal. An average of 4.6 first-stage larvae per louse was observed in 87% of the infected lice; 26% contained an average of 1.4 second-stage larvae per louse, and 54% had an average of 3.0 third-stage larvae per louse.

Morphologic characteristics of the larvae are similar to those described for the canine filariid, *D. reconditum*, in lice (Pennington and Phelps 1969) (Figs. 1–3). In *E. horridus*, the ingested microfilaria transforms into a short, thick "sausage" stage, gradually becoming longer and developing a tail and protruding cephalic knob.

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TABLE 1. Linear measurements of larval stages* of *Dipetalonema spirocauda* in *Echinophthirius horridus*

		Length, μm		Width, μm	
Larval stage	No. measured	$\bar{x}\pm$SD	Range	$\bar{x}\pm$SD	Range
Microfilaria	40	286±10	266–302	5.3±0.5	4.4–6.2
1	66	280±60	197–406	8.4±5.7	4.4–25.8
2	7	923±202	689–1184	29.7±3.2	24.6–32.7
3	31	1470±497	1176–1974	23.8±3.2	19.6–32.0

*Microfilariae were fixed in 2% formalin. All other stages were measured in physiological saline.

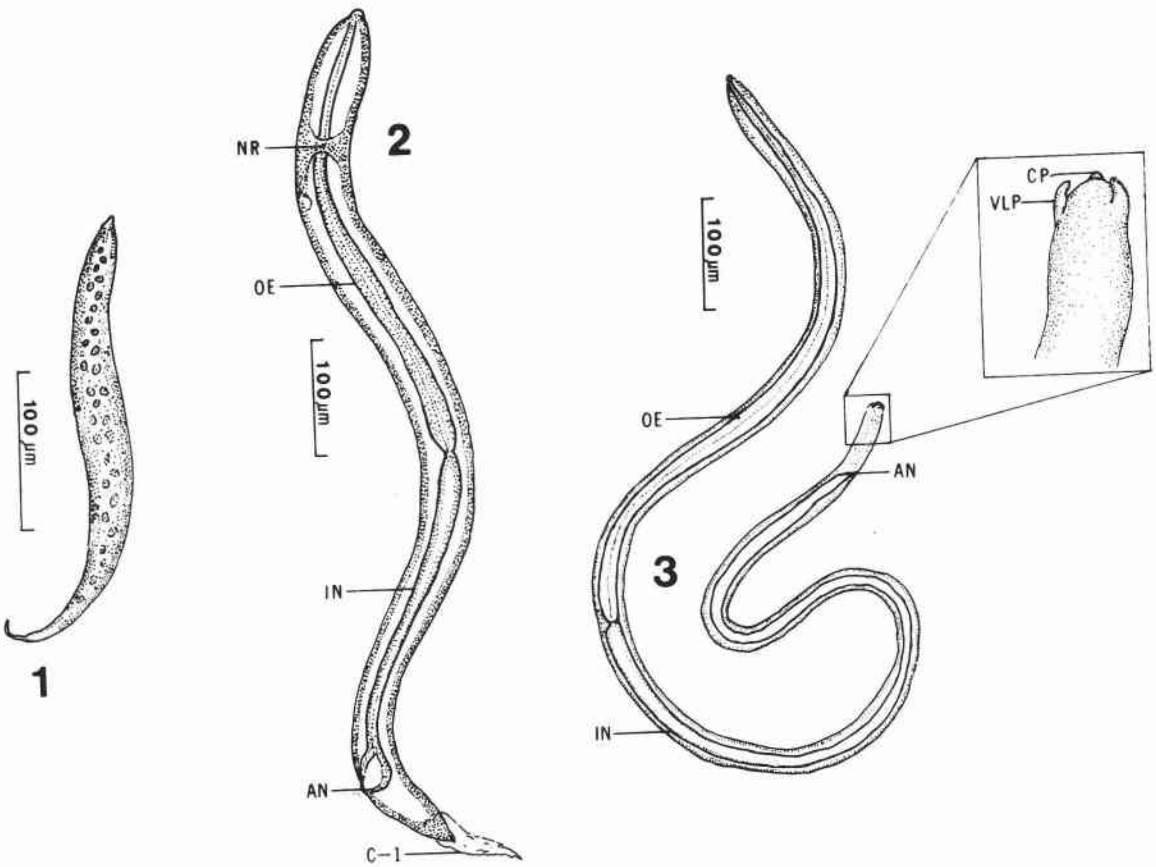

FIG. 1. Early first-stage larva. FIG. 2. Second-stage larva, lateral view. FIG. 3. Third-stage larva, lateral view with enlarged projection of posterior end, showing caudal and ventrolateral papillae. AN, anus; C-1, remnant of first-stage cuticle; CP, caudal papilla; IN, intestine; NR, nerve ring; OE, oesophagus; VLP, ventrolateral papilla.

These structures are lost during the moult to the second-stage larva, which is considerably longer and thicker than the previous stage. The third-stage larva is even longer, but thinner, with one caudal papilla and two ventrolateral "ears" at the posterior end. It is very active, thrashing vigorously in the haemocoel of the louse.

These observations implicate the seal louse as an intermediate host of the seal heartworm. Verification would require a transmission study using parasite-free, laboratory-reared seals and lice, neither of which can be realistically obtained at present.

Previous attempts to establish the role of lice in the life cycle of *D. spirocauda* have been unsuccessful, possibly due to low feeding activity of the lice at the time of sampling, or to a low level of circulating microfilariae in the seals from which the lice were taken (Obiamwe 1977). Our finding is particularly interesting in view of the rarity with which sucking lice serve as vectors of filariid worms. The only other known example is the canine louse, *Linognathus setosus*, which can serve as the intermediate host for *D. reconditum* (Pennington and Phelps 1969).

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A tide simulator and examples of its use

THOMAS H. CAREFOOT
Department of Zoology, University of British Columbia, Vancouver, B.C., Canada V6T 2A9

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The design and operation of a tide simulator, suitable for teaching or research use, is presented. Two examples of its application to the teaching of marine ecology are included, one examining the influence of higher temperature on the vertical distributions of four species of intertidal snails, the other comparing the distributions of two species of limpets in response to a predatory sea star.

CAREFOOT, T. H. 1981. A tide simulator and examples of its use. Can. J. Zool. **59**: 1459–1463.

On trouvera ici la description et le mode d'opération d'un simulateur de marée utilisable pour des fins d'enseignement et de recherche. Deux exemples illustrent l'application pratique de l'appareil dans l'enseignement de l'écologie marine: l'un étudie l'influence de la température élevée sur la répartition verticale de quatre espèces de gastéropodes intercotidaux, l'autre permet de comparer les répartitions de deux espèces de patelles en réaction à la présence d'une étoile de mer prédatrice.

[Traduit par le journal]

A tide simulator which has been useful for classroom demonstrations and for project work on the physiology and ecology of marine invertebrates is described. While its design is based on other sinusoidal models (de Blok 1964; Evans 1964, Micallef 1967; Underwood 1972), it has several novel features and perhaps other researchers and teachers may find its description and suggestions for application useful. The sinusoidal type of tide machine is recommended over the siphonal type (Fletcher and Jones 1975) or timed pumps (de Santo 1967) because of the more natural appearance of the tide wave generated and because with the proper control system diverse tides can be produced. The present model relies on a supply of natural seawater drawn from a large, recirculating, refrigerated system. Where running seawater is not available a smaller closed-circulation system could be used.

The major features of the apparatus are shown in Fig. 1. The main tank consists of a partitioned plywood box (1.0 m in height × 0.8 m × 1.8 m) sealed with several coatings of fiberglass and set into a welded aluminum frame for additional support. The median partition and front consist of 12.7 mm plexiglass, glued and screwed along their common seam, and slotted into the plywood

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