zole carbamates, more differences than similarities were noted as indicated below. **Ia** and **IIa**[6] showed similar anti-*H. nana* activity; yet **Ia** revealed strong insecticidal action, whereas **IIa** did not. Very slight inhibition in parasite development with their subsequent recovery resulted with **Ib**, whereas **IIb** (albendazole)[5] retarded significantly and even killed some *H. nana* larvae. Compound **Ic** had no effect. Compound **IIc** (fenbendazole), on the other hand, was effective in significantly inhibiting cysticercoid development. A similar relationship was observed for the pair **Id** and **IId** (oxfendazole)[6]; **Id** had no effect, whereas **IId** strongly retarded parasites development. **Ie** proved to be the most potent of the imidazo[1,2-a]pyridine carbamates tested. It strongly inhibited *H. nana* development with many parasites not recovering from its effect. Unfortunately **IIe** was not available for testing. Since all the benzimidazoles mentioned above inhibited significantly the larval development of *H. nana*, it is possible that **IIe** could also be an effective anticestocidal agent. The observed similarity of structure-activity relationships between these two classes of compounds for *Nematospiroides dubius*[3] is clearly not visible for the tapeworm *H. nana*.

It is interesting to note that compounds **Ib**, **Ic** and **Id**, found to be essentially ineffective against *H. nana* in this study, were very effective against *N. dubius*[3]. Also, **Ia**, effective against *H. nana*, was relatively ineffective against *N. dubius*. On the other hand, compound **Ie**, reported to be one of the most potent imidazo[1,2-a]pyridine carbamates against *N. dubius* and many other roundworms[3], was also found to be the most potent against *H. nana* of the compounds used in this study. Thus **Ie** shows the potential of being a broad spectrum anthelmintic, effective against both nematodes and cestodes.

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Intergeneric interactions between *Eimeria separata* (Apicomplexa) and *Nippostrongylus brasiliensis* (Nematoda) in the rat[1]

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Summary. Ova production in *Nippostrongylus brasiliensis* infected rats was significantly greater than in rats singly infected with the helminth when *Eimeria separata* infections were introduced 4, 6 and 11 days postinoculation with *N. brasiliensis*. Patent periods were unaltered during concurrent infections. These results suggest that the presence of *E. separata* affects helminth fecundity but does not increase *N. brasiliensis* longevity as has been shown with *E. nieschulzi*.
Key words. Eimeria separata, Nippostrongylus brasiliensis, intergeneric interactions.

Intergeneric interactions have been demonstrated between the small bowel protozoan parasite, *Eimeria nieschulzi*, and the nematodes, *Nippostrongylus brasiliensis* and *Trichinella spiralis*, during concurrent infections in rats. Duszynski et al.[3] demonstrated suppressed rejection of *T. spiralis* in immunized rats concurrently infected with *E. nieschulzi*. Conversely, Stewart et al.[4] reported that rats inoculated with *T. spiralis* during a primary infection with *E. nieschulzi* expelled the helminth more rapidly than control animals. At this time (1978), it was suggested that this accelerated rejection might be due to the eimerian's ability to modulate the host's immune and/or inflammatory responses[3,4]. Recently (1984), it has been shown that *E. nieschulzi* has the ability to reduce the systemic inflammatory response by interferring with some phase of directed leukocyte migration[5].

Nippostrongylus brasiliensis and *T. spiralis* both undergo similar rejection phenomena by 16 days postinoculation (PI) during a primary infection. Recently, Bristol et al.[6] demonstrated that the patent period of *N. brasiliensis* was significantly longer in rats concurrently infected with *E. nieschulzi*, indicating suppressed rejection of at least a part of the nematode population. Since both parasites reside in the middle third of the small intestine, it was of interest to us to determine whether another species of *Eimeria* that parasitizes a different region of the alimentary tract than *N. brasiliensis* might also modulate rejection of the nematode thus indicating a more general ability of rat coccidia to affect host resistance. To determine this, *N. brasiliensis* and the rat caecal coccidium, *E. separata*, were administered to laboratory rats. Nematode fecundity and longevity and *E. separata* patent period and oocyst production were quantified during single and concurrent infections.

Materials and methods. Specific pathogen-free, outbred male Wistar rats (Timco Breeding Laboratories, Houston, TX) weighing 200–250 g were inoculated per os with $10^5 \pm 6 \times 10^3$ sporulated oocysts of *E. separata* Becker and Hall, 1931 and/or subcutaneously with $4 \pm 0.24 \times 10^3$ L_3 larvae of *N. brasiliensis* Travassos, 1920. At the time of inoculation, oocysts were 2–4 months old while larvae were 14 days of age. The *N. brasiliensis* inoculum variability was 6% which is within the 95% confidence limit (6–9%) established by Keymer et al.[7] irrespective of inoculum size. Eight groups of 5 rats each were inoculated according to the infection schedule in the table.

Feces from infected rats were collected at 24 h intervals until 2 days after ova production had ceased, mixed for 10 sec in a Waring blender, strained through 40-, 60- and 80-mesh brass sieves and the final volume brought to 400 ml. Samples were thorougly agitated, 1 ml withdrawn, concentrated by coverslip flotation and oocysts and ova counted under a compound microscope. If more than 300 oocysts or ova were present in 1 ml of undiluted fecal suspension, appropriate dilutions (10 × to 1000 ×) were made so that oocysts and ova could be accurately counted. Rats were sacrificed 2 days after ova production had ceased and the worms expelled from the rat intestine, thus, worm burdens could not be calculated in the present study. This rat strain is, however, used in our laboratory for *N. brasiliensis* in-

Total oocyst and ova ($\bar{x} \pm$ SE) produced during single and concurrent infections with *Eimeria separata* and *Nippostrongylus brasiliensis*

Group	Infection schedule (N = 5)	*E. separata* Oocysts × 10^4	*N. brasiliensis* Ova × 10^4
1	Single infection	–	29 ± 10
2	Single infection	280 ± 150	–
3	N.b. and E.s. simultaneous	140 ± 35	38 ± 8
4	E.s. on day 4 PI N.b.	230 ± 120	91 ± 25*
5	E.s. on day 6 PI N.b.	120 ± 60	56 ± 16*
6	E.s. on day 9 PI N.b.	115 ± 45	39 ± 8
7	E.s. on day 11 PI N.b.	121 ± 61	82 ± 21*
8	N.b. on day 2 PI E.s.	100 ± 50	55 ± 11

* Differs significantly ($p \leq 0.05$) from group 1.

fections and the following data on worm burdens have been routinely obtained on day 10 PI that had been administered 1×10^3 larvae: total worm burden = 271 ± 35, female worms = 154 ± 31 and male worms = 117 ± 16. These numbers are lower than those reported by Keymer et al.[7], however, their counts were made at 7 days PI while ours were calculated at 10 days PI at which time self-cure had begun. A sex ratio of females to males > 1 is consistent with that obtained previously[7].

Data were determined to be parametric by the F_{max} distribution test and the one-way analysis of variance was then used to determine statistical significance ($p \leq 0.05$).

Results and discussion. Ova production by *N. brasiliensis* was elevated significantly during some but not all of the concurrent infections while *E. separata* fecundity was unaltered. Oocyst production was less than that of controls in all concurrently infected groups, however, statistical significance could not be demonstrated due to the large variance for the singly-infected group in this rat strain. Although each group was composed of a small number (N = 5) of rats, results of the present study are in agreement with those obtained during *E. nieschulzi-N. brasiliensis* concurrent infections[6]. Since rats were sacrificed 2 days after ova production had ceased in the present study, it is not known whether alterations in ova production resulted from *E. separata* affecting *N. brasiliensis* fecundity directly or from decreased numbers of helminths establishing in the presence of *E. separata*. At this time, all *N. brasiliensis* had been eliminated from the host intestine.

The presence of *E. nieschulzi* during a *N. brasiliensis* infection has been shown to suppress rejection of the nematode[6], however, when *E. separata* was superimposed on a *N. brasiliensis* infection, the patent periods of both *E. separata* (4 ± 0 days) and *N. brasieliensis* (8 ± 0.3 days) were not significantly different from those in singly-infected control rats.

The affect of *E. separata* on *N. brasiliensis* ova production, irrespective of the mechanism, suggests that a systemic effect may be responsible since these parasites do not inhabit the same region of the gastrointestinal tract. This postulation is supported by the fact that chicken coccidia, of the genus *Eimeria*, cause pathologic changes in regions distant from the site of endogenous development[8,9] and the fact that the small intestine weight ratios are elevated in rats singly infected with *E. separata*[10]. More importantly, since *E. nieschulzi* but not *E. separata* is capable of altering the patent period length of *N. brasiliensis*, it suggests that *E. nieschulzi* may be unique among rat eimerians in its ability to alter the host's immune and/or inflammatory response[3,5,11] and effect rejection of *N. brasiliensis*.

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A non-peroxide norsesterterpene from a marine sponge *Hyrtios erecta*

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Summary. A new norsesterterpene, hyrtial **4**, and known sesterterpenes, **1–3**, have been isolated from an anti-inflammatory active crude extract of the sponge *Hyrtios erecta*.
Key words. Sponge, marine; *Hyrtios erecta;* norsesterterpene; sesterterpenes; hyrtial.

Demosponges which are soft to the touch yet seem to repel normal sponge predators such as rasping fish or nudibranchs are of interest to us[1]. Several years ago we encountered an abundant black Tongan sponge, *Hyrtios erecta*, whose crude extract was ichthyotoxic and possessed anti-inflammatory activity[2].

Semipure heteronemin **1a**[3] crystallized from the crude dichloromethane extract. Interestingly, **1a** was first isolated in 1976[3a] whereas its correct stereostructure was not described until 1981[3d]. Flash chromatography followed by HPLC yielded, in order of increasing polarity, hyrtial **4**[4], 12-epi-scalaradial **2**[5], and 12-epi-scalarin **3**[6].

The molecular formula of **4** ($C_{26}H_{40}O_3$) was deduced by considering both its mass spectrum, highest m/z = 340 (M^+–HOAc) and ^{13}C-NMR attached proton test (APT) results[7]. Diagnostic NMR signals revealed key structural elements such as: an equatorial C_{12}-OAc [^{13}C δ170.2 (C=O), 21.6 (Me), ^{1}H δ4.70 (dd, J = 11,4 Hz, H_{12}, 1.70 (s, Me)]; C_{17}–CHO [^{13}C δ192.8 (C=O), ^{1}H δ9.34 (H_{24})]; a trisubstituted C=C [^{13}C δ148.6 (C_{16}), 139.6 (C_{17}), ^{1}H δ6.06 (b.s., H_{16})]; axial methyls[8] at $C_{4,8,10,13}$ [^{13}C δ20.1, 16.9, 16.7, 14.7]; and axial protons at $C_{5,9,14}$ J_{aa+ae} > 15 Hz for each methine H. The appearance of four methine ^{13}C signals near [δ60, 59, 56, 54] are helpful in pinpointing a normal scalarane frame (see structures). How-