

# Cuticular Ridges Pattern of *Nippostrongylus brasiliensis* (TRAVASSOS, 1914) (Nematoda: Heligmonellidae) in Eight Populations from *Rattus norvegicus* in Japan

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## Introduction

*Nippostrongylus brasiliensis* (TRAVASSOS, 1914) TRAVASSOS et DARRIVA, 1929 (Trichostrongyloidae; Nippostrongylinae) was described from small intestine of Muridae rats, in particular, from *Rattus* spp. and has a worldwide distribution<sup>1,3,14,15</sup>. *N. brasiliensis* is also the predominant species of parasitic nematode of *Rattus norvegicus* and *R. rattus* in Japan<sup>7,10,12,13,15,17,20,24~28</sup>.

This nematode has been used in the fields of biomedical science for more than half of century, and more than one thousand papers dealing with this nematode have been published<sup>14,19</sup>.



Fig. 1. Localities of origin of 6 different populations of *Nippostrongylus brasiliensis* in Japan dealt in this study (Number of localities are as same in Table 1)

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In our laboratory, we are also maintaining two strains, or isolates, of this nematode with male Wistar rats. The first strain of *N. brasiliensis* has been isolated from wild brown rats, *R. norvegicus*, captured in Hokkaido and maintaining since 1984, and the another one has been maintained in Jikei Medical University, Tokyo, Japan (the origin of this population was the laboratory of Dr. Bloch, Harvard University, U. S. A.). Some differences in biological aspects have been recognized between the two strains. The differences are prepatent period, longevity and IgE class antibody productivity in the host<sup>10,20</sup>.

Before confirming the biological differences between the different populations (=strains or isolates) of *Nippostrongylus brasiliensis*, the authors compared their morphology, in particular, on the structure and the number of cuticular ridges

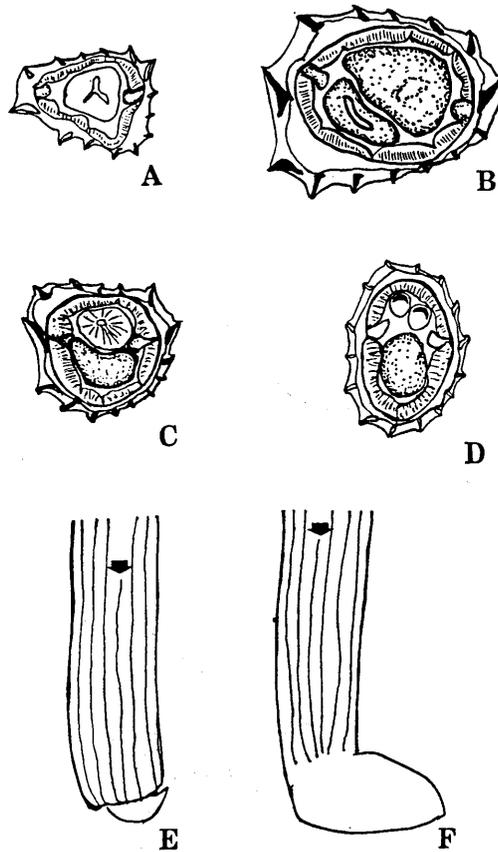


Fig. 2. Morphology of cuticular ridges (Synlophe) of *Nippostrongylus brasiliensis* in Japan.

A-D Cross section.

A. Midbody of male. With 14 ridges.

B. Midbody of female. With 14 ridges.

C. Posterior region of female. With 15 ridges.

D. Posterior end of male. With 15 ridges.

E and F Posterior region (Lateral view).

E. Female. Arrow shows the 15th ridge.

F. Male. Arrow shows the 15th ridge.

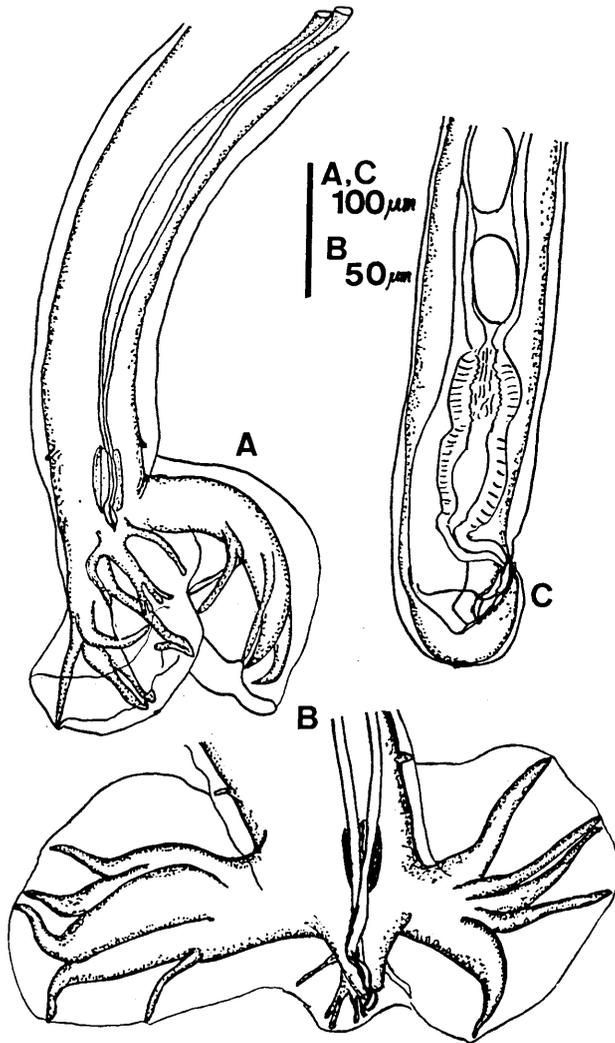
(synlophe) of the laboratory maintained 2 strains and other 6 populations of *N. brasiliensis* naturally infected in *R. norvegicus* collected from geographically different areas in Japan.

### Materials and Methods

#### *Nippostrongylus brasiliensis*

##### (1) Laboratory strains

1) NBJ: Maintained in the Department of Parasitology, School of Medicine, Jikei University (courtesy of Dr. Naoki Watanabe, Originated from Dr. Bloch, Harvard University, U. S. A.)



**Fig. 3.** Adult *Nippostrongylus brasiliensis*.

- A. Posterior end of male (Ventral view).
- B. Posterior end of male (orsal view).
- C. Posterior view of female (Lateral view).

2) NbR: Maintained in the Department of Parasitology, School of Veterinary Medicine, Rakuno Gakuen University. (Isolated from the *R. norvegicus* trapped in Hokkaido).

(2) Naturally infected in *R. norvegicus* in Japan

- 1) Hokkaido, Ebetsu city.
- 2) Aomori Prefecture. (By courtesy of Dr. Yagisawa)
- 3) Aichi Prefecture, Nagoya City. (By courtesy of Dr. Makiya)
- 4) Hyogo Prefecture, Kobe City (Courtesy of Dr. Uga)
- 5) Ehime Prefecture, Matsuyama City (By courtesy of Prof. Nishida)
- 6) Fukuoka Prefecture (Courtesy of Drs. Takao and Yoneda)

Worms were fixed in 5~10% formalin solution and treated with lactophenol for microscopy. The number of cuticular ridges were counted on the cross section of midbody, cut with a blade under a dissecting microscope. Cross sections were embedded in lactophenol or glycerine jelly and covered with a small piece of cover glass.

## Results

### Description of *Nippostrongylus brasiliensis*

Synlophe: The number of cuticular ridges are 14 in male and female of the all specimens. In males, 15 or 16 ridges, in some cases, existed near the tail end. In males, 15 or 16 ridges appeared near the tail end. The size of ridges decreased in number posteriorly. In the cross section of the midbody, the gradients in size of ridges were right to left in dorsal and left to right in ventral. The lateral left ridge was the largest and axis of orientation was oblique to the dorsoventral axis.

Male caudal bursa: Lateral lobes asymmetric. Right lobe larger than left



Fig. 4. Locality of 6 species of the genus *Nippostrongylus* LANE, 1923.

1. *N. rauschi* CHABAUD et DESSET, 1966.
2. *N. rysavyi* (ERHARDOVA, 1959) DURETTE-DESSET, 1970.
3. *N. magnus* (MAWSON, 1961) DURETTE-DESSET, 1970.
4. *N. typicus* (MAWSON, 1961) DURETTE-DESSET, 1970.
5. *N. djumachani* (TENORA, 1969) DURETTE-DESSET, 1970.
6. *N. witenbergi* GREENBERG, 1972.

one. Dorsal lobe small. Ventroventral, posteroventral, anterolateral and medio-lateral ray of the left lateral lobe is of almost the same size. Posterolateral ray of the left lateral lobe thick, and diverges from mediolateral ray and vent posteriorly.

Female: Tail short vent ventrally. The cuticle of posterior portion loose and covers the tail end. Vulva opens near the anus.

### Discussion

Seven species have been described within the genus *Nippostrongylus* LANE, 1923<sup>1-3,5,11,14,15,18,21-23,29</sup>. The number of cuticular ridges are in the range of 12~14 in midbody among these species (Table 2).

*N. brasiliensis* is the most common nematode parasite of the *Rattus* spp. (in particular, in *R. norvegicus* and *R. rattus*) in the world and is very commonly known to parasitologists. It is likely that their precise morphology has been over-

**Table 1.** Number of ridges (midbody) of *Nippostrongylus brasiliensis* (TRAVASSOS, 1914) of different populations from *Rattus norvegicus* in Japan

Populations	Male	Female
Laboratory isolates		
1 NbR	14 (10)	14 (10)
2 NbJ	14 (10)	14 (10)
Natural infection		
1 Hokkaido (Sapporo, Ebetsu)	14 (10)	14 (10)
2 Aomori Pref.	14 ( 5)	14 ( 5)
3 Aichi Pref. (Nagoya)	14 ( 1)	14 ( 2)
4 Hyougo Pref (Koube)	14 ( 3)	14 ( 3)
5 Ehime Pref. (Matsuyama)	14 ( 2)	14 ( 2)
6 Fukuoka Pref. (Kurume)	14 ( 3)	14 ( 3)

Numbers in parenthesis show number of specimen examined.

NbR: Maintained in the laboratory of the present authors.

NbJ: Courtesy of Dr. Watanabe, the Department of Parasitology, Jikei University, School of Medicine (Origin was in U. S. A.).

**Table 2.** Seven species of the genus *Nippostrongylus* LANE, 1923

species & references	geological distribution	hosts	number of ridges
1. <i>brasiliensis</i> [1, 2, 14, 15]	cosmopolitan	<i>Rattus</i> spp. <i>Mus musculus</i>	14
2. <i>rauschi</i> [1]	Malaysia	<i>Cynocephalus volans</i>	14
3. <i>djumachani</i> [2, 3, 26]	Afganstan	<i>Nesokia indica</i>	14
4. <i>magnus</i> [2, 3, 18]	Australia	<i>Rattus</i> spp. <i>Melomys cervinipes</i>	12
5. <i>typicus</i> [2, 3, 18]	Australia	<i>R. assimilis</i>	12
6. <i>rysavyi</i> [3, 5]	China	<i>R. rattus</i> <i>Cricetulus barabensis</i>	12
7. <i>witenbergi</i> [11]	Israel	<i>N. indica</i>	14

Numbers in [ ] mean the same as in references.

looked. For example, *Orientostrongylus ezoensis* TADA, 1975 (Nippostrongylinae) have been found in the nematode populations from *R. norvegicus*, which had been identified as *N. brasiliensis* by many parasitologists over a long period in Japan<sup>6,7,13,20</sup>.

The present authors showed that the number of cuticular ridges in the midbody of *N. brasiliensis* is always consistent, 14, among the different populations. The present results confirmed the results of Lichtenfels<sup>15,16</sup>. In his study, the number of cuticular ridges of *N. brasiliensis* was also always 14 in different populations.

Fukumoto et al. described that the number of ridges was constant, 13, at the midbody of both sexes among the three populations of *Lagostrongylus leporis* (SCHULZ, 1931) (Brevistriatinae: Heligmonellidae) collected from the three species of lagomorph hosts captured in Japan<sup>8,9</sup>.

The present authors also compared the different population of *O. ezoensis* TADA, 1975 collected from *R. norvegicus* captured in geographically different areas of Japan. The number of cuticular ridges was not consistent among those populations, they could not separated from the population of *O. ezoensis* in different species or subspecies. They considered that the number of ridges of the genus *Orientostrongylus* DURETTE-DESSET, 1970 increased in the species detected in the northern part of Asia compared with those species in the southern part of Asia<sup>7</sup>.

The authors considered that the consistent and small number of ridges is the one of primitive characteristics in related genera in the family Heligmonellidae<sup>4,7-9</sup>. According to the Durette-Desset's definition<sup>2-4</sup>, the morphology of ridges on cross section of the genus *Nippostrongylus* showed the primitive characteristics as compared to those of the genus *Orientostrongylus*<sup>3,4</sup>.

And the present authors considered that the relationship among the genera which are classified in the family Heligmonellidae, in particular in the subfamily Nippostrongylinae, should be reconsidered.

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### Summary

The morphology of the cuticular ridges pattern "synlophe" in the 8 different populations of the rat intestinal nematode, *Nippostrongylus brasiliensis* (TRAVASSOS, 1914) was examined. The number of ridges on the midbody was constant, 14, within the both sexes among the 2 strains maintained with laboratory rats (one originated in Japan, the other originated in the U. S. A.), and 6 populations collected from the naturally infected brown rat, *Rattus norvegicus*, captured in the 6 prefectures in Japan. It was concluded that *N. brasiliensis* has consistent and small number of ridges among the different host populations in Japan and over the world.

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## 要 約

毛線虫上科内の科 Heligmonellidae に分類される小線虫 *Nippostrongylus brasiliensis* (TRAVASSOS, 1914) TRAVASSOS et DARRIBA, 1929 は、日本を含む世界各地の *Rattus* 属のネズミの小腸から報告されている。

本種について種内の個体変異の状況を明らかにする目的で、synlophe の形態を中心に形態学的な観察をおこなった。特に体表のクチクラの隆起線の数に着目して、日本国内の地理的に異なった 6 地域 (北海道, 青森県, 愛知県, 兵庫県, 愛媛県と福岡県) で捕獲されたドブネズミ *Rattus norvegicus* の小腸から採取された 6 つの自然感染個体群と、北海道産のドブネズミおよびアメリカ合衆国起源で、実験室内でラット *Rattus norvegicus* を用いて継代した 2 つの実験室内継代個体群, の計 8 つの群について比較した。その結果 8 つの全個体群において、雌雄いずれも虫体の中央部で、14 本の隆起線が認められ、極めて安定した形質であることが確認された。