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A NEW GENUS OF THE INTESTINAL NEMATODE, *LAGOSTRONGYLUS* (HELIGMONELLIDAE) FROM LAGOMORPHS: A REVIEW OF RELATED GENERA OF SUBFAMILIES HELIGMONELLINAE AND BREVISTRIATINAE

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A new genus *Lagostrongylus* (Heligmonellidae: Nematoda) is proposed for *Heligmonella leporis* (SCHULZ, 1931) DURETTE-DESSET, 1971. The synlophe morphology of *Lagostrongylus leporis* (SCHULZ, 1931) comb. n. should be classified in the subfamily Brevistriatinae. Relationship of *Lagostrongylus leporis* and related genera belonging to Heligmonellidae are discussed.

Key words: *Lagostrongylus* gen. n., *Heligmonella leporis*, Brevistriatinae

Heligmonella leporis (SCHULZ, 1931) DURETTE-DESSET, 1971 has been reported in lagomorphs from Sakhalin, U. S. S. R., and from several areas in Japan (SCHULZ, 1931; YAMAGUTI, 1935; YAGISAWA, 1978; KAMIYA et al., 1979; FUKUMOTO et al., 1983). SCHULZ (1931) classified it as *Longistriata leporis*. DURETTE-DESSET (1971) classified it in the genus *Heligmonella* MÖNNIG, 1927 with four other species of the genus *Longistriata*.

FUKUMOTO et al. (1986) examined the three populations of *H. leporis* from different host species collected in Japan with respect to morphology of the synlophe, and identified that the synlophe chracteristics were different from those of the genus *Heligmonella* MÖNNIG, 1927 defined by DURETTE-DESSET (1971, 1983). They recommended that the taxon *H. leporis* be identified in the subfamily Brevistriatinae.

Herein the authors proposed a new genus *Lagostrongylus* for *Heligmonella leporis* (SCHULZ, 1931) DURETTE-DESSET, 1971, and reviewed related genera in subfamilies Heligmonellinae and Brevistriatinae (Heligmonellidae).

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Lagostrongylus gen. n.

Trichostrongyloidea, Heligmonellidae (SKRJABIN & SHIKHOBALOVA, 1952, tribe) DURETTE-DESSET & CHABAUD, 1977, Brevistriatinae DURETTE-DESSET, 1971. Synlophe consisting of 13 (or 12) cuticular ridges of different sizes with internal cuticularised skeleton. Ridges continuous. Seven ridges present dorsally and 6 ridges ventrally at midbody. The gradient in size of ridges is right to left dorsally. The axis of orientation of ridges is subfrontal to the sagittal axis. A small carene supported by two ridges on the left dorsal side of the body. Cephalic vesicle with fine annulations. Minute cervical papillae present. Lateral lobe of bursa symmetrical. Minute preburbursal papillae present. Antero-ventral and postero-ventral rays with common trunk, and distal extremity of each extends to bursal margin. Bursal margin at region of postero-ventral rays protrudes. Antero-lateral rays turn anteriorly at distal extremity. Medio-lateral and postero-lateral rays with common trunk. Externo-dorsal rays arise one-third the distance from the proximal extremity of the dorsal ray symmetrically or asymmetrically, and distal end of rays does not extend to margin of bursa. Dorsal ray thick, with distal end divided into two branches and each branch bifurcated; inner branches extend to bursal margin. Spicules equal in length, long and slender. The distal end of spicules is slightly inflated and has a blunt end or a simple and sharp end. Gubernaculum present. Female monodelphic.

Type species: *Lagostrongylus leporis* (SCHULZ, 1931) gen. et comb. n.
Synonym: *Longistriata leporis* SCHULZ, 1931
Heligmonella leporis (SCHULZ, 1931) DURETTE-DESSET, 1971
Longistriata leporis sensu YAMAGUTI, 1935
Host: *Lepus timidus*
Locality: Sakhalin, U. S. S. R.
Other hosts and localities: *Lepus brachyurus brachyurus* (YAMAGUTI, 1935; FUKUMOTO et al., 1986), *Lepus timidus ainu* (FUKUMOTO et al., 1986), *Lepus brachyurus angustidens* (YAGISAWA, 1978) and *Pentalagus furnessi* (KAMIYA et al., 1979; FUKUMOTO et al., 1983); Japan
Other species: *L. kurenzovi* (SADOVSKAJA, 1952) [Syn. *Longistriata kurenzovi* SADOVSKAJA, 1952=*Heligmonella kurenzovi* (SADOVSKAJA, 1952)]; *Lepus timidus, L. mantscuricus*; U. S. S. R.
L. indica (SINGH, 1968) [Syn. *Longistriata indica* SINGH, 1968=*Heligmonella indica* (SINGH, 1968) DURETTE-DESSET, 1971]; *Lepus ruficaudatus*; India

According to the classification of the subfamily Brevistriatinae by DURETTE-DESSET (1971, 1983), the morphological marks are: axis of orientation of ridges inclined more than 45° (67°–90°) from sagittal axis: carene absent, or, if present, dorsal ray divided in its posterior half: gradient in size of ridges lacking, or from right to left on dorsal

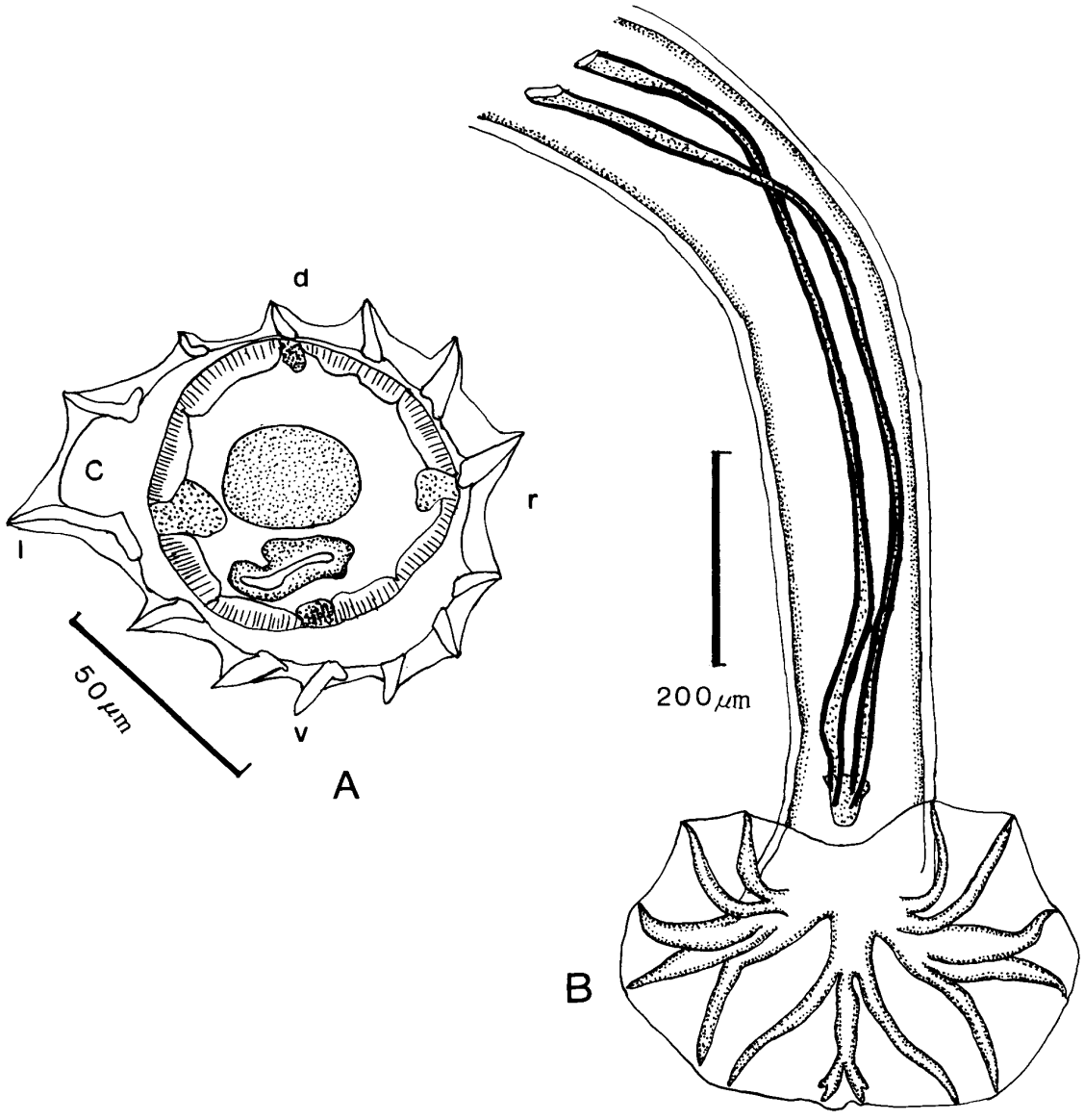

FIGURE 1 A Cross section (midbody) of female *Lagostrongylus leporis* (SCHULZ, 1931) comb. n. from *Pentalagus furnessi*
(C: carene, d: dorsal, l: left, r: right, v: ventral)
B Caudal end of male of *Lagostrongylus leporis* (SCHULZ, 1931) comb. n.

side or medio-lateral.

The 10 genera which have been identified in the subfamily Brevistriatinae at the present time are: *Brevistriata* TRAVASSOS, 1937; *Calypsostrongylus* SCHMIDT et al., 1967; *Quentinstrongylus* DURETTE-DESSET, 1969; *Cordicauda* DURETTE-DESSET, 1971; *Metheligmonella* DURETTE-DESSET, 1971; *Paraheligmonina* DURETTE-DESSET, 1971; *Srivastavanema* (SINGH, 1962) DURETTE-DESSET & LIM BOO LIAT, 1975; *Fissicauda* DURETTE-DESSET & KRISHNASAMY, 1976; *Kuala* DURETTE-DESSET & KRISHNASAMY, 1976; *Macrostrongylus* OW YANG et al., 1983.

The genus *Lagostrongylus* is similar to *Paraheligmonina* in the following characteristics: (1) carene present; (2) dorsal ray divided distally; and (3) dorsal lobe not hypertrophied. But *Lagostrongylus* differs from *Paraheligmonina* as follows: (1) the axis of the orientation of ridges does not incline from the sagittal axis; (2) the structure of carene is small; and (3) there are few ridges (13 or 12 at midbody).

The history of classification of *Heligmonella leporis* (SCHULZ, 1931) DURETTE-DESSET, 1971 and related species of the genus *Heligmonella* MÖNNIG, 1927

MÖNNIG (1927) described *Heligmonella spira* from the intestine of *Thryonomys swinderianus* collected in South Africa.

TRAVASSOS (1937) reviewed the family Trichostongylidae. In his monograph, the genus *Heligmonella* was not recognized, and he classified this taxon as belonging to the genus *Longistriata* of the subfamily Viannaiinae. *Heligmonella leporis* was also included in the genus *Longistriata.*

ORTLEPP (1939) recognized the name *Heligmonella* as one of the subgenera of the genus *Longistriata* for *H. spira.*

SKRJABIN & SHIKHOBALOVA (1952) recognized the genus *Heligmonella* in the tribe Heligmonellea, subfamily Longistriatinae, family Heligmosomatidae, superfamily Trichostrongyloidea. They recognized eight species including *H. spira* in the genus *Heligmonella,* but *H. leporis* and *H. kurenzovi* were classified as belonging to the genus *Longistriata.*

YAMAGUTI (1961) recognized *Longistriata leporis* and *L. kurenzovi.* The genus *Heligmonella* was synonymized in *Longistriata.*

DURETTE-DESSET and her colleagues classified the superfamily Trichostrongyloidea with respect to morphology of the synlophe and the phylogeny of hosts.

DURETTE-DESSET (1969a) synonymized *Viannella africana* CLAPHAM, 1947 from *Thryonomys swinderianus* collected in South Rhodesia and Kenya with *Longistriata spira* (MÖNNIG, 1927)

DURETTE-DESSET (1971) identified the family Heligmosomidae in the superfamily Trichostrongyloidea. The genus *Heligmonella* was classified in the subfamily Helig-

monellinae with the genera *Tricholinstowia* and *Paraheligmonella*. Five species were recognized in the genus *Heligmonella*, i. e., *H. spira, H. asymmetrica, H. leporis, H. kurenzovi* and *H. indica*.

DURETTE-DESSET (1974) described *Heligmonella dremomysi* from the intestine of *Dremomys lokriah* (Rodentia) collected in Nepal.

DURETTE-DESSET et al. (1975) found *Heligmonella limbooliati* from the intestine of *Trichys lipura* (Rodentia) collected in Malaysia.

In a review of the genus *Impalaia*, GIBBONS et al. (1977) transfered *Impalaia dremomys* YEN, 1973 from *Dremomys rufigens rufigens* collected in Yunnan Province, China, to the genus *Heligmonella*. Therefore, *H. dremomysi* DURETTE-DESSET, 1974 became a homonym of YEN'S species, and they proposed a new name *Heligmonella moreli* for the former.

DURETTE-DESSET & CHABAUD (1977) proposed a new classification of the superfamily Trichostrongyloidea. In their systematics, the genus *Heligmonella* was included in the subfamily Heligmonellinae, family Heligmonellidae. Four genera were recognized in Heligmonellinae : *Heligmonella, Tricholinstowia, Paraheligmonella* and *Trichotravassosia*, and the following eight species were included in the genus *Heligmonella* : *H. spira, H. leporis, H. kurenzovi, H. indica, H. asymmetrica, H. limbooliati, H. dremomys* (YEN, 1973) GIBBONS et al., 1977 and *H. moreli* GIBBONS et al., 1977.

DURETTE-DESSET & CHABAUD (1981) moved the genus *Xericola* from Brevistriatinae to the Heligmonellinae.

DURETTE-DESSET (1983) proposed a new genus *Sciuricola* in Heligmonellinae and she transfered *H. dremomys* and *H. moreli* to the genus *Sciuricola*. Therefore, at the present time, the following six genera are recognized in the Heligmonellinae : *Heligmonella, Tricholinstowia, Paraheligmonella, Xericola, Trichotravassosia* and *Sciuricola*, and the following six species are included in the genus *Heligmonella* : *H. spira, H. asymmetrica, H. leporis, H. kurenzovi, H. indica* and *H. limbooliati*.

FUKUMOTO et al. (1986) considered that *H. leporis* should be classified in the subfamily Bevistriatinae. The general morphology of the male bursa and the number of cuticular ridges of *Heligmonella kurenzovi* and *H. indica* is similar to that of *Lagostrongylus leporis*. The geographical distribution and the host species also suggest the similarity of these species. The authors also considered that *H. kurenzovi* and *H. indica* should be classified in the genus *Lagostrongylus*.

Relationship of the genus *Lagostrongylus* gen. n. and related genera within subfamilies Brevistriatinae and Heligmonellinae

DURETTE-DESSET (1969b) described seven new species of the genus *Longistriata*, i. e., *L. atheruri, L. paratheruri, L. adami, L. paradami, L. asymmetrica, L. tcheprakovae*

and *L. caillaudae* from one material of *Atherurus africanus* (Rodentia) collected in Congo.

DURETTE-DESSET (1970a) also reported five new species of the genus *Longistriata*, i e., *L. paratrifuricata, L. quartanuda, L. posterior, L. rara* and *L. mabokensis* from the sciurids, *Funisciurus lemniscatus and F. pyrrhopus*, collected in the Republic of Central Africa. And she redescribed *Heligmonina magna* from *Protoxerus stangeri* in Gabon and *Heligmonella streptocerca* from *F. lemniscatus* in the Central Africa.

DURETTE-DESSET (1970b) reported three species of the genus *Longistriata*, i. e., *L. petteri, L. bainae* and *L. lemniscomys* from Muridae, *Hylomyscus stella, Steatomys opinus, Arvicanthis niloticus* and *Lemniscomys striatus*, collected in the Congo.

DURETTE-DESSET (1971) reclassified these African heligmosome nematodes as *Heligmonella asymmetrica* (subfam. Heligmonellinae), and reported fourteen species of the genus *Paraheligmonina* (subfam. Brevistriatinae), i. e., *P. magna, P. adami, P. atheruri, P. caillaudae, P. mabokensis, P. opi, P. paracaillaudae, P. paradami, P. paratheruri, P. paratrifuricata, P. quartanuda, P. rara, P. streptocerca* and *P. tcheprakovae.*

DURETTE-DESSET et al. (1975) described *Heligmonella limbooliati* and three species of the genus *Cordicauda* (subfam. Brevistriatinae), i. e., *C. trichysi, C. malayensis* and *C. magnabursa* from the small intestine of *Trichys lipura* (Rodentia) collected in Malaysia.

DURETTE-DESSET (1974) found *Xericola marocanus* from *Atlantoxerus getulus* in Morocco, North Africa. The genus *Xericola* has a small carene on the left dorsal side of the body and 14 ridges at midbody. She classified the genus *Xericola* as being between the genus *Heligmonella* (subfam. Heligmonellinae) and the genus *Paraheligmonina* (subfam. Brevistriatinae), and considered that the genus *Xericola* was the most primitive in the subfamily Brevistriatinae.

DURETTE-DESSET (1981, 1983) reclassified the genus *Xericola* into the subfamily Heligmonellinae because the axis of orientation of ridges inclines about 45° to the sagittal axis.

DURETTE-DESSET & LIM BOO LIAT (1975) found *Srivastavanema* (Brevistriatinae) in petauristine rodents in Viet Nam. The genus *Srivastavanema* was classified as being between the genera *Heligmonella* and *Cordicauda-Brevistriata.*

The morphology of the genera *Paraheligmonina* and *Cordicauda* is closely related, especially in synlophe. The genus *Cordicauda* also differs from *Lagostrongylus* by : 1) dorsal ray divided proximally, 2) dorsal lobe hypertrophied and 3) well developed carene supported by two large ridges.

DURETTE-DESSET et al. (1975) considered that *Paraheligmonina* and *Cordicauda* might have evolved from the common *Heligmonella* type nematode within the common ancestor of rodent hosts developed in Asia and Africa. According to this hypothesis, the relationship of the *Heligmonella-Xericola-Paraheligmonina* line in Africa and the

Heligmonella-Srivastavanema-Cordicauda and *Brevistriata* line in Asia might have evolved parallel within the evolution of hosts.

DURETTE-DESSET & LIM BOO LIAT (1975) also described that *Heligmonella indica* should be classified as being between *Heligmonella* and *Srivastavanema* in Asia, and they considered that *Paraheligmonina gracilis* also evolved in European *Glis glis* (DURETTE-DESSET, 1969b).

The present study might supports the hypothesis of DURETTE-DESSET in part. The authors considered that the genus *Lagostrongylus* is the most primitive genus in the subfamily Brevistriatinae (fig. 2).

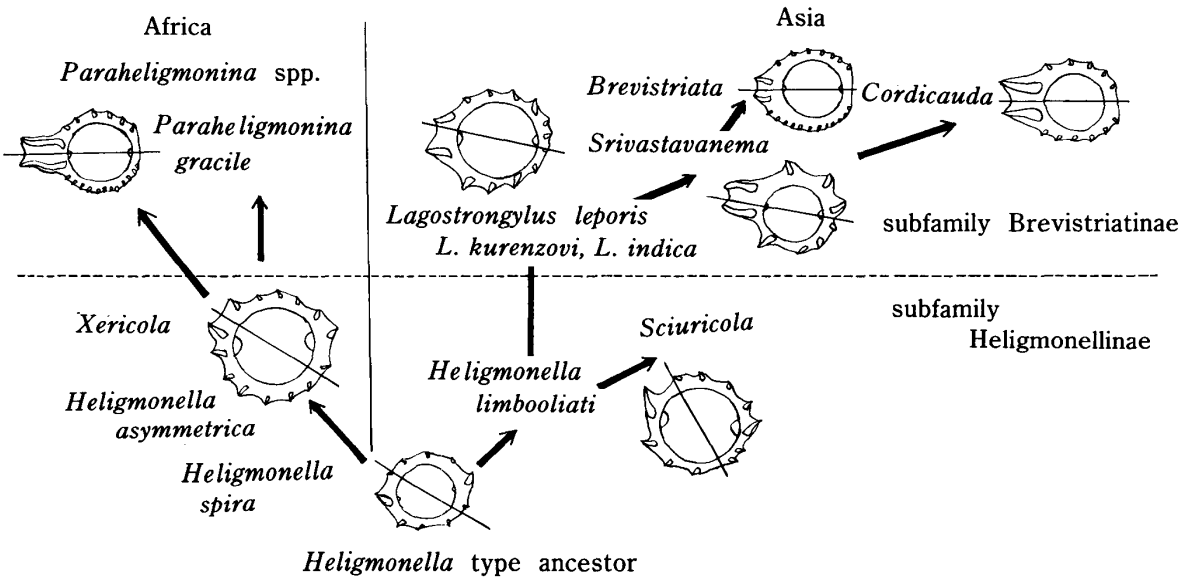

FIGURE 2 *The relationships of genus Lagostrongylus and the related genera of the subfamilies Heligmonellinae and Brevistriatinae* (DURETTE-DESSET et al., 1975, modified)

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REFERENCES

1) CLAPHAM, P. A (1947): On *Viannella africana* n. sp., *Cheilospirura falconis* n. sp. and *Oesophagostomum terdentatum* MAPLESTONE, 1932 *J. Helminthol.*, **22**, 29–36
2) DURETTE-DESSET, M.-C. (1969a): Nouvelles données morphologiques sur quelques Nématodes Héligmosomes, parasites de Rongeurs *Ann. Parasitol. Hum. Comp.*, **44**, 37–46
3) DURETTE-DESSET M.-C. (1969b): Sept nouvelles espèces de Nématodes Héligmosomes, parasites d'un *Atherurus africanus* GRAY, et remarques sur leur répartition dans l'intestin *Cah. La Maboké*, **7**, 109–130.
4) DURETTE-DESSET, M.-C. (1969c): Description de *Quentinstrongylus graphiuri* n. gen., n. sp., Héligmosome parasite d'un Gliridé en Afrique tropicale *Ibid.*, **7**, 131–134
5) DURETTE-DESSET, M.-C. (1969d): Redescription de l'Héligmosome du Loir (*Glis glis* L.) *Ann. Parasitol. Hum. Comp.*, **44**, 609–616
6) DURETTE-DESSET, M.-C. (1970a): Les systèmes d'arêtes cuticulaires chez les Nématodes Héligmosomes IV. Description de six espèces nouvelles, parasites de Sciuridés africains; redescription d'*Heligmonina magna* BAYLIS, 1928 *et d'Heligmonella streptocerca* BAYLIS, 1928 *Cah. La Maboké*, **8**, 41–61
7) DURETTE-DESSET, M.-C. (1970b): Description de deux nouvelles espèces de Nématodes Héligmosomes, parasites de Rongeurs africains, et de la femelle de *Longistriata rara* DURETTE-DESSET, 1970 *Ibid.*, **8**, 139–146
8) DURETTE-DESSET, M.-C. (1971): Essai de classification des Nématodes Héligmosomes Corrélations avec la paléobiogéographie des hôtes *Mem. Mus. Natl. Hist. Nat.*, Sér. A., Zool., **49**, 1–126
9) DURETTE-DESSET, M.-C. (1974): Description de deux nouveaux Nématodes Héligmosomes chez un Sciuridé du Népal *Bull. Mus. Natl. Hist. Nat.*, 3^{e} Sér., N° 232, Zool., **156**, 819–825
10) DURETTE-DESSET, M.-C. (1974): *Xericola marocanus* n. gen., n. sp. (Heligmosomide), parasite d'un Sciuridé marocain *Ann. Parasitol. Hum. Comp.*, **50**, 201–207
11) DURETTE-DESSET, M.-C. (1983): Keys to genera of the superfamily Trichostrongyloidea In: CIH Keys to Nematode Parasites of Vertebrates, No. 10 Eds. ANDERSON R. C. & CHABAUD, A. G., 1–86, Farnham Royal, Bucks, England: Commonwealth Agricultural Bureaux
12) DURETTE-DESSET M.-C. & LIM BOO LIAT (1975): Sur deux nouvelles espèces du genre *Srivastavanema* (K. S. SINGH, 1962, s.-genre) (Nématode, Héligmosome), parasites de Petauristinae en Malaisie *Ann. Parasitol. Hum. Comp.*, **50**, 87–95.
13) DURETTE-DESSET, M.-C., DIAW, O. & KRISHNASAMY, M. (1975): Quatre nouvelles espèces de Nématodes Héligmosomes parasites de l'intestin d'un *Trichys lipura* GUNTHER malais; Comparaison avec la faune d'*Atherures* congolais *Ibid.*, **50**, 477–491.
14) DURETTE-DESSET, M.-C. & KRISHNASAMY, M. (1976): Brevistriatinae (Nematoda: Heligmosomidae) III. Description de *Fissicauda* n. gen. et de *Kuala* n. gen. parasites de petis Mammifères malais *Bull. Mus. Natl. Hist. Nat.*, 3^{e} Sér., No° 388,

Zool., **270**, 697–710

15) DURETTE-DESSET M.-C. & CHABAUD, A. G. (1977): Essai de classification des Nématodes Trichostrongyloidea *Ann. Parasitol. Hum. Comp.*, **52** 539–558

16) DURETTE-DESSET M.-C. & CHABAUD, A. G. (1981): Nouvel essai de classification des Nématodes Trichostrongyloidea *Ibid.*, **56**, 297–312

17) FUKUMOTO, S. -I., KAMIYA, M. & OHBAYASHI, M. (1986): Morphological study of the synlophe of intestinal nematode, *Heligmonella leporis* (SCHULZ, 1931) DURETTE-DESSET, 1971 (Heligmonellidae: Trichostrongyloidea) from lagomorphs in Japan *Jpn. J. Vet. Res.*, **34**,203–217

18) FUKUMOTO, S. -I., OKU, Y. YAMAGUCHI, K., KAMIYA, M. & SUZUKI, H. (1983): Helminth fauna of the Amami black rabbit, *Pentalagus furnessi Jpn. J. Parasitol.*, **28** (Suppl.), 73 (in Japanese)

19) GIBBONS, L. M., DURETTE-DESSET, M.-C. & DAYNAS, P. (1977): A review of the genus *Impalaia* MÖNNIG, 1923 (Nematoda: Trichostrongyloidea) *Ann. Parasitol. Hum. Comp.*, **52**, 435–446

20) KAMIYA, M., SUZUKI, H. & HAYASHI, K. (1979): Helminth parasites of *Romerolagus diazi* and *Pentalagus furnessi Jpn. J. Parasitol.*, **28** (Suppl.), 73 (in Japanese)

21) MÖNNIG, H. O. (1927): On a new *Physaloptera* from an eagle and a trichostrongyle from the cane rat, with notes on *Polydelphis quadricornis* and the genus *Spirostrongylus Trans. R. Soc. S. Africa,* **14**, 261–265

22) ORTLEPP, R. J. (1939): South African helminths Part VI Some helminths, chiefly from rodents *Onderstepoort J. Vet. Sci. Anim. Ind.*, **12**, 75–101

23) OW YANG, C. K., DURETTE-DESSET M.-C. & OHBAYASHI, M. (1983): Sur les Nematodes Parasites de Rongeurs de Malaisie II. Les Trichostrongyloidea *Ann. Parasitol. Hum. Comp.*, **58**, 467–492

24) SCHMIDT, G. D., MYERS, B. Y. & KUNTZ, B. E. (1967): Nematode parasites of Oceanica I. *Brevistriata sundasciuri* sp. n. and *Calypsostrongylus ogdeni* gen. et sp. n. (Heligmosomatidae: Longistratinae) from squirrels of Palawan and Taiwan *J. Parasitol.*, **53**, 613–617

25) SINGH, K. S. (1962): Parasitological survey of Kumaun Region Part II *Longistriata longispicularis* n. sp. (Heligmosomidae: Trichostrongyloidea: Nematoda) from a flying squirrel *Indian J. Helminthol.*, **14**, 24–30

26) SINGH, K. S. (1968): *Longistriata indica* sp. n. (Heligmosomatidae: Trichostrongyloidea: Nematoda) from a hare from India *Proc. Nat. Inst. Sci. India., Part B.* **35**, 53–59

27) SKRJABIN, K. I., SHIKHOBALOVA, N. P. & SCHULZ, R. S. (1954): Principles of nematology, Vol. IV Dictyocaulidae, Heligmosomatidae and Ollulanidae of animals, 1–323, Izdatz. Akad. Nauk SSR; Moscow (in Russian)

28) TRAVASSOS, L. (1937): Revisão da familia Trichostrongylidae Leiper, 1912 *Monogra. Inst. Oswaldo Cruz,* No. 1, 1–512

29) YAGISAWA, M. (1978): Studies on zoonotic helminths from mammals in northern Honshu, Japan *Hirosaki-Igaku,* **30**, 239–284

30) YAMAGUTI, S. (1935): Studies on the helminth fauna of Japan Part 13 Mammalian

nematodes *Jpn. J. Zool.*, **6**, 433–457

31) YAMAGUTI, S. (1961): Systema Helminthum, Vol. 3 The nematodes of vertebrates, 1–1261, Interscience: New York

32) YEN, W. C. (1973): Helminths of birds and wild animals from Lin-Tsan Prefecture, Yunnan Province, China II. Parasitic nematodes of mammals *Acta Zool. Sinica*, **19**, 354–364