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Changing Epidemiology of Angiostrongyliasis Cantonensis in Okinawa Prefecture, Japan

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Okinawa Prefecture experienced an outbreak of angiostrongyliasis in January of 2000 (1). The origin of the infection's outbreak could not be identified. We examined the past records of *Angiostrongylus cantonensis* (*Ac*) infection outbreaks and investigated the current distribution of *Ac*'s intermediate and paratenic hosts with infective third-stage larvae in Okinawa. In order to find the infective larvae of *Ac* in the giant African snail, *Achatina fulica*, the pallial organ (lung) of the snail was compressed between two glass plates and examined under a microscope (2) (Figs. 1A, 1B). In other host animals, the whole body was digested in artificial gastric juice (1% pepsin/1% HCl), and the digested material was allowed to sediment; the sediment thus formed was then examined microscopically. In particular, albino rats were given larvae from *Platydemus manokwari* (Fig. 2) and *Parmarion martensi* (Fig. 3) orally with the specimen, and identification was made based on the morphology of the adult *Ac* recovered at 59 days post-inoculation.

As shown in Table 1, the *Ac* epidemic showed different features before and after 1990. Before 1990, 17 in 21 (80%) of the infections were traced to their infection sources, while after 1990 only 2 in 14 could be traced to its source. The infection was more frequent (15/21) in April - November before 1990, although it was more frequent (11/14) in December -

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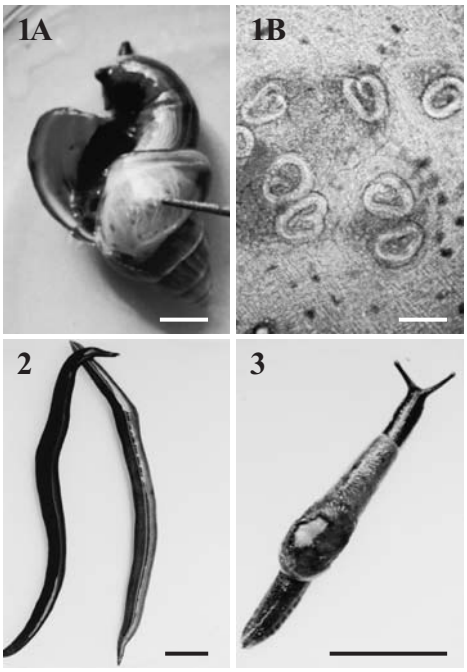

Fig. 1A. *Achatina fulica* (the giant African snail), the pallial organ (lung) is shown. Scale: 1 cm.
Fig. 1B. I nfective third-stage larvae of *Ac* in the tissue. Scale: 100 μm.
Fig. 2. *Platydemus manokwari*; newly discovered paratenic host of *Ac* in Okinawa. Scale: 1 cm.
Fig. 3. *Parmarion martensi*; newly discovered intermediate host of *Ac* in Okinawa. Scale: 1 cm.

March after 1990.

Table 2 shows the *Ac*-positives among the intermediate and paratenic hosts collected in the present and in past field surveys. In the 2000s, among six intermediate host species that were positive in the 1970s, *Satuma mercatoria*, *Acusta despecta*, and *Bradybaena circulus* became negative, and the positive rate of *A. fulica*, the prevailing host, that was 39% in the 1970s decreased to 10% in the 2000s. Meanwhile, *P. martensi* whose presence was not recognized in the 1970s became prevalent in the 2000s, particularly in the northern part of the mainland of Okinawa, and its infection rate was as high as 20.3%. *P. manokwari*, whose presence in Okinawa was noticed recently

Table 1. Epidemiologic characteristics of angiostrongyliasis cantonensis in Okinawa, 1969 - 1989 and 1990 - 2000

Characteristics	1969 - 1989 (20 years)	1990 - 2000 (10 years)
Human cases	21	14
Age range (mean) (y)	1 - 68 (32.4)	11 - 62 (26.0)
Ratio, Male to Female	1:1.25	1:1.8
Suspected place of infection (%)		
Okinawa Island	14 (66.7)	14 (100)
Miyako Island	6 (28.6)	0 (0.0)
Unknown	1 (4.8)	0 (0.0)
Suspected source of infection (%)		
Eating host with the infective larva	12 (57.1)	0 (0.0)
Achatina fulica	6 (28.6)	0 (0.0)
Veronicella alte	3 (14.3)	0 (0.0)
Bufo asiaticus	3 (14.3)	0 (0.0)
Handling of *Achatina fulica*	5 (23.8)	1 (0.7)
Crushing with the bare hand	1 (4.8)	1 (0.7)
Handling with the bare hand	3 (14.3)	0 (0.0)
Swallowing by the play	1 (4.8)	0 (0.0)
Ingestion of a fresh vegetable	0 (0.0)	1 (0.7)
Unknown	4 (19.0)	12 (85.7)
Occurrence time (%)		
Apr.–Nov. (Active period of *A. fulica*)	15 (71.4)	3 (21.4)
Dec.–Mar. (Non-active period of *A. fulica*)	3 (14.3)	11 (78.6)
Unknown	3 (14.3)	0 (0.0)

(Ref. 6)

Table 2. Surveys of the host animals of *Angiostrongylus cantonensis* infective larvae in Okinawa, the 1970s and the 2000s

Species	The 1970s[1)] Infected/Examined (%)	The 2000s Infected/Examined (%)
Intermediate hosts		
Terrestrial snails		
Achatina fulica	1,049/2,683 (39.1)	222/2,189 (10.1)
Satsuma mercatoria	36/240 (15.0)	0/139 (0.0)
Acusta despecta	3/427 (0.7)	0/904 (0.0)
Bradybaena circulus	3/448 (0.7)	0/53 (0.0)
Cyclophorus turgidus		0/529 (0.0)
Parmarion martensi	**	153/753 (20.3)
Aquatic snail		
Ampullarium sp.	**	0/3,764 (0.0)
Slugs		
Veronicella alte	76/347 (21.9)	108/783 (13.8)
Limax valentianus	9/50 (18.0)	3/78 (3.8)
Meghimatinum confusum	0/24 (0.0)	0/95 (0.0)
Paratenic hosts		
Land planarian		
Platydemus manokwari	**	227/1,613 (14.1)
Amphibians		
Bufo asiaticus	37/108 (34.0)	1/18 (5.6)
Bufo marinus	0/37 (0.0)	0/6 (0.0)
Rana catesbeiana	7/44 (15.9)	*
Rhacophorus leucomystax	1/4 (25.0)	*
Rana limnocharis	1/8 (12.5)	*

*: Not examined, **: Not discovered from the field.
1): Based on references 7, 8.

in 1993 (3), also showed a high infection rate of 14.1%.

Ac infection is mediated not only by ingestion of the *Ac*-carrier intermediate or paratenic hosts but also through the ingestion of vegetables, drinking water, and by contact with fingers that are contaminated by the infective larvae of *Ac* (4).

In the outbreak in January 2000 in Okinawa that involved seven patients, the clinical symptoms and immunological reactions were too weak for typical angiostrongyliasis and were somewhat similar to those of infection by low doses of *Ac* larvae. In the epidemic, larvae-contaminated fresh vegetables such as lettuce and cabbage were suspected as the source of infection. The first *Ac* infection case via a fresh vegetable salad had been reported for a patient who developed symptoms 7 days after a short trip to Okinawa in December 1999 (5). Among the 52 *Ac* cases reported so far in Japan, 35 were from Okinawa Prefecture (6).

As already indicated, the peak season of infection was displaced from April - November to December - March, and tracing the infection to its source has become more difficult in recent years. The displacement of the outbreak season coincided with the decline in the infection rate in *A. fulica* that is more active in April - November and the appearance of new hosts *P. martensi* that is more active in the winter season, while *P. manokwari* is active throughout the year. In relation to the displacement of the outbreak season, it should be noted that the harvest season for lettuce is November-May and that for cabbage is November-July.

Ac-infected *P. martensi* and *Veronicella alte* were examined histologically. *Ac* larvae were present in the muscular layer just beneath the body surface of these snails. However, the former species appeared to be more easily infected because of the less dense muscular layer and tended to contain a greater number of larvae. *P. manokwari* is frequently observed adhering to the lower side of cabbage leaves. It is quite possible that the larvae are released from the hosts when sliced together with the cabbage leaves in the preparation of fresh salad.

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REFERENCES

1. Toma, H. and Sato, Y. (2000): A mini-outbreak of angiostrongyliasis in Okinawa. Clin. Parasitol., 11, 40-43 (in Japanese).
2. Kishimoto, T. (1972): A survey of *Angiostrongylus cantonensis* in Okinawa. 1. Method for determination of *A. cantonensis* larvae in *Achatina fulica*. Rep. Okinawa Pref. Inst. Pub. Health, 6, 117-118 (in Japanese).
3. Kawakatsu, M., Oki, I., Tamura, S., Ito, H., Nagai, Y., Ogura, K., Shimabukuro, S., Ichinohe, F., Katsumata, H. and Kaneda, M. (1993): An extensive occurrence of a land planarian, *Platydemus monokwari* DE BEAUCHAMP, 1962, in the Ryukyu Island, Japan (Turbellaria, Tricladida, Terricola). Biol. Inl. Water, no. 8, 5-14.
4. Alicata, J. E. and Jindrak, K. (1970): Angiostrogylosis in the Pacific and Southeast Asia. C C Thomas, Publisher, Springfield, Ill.
5. Hattori, H., Kato, T., Nagato, M., Okano, C., Suzuki, H., Nawa, Y. and Nakahata, T. (2001): Eosinophilic meningitis caused by *Angiostrongylus cantonensis* infection in Okinawa. J. Jpn. Pediat. Soc., 105, 719-721 (in Japanese with summary in English).
6. Asato, R., Taira, K., Nakamura, M., Kudaka, J. and Itokazu, K., (2002): Emerging and re-emerging infection investigation report in Okinawa: Epidemiological studies on *Angiostrongylus cantonebsis* (1). Okinawa Prefectural Institute of Health and Environment. p. 12 (in Japanese).
7. Asato, R. and Kishimoto, T. (1976): A survey of *Angiostrongylus cantonensis* in Okinawa. 6. Distribution and positive rate of *A. cantonensis* in mollusks and frogas. Rep. Okinawa Pref. Inst. Pub. Health, 9, 50-55 (in Japanese).
8. Asato, R., Sato, Y. and Otsuru, M. (1978): The occurrence of *Angiostrongylus cantonensis* in toads and froga in Okinawa prefecture, Japan. Jpn. J. Parasitol., 27, 1-8.