Angiostrongyliasis due to *A. cantonensis*: first evidence in French West Indies and an up-date in the French overseas territories

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Introduction

Angiostrongylus cantonensis

- *A. cantonensis* : nematode of rat pulmonary arteries
- Leading infectious cause of eosinophilic meningitis in humans

Human angiostrongyliasis (HA)

- Commonly a self-limited meningitis syndrome
- Large spectrum of symptoms possible: asymptomatic disease, mild headache, encephalitis, radiculomyelitis, meningoencephalitis with permanent neurological injury or even death

***Life cycle of A. cantonensis* (Figure 1)**

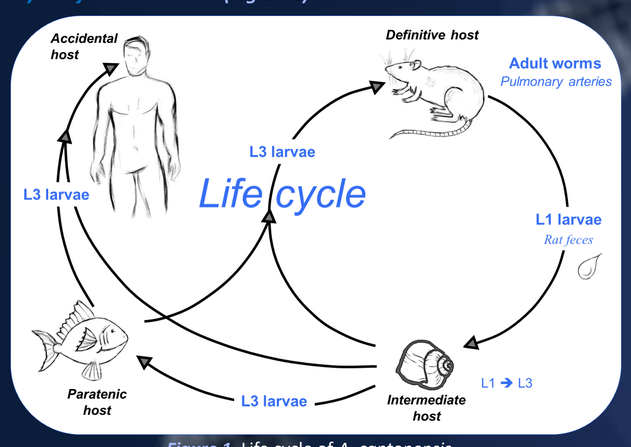


Figure 1. Life cycle of *A. cantonensis.*

Rats are definitive hosts. Intermediate hosts (snails and slugs) swallow 1st stage larvae excreted in rats feces. Humans become infected through food containing 3rd stage larvae. Food items may include uncooked snails or slugs vegetables contaminated with snails, slugs, or mollusc secretions (slime), or infected paratenic hosts (i.e., crabs, freshwater shrimp).

Geographic distribution: *(Figure 2)*

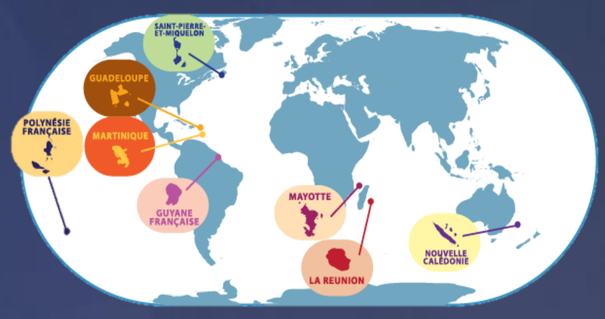
- Most human cases: Southeast Asia, Pacific Basin
- Also possible in some limited parts of Africa and both American continents
- In the Greater Antilles: recent emergence in Cuba, Dominican Republic, Jamaica
- In South America: recent emergence in Brazil and Ecuador
- In French Territories of the Americas (Guadeloupe, Martinique and French Guiana): no human cases documented so far

Figure 2. Geographic distribution of angiostrongyliasis human cases worldwide.
Adapted from Wang et al., Lancet Infectious diseases, 2008

✦ *French overseas territories included in the study*

Objectives

- ✓ Report the first cases of human angiostrongyliasis (HA) in the French Territories of the Americas (Guadeloupe, Martinique, French Guiana) & perform an investigation of the environmental presence of *A. cantonensis* in these territories.
- ✓ Provide an update of this disease in all French overseas territories (French Polynesia, New Caledonia, Mayotte Island, La Réunion Island)



Material & Methods

Clinical study. Between 1999 and 2017, all cases of eosinophilic meningitis in French Antilles and French Guiana were investigated using real-time-PCR of CSF or by detection of specific antibodies in sera and CSF. Descriptive analysis was conducted for clinical, biological and radiological features.
Concurrently, cases of HA already diagnosed in French Polynesia, New Caledonia, Mayotte Island and Reunion Island were retrospectively included in the study as far as the medical charts were available. Descriptive analysis was made for clinical, biological, radiological features and risk behavior related to each territory. Results are found in ***Table 1*****.**

Environmental study. Concurrently, 440 mollusks of 9 species (mainly *Achatina fulica* snails) were collected between 2014 and 2017 at different locations and periods and analyzed for carriage of parasites using real-time-PCR. Preliminary results are found in ***Table 2***.

Results

1. Clinical study

	French West Indies		South America	Indian Ocean		Pacific Basin	
	Guadeloupe Island [a]	Martinique Island	French Guiana [b]	Mayotte Island [c]	La Réunion Island [d]	New Caledonia	French Polynesia [e]
Year of first human case	1999	2002	2017	1996	1969	1951	1961
Number of reported cases before our study [period, years]	0	0	0	23 [1996 – 2012]	8 [1969 – 1998]	72 [1951 – 2008]	303 [1961 – 2012]
Cases reported during our study [period, years]	4 [1999 – 2017]	8 [2002 – 2017]	1 [2017]	7 [2013 – 2017]	0 (1 from Mayotte) [2017]	11 [2009 – 2017]	37 [2012 - 2017]
Mean annual incidence (case/ year)	0.22	0.47	1	1.4	0.1	1.3	7.4
Demographic characteristics							
Age (years)	2.2 [0.6 – 5.0]	24.3 [0.87 – 63.6]	10 [10 – 10]	1 [0.5 – 75]	3.5 [0.83 – 50]	36 [0.2 – 73]	29.5 [3 – 67]*
Sex (male)	25%	75%	100%	76.2%	100%	54.5%	43.8%*
Exposure risk (contact with snails, shrimps, mental disorders)	100%	62.5%	100%	58.3%	100%	100%	92.3%*
Main mode of transmission	*A. fulica* (snails)	*A. fulica* (snails)	*A. fulica* (snails)	*A. fulica* (snails)	ND	*A. fulica* (snails)	Raw shrimps, « Chevrettes » (Taioro, Mitihue)
Clinical presentation							
Meningeal syndrom	100%	100%	100%	23.5%	25%	0%	18.8%*
Focal neurological deficit	50%	87.5%	100%	88.2%	62.5%	72.7%	37.5%*
Laboratory tests							
Total WBC count (G/L)	14.1 [12.1 – 16]	10.0 [6.61 – 20.75]	12.3 [12.3 – 12.3]	ND	18.5 [11.3 – 24.0]	ND	ND
Eosinophilic count in blood (G/L) (% of WBC)	2.6 [2.3 – 3.6] (18.5% [17 – 25.5])	1.72 [0.49 – 6.43] (12.5% [5 – 31])	5.49 [5.49 – 5.49] (44.6% [44.6 – 44.6])	2.5 [0.1 – 8.4] (15.9% [1.0 – 33.3])	2.8 [1.7 – 5.4] (15.0% [15.0 – 22.0])	1.0 [0.0 – 3.1]	0.9 [0.1 – 2.9]*
WBC count in CSF	715 [190 – 3000]	505 [0 – 2280]	550 [550 – 550]	ND	1125 [300 – 1700]	260 [70 – 1100]	600 [1 – 1000]*
Eosinophilic count in CSF (/mm³) (% of WBC)	555 [84 – 2040] (56.5% [30 – 89])	74.5 [0 – 1550] (25.0% [4 – 68])	506 [506 – 506] (92% [92 – 92])	193 [3 – 690] (45% [5 – 76])	374 [0 – 1275] (47% [34 – 75])	70 [7 – 608] (21% [8 – 75])	161 [0 – 670]* 38% [0 – 67])
Glycorachia (mmol/L)	1.3 [0.91 – 2.8]	2.81 [0.1 – 4.3]	4.2 [4.2 – 4.2]	2.3 [1.1 – 3.5]	2.2 [1.9 – 7.0]	2.13 [0.54 – 6.32]	2.22 [1.28 – 3.72]*
Proteinorachia (g/L)	0.66 [0.21 – 1.1]	1.14 [0.33 – 1.71]	0.43 [0.43 – 0.43]	0.73 [0.22 – 1.69]	0.6 [0.3 – 0.65]	0.89 [0.6 – 5.96]	0.86 [0.22 – 3.35]*
Positive *A. cantonensis* PCR in CSF	100%	ND	100%	87.5%	ND	100%	62.5%*
Positive *A. cantonensis* serology in sera	100%	87.5%	100%	ND	100%	100%	ND
Detection of *A. cantonensis* antibodies in CSF	ND	100%	ND	ND	100%	100%	100%*
Management							
Length of hospital stay (days)	20.5 [10 – 35]	27 [15 – 66]	38 [38 – 38]	ND	17.5 [17 – 18]	10 [7 – 150]	4.5 [1 – 10]*
Corticosteroids	100%	62.5%	100%	70.6%	40%	44.4%	56.3%*
Anthelmintic therapy (albendazole or ivermectin)	100%	87.5%	100%	88.2%	80%	55.6%	0%*
Outcome							
Neurological sequelae (%)	25%	62.5%	0%	15%	0%	18.2%	25%
Death (%)	0%	12.5%	0%	25%	20%	0%	0%

Descriptive results are presented as n (%) and as median [min-max].

*Only the cases occurring in 2017 were statistically analyzed from French Polynesia.

ND: not determined

[a] Dard C *et al.*, AJTMH. 2017 ;
[b] Defo A *et al.*, EID. 2018;
[c] Epelboin L *et al.*, PNTD. 2016;
[d] Edmar A *et al*, Méd Mal Infect. 1999. / Graber D *et al.*, Arch pédiatr. 1997. / Petithory J et al., Bull Soc Pat Ex, 1977 / Badiaga S *et al.*, Bull Soc Pat Ex, 1993 / Picot H *et al.*, Acta Tropica, 1975;
[e] Oehler E *et al.*, Parasitol Int, 2014

Table 1. **Clinical presentation of the cases along with the biological, imaging and epidemiological features.**

2. Environmental survey

	French West Indies		South America
	Guadeloupe Island	Martinique Island	French Guiana
Number of collected snails	34	105	135	166
Number of species	1	1	9	3
Snails infected with *A. cantonensis*	11 (32.4%) (Fig. 4)	Currently being analysed (some snails are positive)	Currently being analyzed	Currently being analysed (some snails are positive)

Table 2. **First results of environmental evaluation.** The evaluation of the prevalence of *A. cantonensis* in the local mollusk population of French Territories of America is currently underway.

Figure 3. A. *A. fulica* snail collected in Martinique in June 2017. B. Overview of a part of molluscs collected in Martinique.

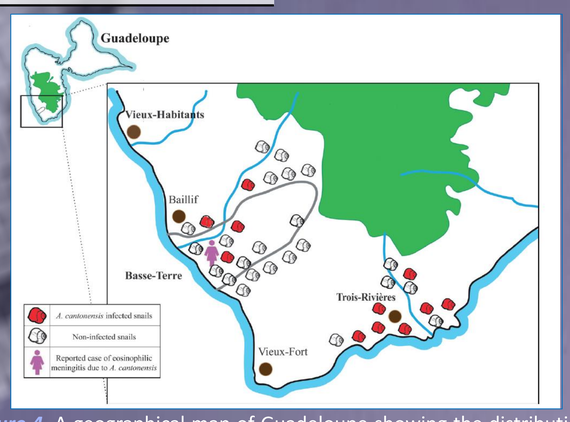


Figure 4. A geographical map of Guadeloupe showing the distribution of the first snails collected for environmental investigation in 2014 in Basse-Terre and Trois-Rivières cities. Among 34 *A. fulica* snails collected, 11 (32.4%) were positive by *A. cantonensis* by PCR. (Dard C. et al. AJTMH. 2017)

Discussion & Conclusion

This study:

- Reports for the first time of human angiostrongyliasis and environmental presence of *A. cantonensis* in Guadeloupe, Martinique & French Guiana: real emergence in the French Territories of America
- Presents an up-to-date analysis of HA cases in the others French Overseas Territories:
  - ➢ angiostrongyliasis is still a major public health problem in Indian Ocean and Pacific Basin
  - ➢ the incidence of the disease is strongly increasing in French Polynesia

Angiostrongyliasis disease in French overseas Territories

- Risk factors:
  - ➢ children playing in soil and with snails
  - ➢ adults with PICA syndrome and mental disorders; consumption of Taioro and Mitihu (raw shrimps & chevrettes) in French Polynesia
- Still a life threatening disease: sequelae from 0 to 62.5%, mortality from 0 to 25%

Angiostrongyliasis, an emerging public health problem?

- *A. fulica* is one of the most invasive mollusc species worlwide, particularly in the Americas
- Misknowledge of the disease: probably underestimate prevalence in all French overseas Territories
- Clinicians should strongly consider angiostrongyliasis when determining the causes of eosinophilic meningitis in the French Overseas Territories, particularly in the Pacific Basin

Preventive measures

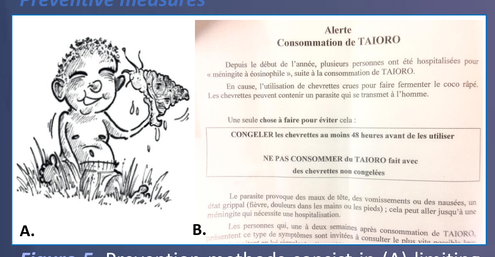


Figure 5. Prevention methods consist in (A) limiting exposure to snails and snails slime (B) avoiding the consumption of uncooked freshwater shrimps (i.e. chevrettes). Picture B is an alert displayed in supermarkets in Tahiti Island to prevent angiostrongyliasis meningitis.

Thanks to Max Sibille & Martin Peju for the pictures.

Where can A. cantonensis PCR or serology be performed?

PCR. Pasteur Institute of Guadeloupe; CH de Polynésie française, Papeete, Tahiti; CH de Mamoudzou, Mayotte, France; CH Territorial de Nouvelle-Calédonie, Nouméa, France; CDC laboratory, Atlanta, USA

Serology. Swiss Tropical and Public Health Institute, Basel, Switzerland

Acknowledgments