THE SPREAD OF *ANGIOSTRONGYLUS CANTONENSIS* IN AUSTRALIA

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Abstract. Until the recent establishment of *Angiostrongylus cantonensis* in North America, Australia was the only developed region endemic for this parasite. Almost 50 years ago the life cycle was elucidated there, in the city of Brisbane, and the first human infections probably occurred in 1959. From the 1970s, increasing numbers of autochthonous infections have been reported along the central east coast of the continent (southeast Queensland and northern New South Wales), involving humans, rats, dogs, horses, flying foxes and marsupials.

Ten years ago, the parasite was discovered in Sydney, almost 1,000 km to the south, in dogs. In that city, it has since been diagnosed as a cause of neurological disease in increasing numbers of dogs, flying foxes, marsupials and zoo primates. Presumably, these infections resulted from the ingestion of snails or slugs, and it seems that virtually all species of native and exotic terrestrial molluscs can serve as intermediate hosts.

It is not known how the parasite was introduced to this continent, or how it has spread over such an extensive territory, although eventually its range could encompass the entire east coast, and potentially other regions. It is also not known if the almost identical, native species, *A. mackerrasae*, is able to infect people (or other non-rodent hosts). All worms recovered to date, from one fatal human case, and from many animal infections, have been confirmed as *A. cantonensis*.

INTRODUCTION

The rat lungworm, *Angiostrongylus cantonensis*, is the primary cause of human eosinophilic meningoencephalitis throughout most of the Indo-Pacific region, and its range is extending within and beyond this locale (Beaver *et al*, 1984; Kliks and Palumbo, 1992; Prociv *et al*, 2000). It probably evolved with its hosts, members of the genus *Rattus* and closely related species, in Southeast Asia (Prociv *et al*, 2000). While the nematode's geographical spread has been linked to that of its most conspicuous intermediate host, the African giant land snail, *Achatina fulica*, the importance of this mollusc in the life-cycle is not known, and it is absent from many endemic areas; the parasite is not highly specific for its intermediate hosts (slugs and snails), and infected rats are the most likely vehicle for its dispersal.

Australia and this metastrongyloid nematode have a historical association - within 20 years of the parasite's discovery, in China, its life-cycle was elucidated in Brisbane (Mackerras and Sandars, 1954;1955), well before it was recognized to be a common human pathogen. Here, we outline the extending range of *A. cantonensis* in Australia, both geographically and in host animals.

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Historical outline

After its discovery in China (where still very little is known about the parasite's distribution), it was next found in the northeastern Australian state of Queensland, where the life-cycle was elucidated in *Rattus norvegicus* (Mackerras and Sandars, 1954;1955). Its human pathogenicity was confirmed in the early 1960s, by extensive epidemiological studies in the Pacific, but its greatest public health impact was found to be in Southeast Asia (Punyagupta *et al*, 1970, 1975; Yii, 1976). The reason for this belated recognition probably lies in the abundance of other infectious diseases in Asia, including systemic helminthiases (Rosen, 1979), that could mask the clinical presentation of angiostrongyliasis, and limited resources would have prevented a definitive diagnosis in most cases.

In Australia, *A. cantonensis* occurs only in the two exotic species, *Rattus rattus* and *R. norvegicus*, and not in the indigenous rat, *R. fuscipes*. When Bhaibulaya (1968, 1975) described *A. mackerrasae* as a distinct species, he had found it mainly in *R. fuscipes*, and only occasionally in *R. norvegicus* (sometimes co-habiting with *A. cantonensis*). Clearly, *A. mackerrasae* is an indigenous parasite, with a high degree of host-specificity – it has not yet been identified in any abnormal hosts (Prociv *et al*, 2000). Subsequently, in Malaysia, *A. malaysiensis* was also recognized as a distinct species whose invasive larvae migrated through the central nervous tissues of rats, attaining the L5 in the subarachnoid space. However, neither it nor *A. mackerrasae*, both with life-cycles virtually

identical to that of *A. cantonensis*, has yet been recovered from a patient, even though the former is suspected of causing human disease in Malaysia (Lim and Ramachandran, 1979) and neighboring countries (Carney and Stafford, 1979). Experimentally, *A. malaysiensis* has been shown to cause neurological disease in monkeys, while findings with *A. mackerrasae* were inconclusive (Cross, 1979).

Australian cases of human angiostrongyliasis were first reported in 1971, but might have occurred as early as 1959, in Brisbane (Prociv *et al*, 2000). Local surveys showed that *A. cantonensis* occurred in populations of exotic rats in pockets along the river, and that virtually all slugs and snails could be experimentally infected, including *Helix aspersa*, the exotic European garden snail (Yong *et al*, 1981). Elsewhere, this snail was reported to be an unsuitable host (Alicata, 1965), although in Sydney, it has been used successfully to transmit infection to rats (Prociv *et al*, 2000). *Achatina fulica* has not yet established in Australia, despite numerous interceptions in ports here (Prociv *et al*, 2000).

Imported human cases have been diagnosed in southern cities, but autochthonous angiostrongyliasis so far has been restricted to southeast Queensland and northern New South Wales (Prociv *et al*, 2000). However, the diagnosis has been presumptive in all cases (although supported in some by positive serology), except for two in which worms were recovered - extremely intense, lethal infections in young children, one from Fiji and the other from Brisbane, in whom numerous adult *A. cantonensis* were found at autopsy throughout the CNS and in pulmonary arterial branches (Cooke-Yarborough *et al*, 1999; Prociv, 1999).

Growing numbers of veterinary reports indicate that *A. cantonensis* accounts for most, if not all, non-human angiostrongyliasis in Australia. Natural infections were first recognized in dogs, in Brisbane, in 1972 (Mason *et al*, 1976), and several distinct clinical presentations have been characterized (Mason, 1987). The first natural infection in a marsupial was reported from a captive wallaby, *Macropus rufogriseus*, in Brisbane (McKenzie *et al*, 1978). Subsequently, in southeastern Queensland, natural infections have been confirmed in horses (Wright *et al*, 1991), captive rufous bettongs (*Aepyprymnus rufescens*) (Higgins *et al*, 1997), captive tamarins (Carlisle *et al*, 1998) and, sporadically, in free-living but neurologically-affected flying-foxes (*Pteropus* species)(Prociv *et al*, 2000).

In the meantime, the parasite was found in Sydney, 1,000 km south of Brisbane, first in young dogs from two separate locations, in June, 1989 and April, 1991 (although confirmed by autopsy in only one of these cases) (Collins *et al*, 1992). Since 1995, infection has been found in a wild brushtailed possum (*Trichosurus vulpecula*), small primates at Taronga Zoo (Prociv, 1999) and exotic rats trapped near the zoo (Prociv *et al*, 2000). In the Sydney metropolis recently, neurological disease affecting five captive grey-headed flying fox, *Pteropus poliocephalus*, was first attributed to lyssavirus infection until autopsy of three revealed severe EME, and male and female *A. cantonensis* were recovered from formalin-fixed brain (Redacliff *et al*, 1999). It is not clear how possums and fruit bats acquire infection, although in times of food shortage, they have been seen foraging on the ground beneath fruit trees, and slugs and snails often climb high into trees, especially during wet weather (Prociv *et al*, 2000).

CONCLUSIONS

While it remains a mystery how and when the parasite arrived in Australia, *A. cantonensis* has been a very successful colonist, reflecting the widespread pre-establishment here of its exotic murine hosts, and its ability to utilize numerous local molluscan intermediate hosts. For some time, its range seemed to be limited to the northeastern coastal regions, but the parasite has now become well established in the Sydney environs. However, even its means of arrival there are not clear: either it was imported in rats or snails from northern foci, or has simply extended its range by contiguous spread. Inevitably, human cases will be diagnosed in Sydney, but only when local clinicians become familiar with the manifestations of angiostrongyliasis.

This extensive southwards spread indicates a potential to establish anywhere on the continent that is ecologically suitable. Most coastal regions of Australia support well-established populations of exotic rats and a variety of terrestrial molluscs. Neurological disease as a result of infection in humans and other animals might inevitably follow.

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