A study in medical history: introduction of medicinal leeches into the West Indies in the nineteenth century

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ABSTRACT
Medicinal leeches were not found in the West Indies prior to 1822, but by the turn of the century, a large, aggressive leech abounded on Puerto Rico, St Lucia, Martinique and other islands. The authors conclude that this "Caribbean leech", described as *Hirudinaria* (*Poecilobdella*) *blanchardi* Moore, 1901, is a junior synonym of the "buffalo" leech *Hirudinaria manillensis* (Lesson, 1842), the medicinal leech of India and neighbouring countries of South-East Asia. The final proof of the true identity of this West Indian leech came from comparison of the nucleotide sequences of the cDNAs of the hirudin polypeptide from leeches from St Lucia and from Bangladesh. The authors present evidence that this leech arrived from ships carrying labourers from colonial India starting in the mid-1840's. Each of these ships were required to have leeches on board for medicinal purposes. During this study, the existence of a second introduced leech species in the West Indies was unexpectedly discovered, in Guadeloupe. The question remains open whether this second species is the medicinal leech intentionally introduced into Guadeloupe from Senegal by the French for breeding purposes in the 1820's.

KEY WORDS
Hirudinea,
Hirudinaria,
hirudin,
medicinal leech,
medical history,
West Indies.

RÉSUMÉ

Une étude d'histoire de la médecine : l'introduction des sangsues médicinales aux Antilles au dix-neuvième siècle. Les sangsues médicinales n'avaient jamais été rencontrées aux Antilles avant 1822, mais à la fin du siècle, une sangsue agressive, de grande taille, était abondante à Porto Rico, Sainte-Lucie, en Martinique ainsi que dans d'autres îles. La conclusion des auteurs est que cette « sangsue des Caraïbes » décrite comme *Hirudinaria* (*Poecilobdella*) *blanchardi* Moore, 1901 est un synonyme junior de *Hirudinaria manillensis* (Lesson, 1842), la sangsue médicinale d'Inde et des régions voisines du Sud-Est asiatique. La preuve définitive de la véritable identité de cette sangsue des Antilles est apportée par la comparaison des séquences de nucléotides du cDNA du polypeptide de l'hirudine des sangsues provenant de Sainte-Lucie et du Bangladesh. Les auteurs démontrent que cette sangsue est arrivée par les navires transportant la main-d'œuvre en provenance de l'Inde coloniale à partir du milieu des années 1840. Chaque navire devait avoir des sangsues à bord, à des fins médicinales. Au cours de cette étude, l'existence d'une deuxième espèce de sangsue introduite aux Antilles a été découverte en Guadeloupe. La question demeure de savoir si cette seconde espèce est bien la sangsue médicinale du Sénégal introduite intentionnellement en Guadeloupe par les Français dans les années 1820.

MOTS CLÉS
Hirudinea,
Hirudinaria,
hirudine,
sangsue médicinale,
histoire de la médecine,
Antilles.

INTRODUCTION

The introduction of a new animal or plant species can have profound consequences, especially on islands and other isolated ecosystems. Many of such introductions have occurred, but usually unrecorded, during the 300 years of active European colonisation when there were mass movements of people and materials to and from the New World. For example, yellow fever along with the mosquito *Aedes aegypti* (Linn.) was introduced into the Caribbean and other parts of the neotropical region aboard slave ships from West Africa in the seventeenth century (Taylor 1971). Clearly, it is of general interest for future environmental impact assessments to identify specific examples of heretofore unrecognised introductions of other bloodsucking animals. We document in this paper a rare example of the introduction of a medicinal leech into the West Indies in the nineteenth century and give evidence of yet another introduced leech.

On certain islands of the eastern Caribbean there abounds today a large medicinal leech species widely known as *Caribeobdella blanchardi*. It was described nearly a century ago and presumed to be unique to the New World (Moore 1901; Ringuelet 1976), having no near relatives whatsoever in the Western Hemisphere (Sawyer & Kinard 1980; Sawyer 1986: 736). In this multidisciplinary paper, we present molecular, morphological and taxonomic evidence for the first time that this remarkable West Indian species is in fact identical to *Hirudinaria manillensis* (Lesson, 1842), the medicinal leech of India and neighbouring countries of South-East Asia. In addition, we discovered in Guadeloupe that a leech also known by the specific name *blanchardi* represents an undetermined species of *Asiaticobdella* of African/Indian origin.

Current systematics recognises six species of "buffalo" leeches in the Hirudinariinae, a subfamily of the Hirudinidae characterised by the presence of a large vaginal caecum ("caecal pouch") in the female reproductive system (Sawyer 1986: 683-687). These six species are divided into two genera which are differentiated as follows: in *Poecilobdella*, the female reproductive system has a distinct "vagina" (termed "vaginal stalk" by some workers) and the male system lacks ejaculatory bulbs (Fig. 1B); whereas in *Hirudinaria*, the female system lacks an elongate "vagina" and the male system has ejaculatory bulbs (Fig. 1A). Five species occur naturally throughout tropical and

subtropical Asia from the western limit of the Indian subcontinent to the Pacific coast including numerous islands and archipelagoes. The sixth nominal species, "*Caribeobdella blanchardi*", was first described as being from Puerto Rico as *Hirudinaria* (*Poecilobdella*) *blanchardi* by Moore (1901).

We also address in this paper the question of when these leeches were introduced into the West Indies and by what mechanism(s). We document that no native medicinal leeches lived in the West Indies prior to 1822. Furthermore, there is no record of the existence of any leech resembling *Hirudinaria* on any of the West

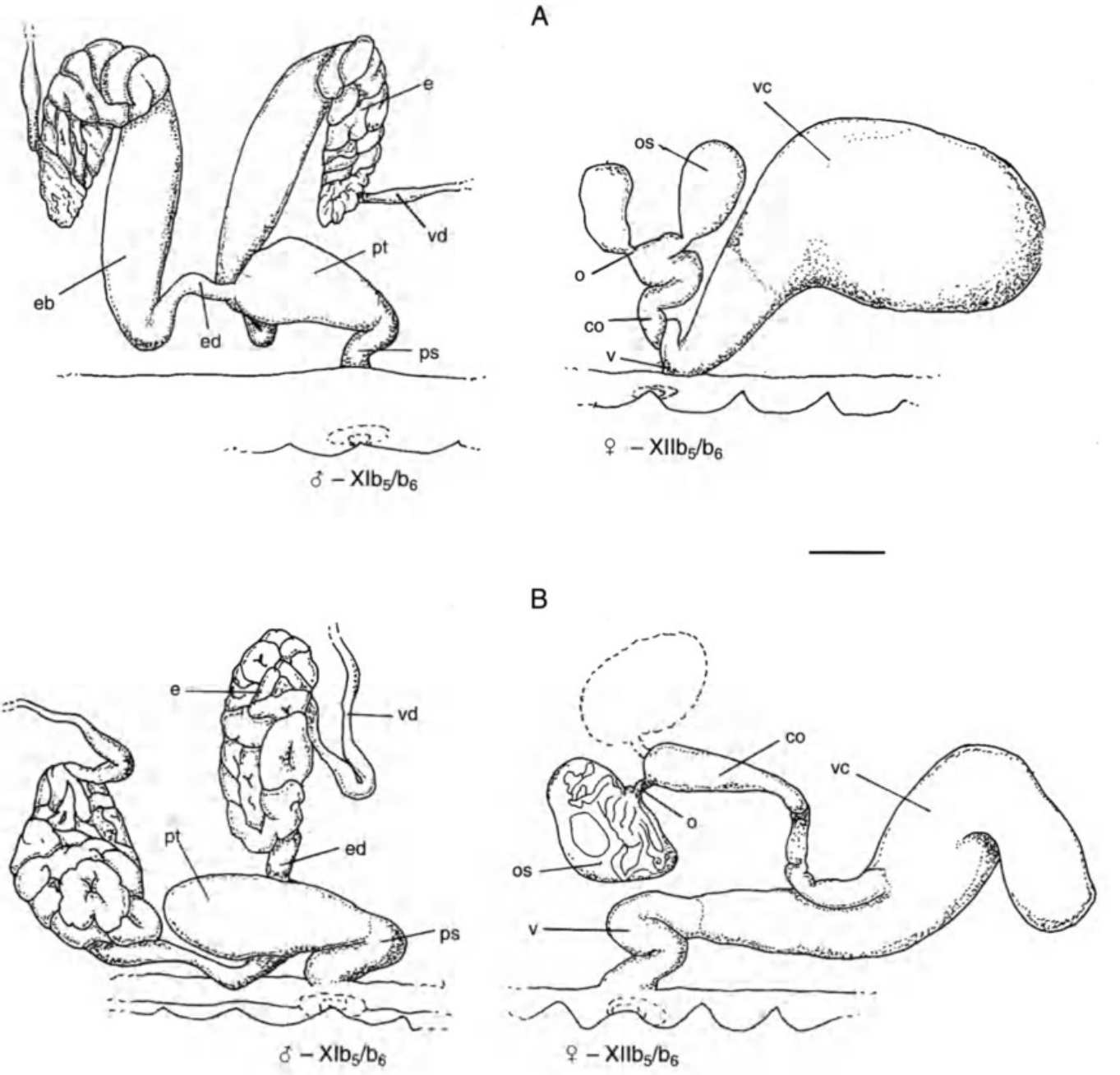


FIG. 1. — Comparison of taxonomically diagnostic features of the male (left) and female (right) reproductive systems of the two genera of "buffalo" leeches, *Hirudinaria* and *Poecilobdella*. **A**, *Hirudinaria manillensis* from St Lucia (the Martinique leech is the same, unillustrated); **B**, *Poecilobdella granulosa* from a dealer in "Madras area", India. See "Methods" for specific localities. **co**, common oviduct; **e**, epididymis; **eb**, ejaculatory bulb; **ed**, ejaculatory duct; **o**, oviduct; **os**, ovisac; **ps**, penis sheath; **pt**, prostate; **v**, "vagina" *sensu lato* (portion between common oviduct and female gonopore); **vc**, vaginal caecum; **vd**, vas deferens. Scale bar: 1 mm. Viewed from the left side, anterior to left. Note both species have a well-developed vaginal caecum.

Indian islands prior to 1827. However, starting in the mid-1840's ships taking emigrant labourers from India to various British and French islands of the West Indies were required to have leeches on board for medicinal purposes. Over a period of several decades these emigrant ships took on thousands of the Indian medicinal leech *Hirudinaria*, primarily at Calcutta and Madras. We conclude that, about the late 1840's, some of these leeches were released onto one or more islands and that their descendants are the leeches thriving today on St Lucia, Puerto Rico, Martinique and other islands. The capability of medicinal leeches to colonize very rapidly areas where similar species do not occur has been documented in Guadeloupe (Pointier *et al.* 1988).

Early records of medicinal leeches in the West Indies

The earliest account of medicinal leeches in the West Indies appears to be a report in 1817 by Dr John Williamson who recorded: "Practitioners in the West Indies labour under a great disadvantage, by not having leeches in that country. They have been sent there at a great expense; but they soon became sickly, and perished" (Williamson 1817: 361). The absence of leeches was later corroborated in 1822 by M. J. Achard, Government Pharmacist at Port Royal, Martinique, who recorded that there were no native species of leeches in Martinique which could be used therapeutically (Achard 1825). In 1827, however, Blainville tantalizingly described from Martinique a 4 cm leech with blood in its crop and other features of the Hirudinidae (Blainville 1827: 250; Moquin-Tandon 1846: 324). In 1893 Raphael Blanchard of Paris, the foremost leech taxonomist at that time, reported without further detail there was a species of "*Hirudinaria*" on Martinique, "whose presence in the Antilles is a real curiosity". In 1897 Blanchard went on to say, in reference to a discussion of "*Hirudinaria* (*Poecilobdella*) *granulosa*", an Asian species: "Also it is very interesting to find it in the Antilles, where it has been, without doubt, transported by man for medicinal purposes; discarded in the streams where it has acclimated. It is found in abundance in Martinique, where it is very prosperous [...]. We have received numerous live animals, in two batches [...]. One batch sent in 1891 by P. Vanhaecke, Superior du Séminaire-Collège de Fort de France [...]. In 1893 we received some from another source, one of which was very large, 245 mm in length. We know only by hearsay that it occurs on islands other than Martinique [...]." In 1901, a similar leech was described as a new species *Hirudinaria* (*Poecilobdella*) *blanchardi* by the eminent taxonomist J. Percy Moore of Philadelphia, from specimens from Puerto Rico. In 1934, Oka obtained specimens of the Martinique leech and compared it externally with what he considered to be the same species from Taiwan.

Early attempts to establish leeches in the West Indies

During the colonial period the medicinal leech *Hirudo medicinalis* Linnaeus, 1758 was very widely used for medicinal purposes throughout Europe, including their colonies (Sawyer 1981). From the beginning of the nineteenth century, medicinal leeches had become increasingly rare in Western European countries, most notably France and England, and had to be imported in large numbers to meet an enormous demand. In a single year, 1832, more than fifty-seven millions leeches were imported into France where they were used mainly in hospitals in the vicinity of Paris. Customs records document that during the nineteenth century more than one billion leeches were imported into France alone from eastern parts of Europe (Sawyer 1981). (Today *Hirudo medicinalis* is listed as an endangered species and accordingly protected worldwide by the CITES convention. While overcollection undoubtedly played a significant role, a full understanding of the factors underlying the decline of this and potentially other medicinal leech species worldwide is problematical).

In the meanwhile demand for medicinal leeches in the New World was growing faster than supply. Although the United States had its own native leech species, *Macrobdella decora* (Say, 1824), sometimes called the "American medicinal leech", it was generally recognized as inferior in that it made a more shallow bite and bled much

less (*e.g.* Wood & Bache 1867: 442). We now know the subfamily Macrobdellinae. *Macrobdella* Verrill, 1872 and allies endemic to North and South America have very reduced bleeding times compared with the true medicinal leeches *Hirudo medicinalis* and *Hirudinaria manillensis* of the Eastern Hemisphere (Munro *et al.* 1991), hence the need for the American colonists to import leeches. Accordingly, large numbers of *H. medicinalis* were imported into the United States from Europe throughout the eighteenth and nineteenth centuries and especially in the period before the American Civil War (Hagy 1991). Because of chronic supply and transportation problems, several serious attempts were made to breed *H. medicinalis* in the United States (Hessel 1881, 1884) but all such efforts failed. The same unsuccessful scenario also took place in the French West Indies.

Since the West Indies in the early nineteenth century did not have any native medicinal leeches, they were entirely dependent upon importation from abroad. At the time the French Antilles were, as was France itself, leech "manic" and had been importing thousands of *H. medicinalis* from Europe since at least 1814 (Achard 1825). On at least one occasion in 1822 the Antilles had even imported leeches, undoubtedly *Macrobdella decora*, from "Newfoundland" (Anonymous 1822).

In order to satisfy increasing demand, the French medical authorities, as early as 1822, made serious attempts to breed *Hirudo* in the French Antilles (Anonymous 1824; Achard 1825), including French Guyana on mainland South America (Conseil de Santé 1831). These attempts at breeding *Hirudo* are documented in various reports in the *Annales maritimes et coloniales* during the 1820's and early 1830's (see Berget & Rey 1874 for full bibliography) but were all unsuccessful.

In 1829 leeches were imported from the French colony of Senegambia in West Africa into the Antilles (*e.g.* Dupuy 1830; Calve 1830). The exact species involved is unclear (see Discussion). In any event, the leech species the authors of this paper collected in abundance in St Lucia, Martinique and Puerto Rico are distinctly members of the Hirudinariinae, a well-characterised subfamily which does not live in Africa. The bloodsucking ("hirudinid") leeches of Africa are very unlike *Hirudinaria manillensis*. No African leech, for example, has a "vaginal caecum" so characteristic of the Asian Hirudinariinae (Sawyer 1986: 684); however, we leave open the possibility that a leech species found today on Guadeloupe is of African origin (see Discussion).

By way of summary, during the 1820's the French imported three species of leeches into the French Antilles, including French Guyana. These were *Hirudo medicinalis* from Europe, *Macrobdella decora* from Newfoundland, and an unidentified hirudinid from Senegambia. None of these species represent the large leech *Hirudinaria manillensis* we collected in St Lucia, Martinique and Puerto Rico.

MATERIALS AND METHODS

Materials

We sampled accessible streams and ponds by slowly wading into the water, disturbing the mud in the process. Leeches were collected by hand or net while they swam near the water surface or while they attached to the bare legs of the collectors. Leeches were either taken alive to the laboratory for breeding and further studies or were preserved under field conditions with 5% formalin or 70% ethanol for later dissection and identification.

We examined preserved specimens from the Caribbean and from Asia in the Smithsonian Institution (Washington), Natural History Museum (London), Muséum national d'Histoire naturelle (Paris) and Institute for Zoological Taxonomy, Zoology Museum, University of Amsterdam. However, owing to uncertainties of labelling and constraints on dissecting old museum material, conclusions herein are based on specimens recently collected alive from nature by the authors or recently by colleagues.

Preserved specimens were pinned under alcohol and dissected from dorsal midline to reveal diagnostic features of male and female reproductive systems. The drawings were made freehand with the aid of an ocular micrometer. At least two mature specimens were dissected from each loca-

lity wherever possible. Dissected specimens are presently in the personal collection of the second author but will eventually be lodged with the Natural History Museum (London) and the Smithsonian Institution (Washington). Specimens of leeches collected alive in St Lucia, Martinique and Puerto Rico were examined externally in detail and then carefully dissected by F. O. P. Hechtel. Each was compared with specimens collected in Bangladesh, India, Philippines and other parts of Asia. The systematics follows that of Sawyer (1986). Sawyer (1986: 683) inadvertently stated that the Hirudinariinae have pharyngeal ridges terminating independently between the jaws. This not the case for any Hirudinariinae examined by us in the West Indies nor in Asia.

MOLECULAR GENETICS

To establish if the leech collected in St Lucia was identical to *Hirudinaria manillensis*, a genetic comparison was made of specimens from St Lucia with specimens from an Asian population of *H. manillensis*. Although *H. manillensis* occurs throughout South-East Asia we chose for this study leeches of this species from Bengal from which, according to historical evidence presented below, the West Indies leeches probably originated. We chose a population from Sylhet, Bangladesh, because it had been the basis of a prior molecular study (Scacheri *et al.* 1993). Toward this end arrangements were made to ship live specimens of *Hirudinaria manillensis* collected from Bangladesh to the laboratory of Biopharm (UK) Ltd in Wales. Similarly, Sawyer collected specimens from St Lucia in 1989 and maintained them alive in Wales. In 1990 Sawyer took live individuals from each population to the laboratory of the fourth author E. Scacheri, in Milan, Italy. Individual heads were dissected from the bodies, washed in 5 M NaCl, and quickly frozen in liquid nitrogen prior to storage at – 80 °C.

Total cellular RNA was prepared from leech heads essentially as described by Harvey *et al.* (1986). The reverse transcriptase reaction was carried out in a 40 µl volume as follows: 10 µg total RNA from leech heads was mixed with 1 µg oligo(dT) primer, 8 µl 5 mM dNTP mix and 8 µl reverse transcriptase buffer (250 mM Tris/HCl pH 8.3, 300 mM KCl, 50 mM MgCl2, 5 mM dithiothreitol), heated to 65 °C for 2 min and quickly chilled on ice. 10 U RNasin (Promega) and 20 U avian myeloblastosis virus reverse transcriptase (Boehringer Mannheim) were added, and the tube was incubated at 42 °C for 2 hours. The reaction mixture was phenol/chloroform-extracted, isopropanol-precipitated and resuspended in 60 µl sterile distilled water. Oligonucleotide primers were synthesized on an Applied Biosystems model 380B DNA synthesizer. To obtain the complete sequence of HM1 cDNA, three rounds of PCR amplification were performed. Amplified products were analyzed on 1.5% agarose gel, phenol-purified and ethanol-precipitated. For further details see Scacheri *et al.* (1993).

HISTORICAL RESEARCH

During the course of this study, we identified that the species from St Lucia, Martinique and Puerto Rico probably originated from the Indian subcontinent sometime in the last century. Accordingly, the question arose as to how and when the leech could have been imported from that far away region. The historical archives of this period in the Oriental and India Office Library, Blackfriars Road, London, and the Colonial Office (CO) records of the Public Record Office (PRO), Kew, London, were a rich source of information. Much of this archival research was conducted with the invaluable assistance of Mrs Betty Thomson, Richmond, Surrey. The third author J. W. Hagy documented the importation of leeches into the French West Indies in the 1820's, using archives of the British Library, London, as well as the Interlibrary resources of the University of Charleston. With funding from the University of Charleston, Hagy focussed on Indian emigration archives of the 1840's at the Oriental and India Office Library, London. Our research eventually focussed on the mass movement of indentured labourers in the 1840's from India following the emancipation of slaves on the West Indian islands. Archival evidence is presented below which documents that leeches regularly accompanied these labourers

HM1 St Lucia	TCAAAAG	ATG	TTC	TCT	CTC	AAG	TTG	TTC	GTT	GTC	TTC	CTG	
Amino acids		Met	Phe	Ser	Leu	Lys	Leu	Phe	Val	Val	Phe	Leu	
HM1 Bangladesh		ATG	TTC	TCT	CTC	AAG	TTG	TTC	GTT	GTC	TTC	CTG	
									↓				
HM1 St Lucia	GCT	GTT	TGC	ATC	TGC	GTG	TCT	CAA	GCA	GTG	AGC	TAC	ACT
aa	Ala	Val	Cys	Ile	Cys	Val	Ser	Gln	Ala	Val	Ser	Tyr	Thr
HM1 Bangladesh	GCT	GTT	TGC	ATC	TGC	GTG	TCT	CAA	GCA	GTG	AGC	TAC	ACT
	5					10					15		
HM1 St Lucia	GAT	TGT	ACG	GAA	TCA	GGC	CAG	AAT	TAT	TGT	CTA	TGC	GTG
aa	Asp	Cys	Thr	Glu	Ser	Gly	Gln	Asn	Tyr	Cys	Leu	Cys	Val
HM1 Bangladesh	GAT	TGT	ACG	GAA	TCA	GGC	CAG	AAT	TAT	TGT	CTA	TGC	GTG
			20					25					30
HM1 St Lucia	GGA	GGT	AAT	CTC	TGC	GGT	GGA	GGC	AAA	CAT	TGT	GAA	ATG
aa	Gly	Gly	Asn	Leu	Cys	Gly	Gly	Gly	Lys	His	Cys	Glu	Met
HM1 Bangladesh	GGA	GGT	AAT	CTC	TGC	GGT	GGA	GGC	AAA	CAT	TGT	GAA	ATG
					35					40			
HM1 St Lucia	GAC	GGT	TCT	GGA	AAT	AAA	TGC	GTC	GAT	GGG	GAA	GGT	ACT
aa	Asp	Gly	Ser	Gly	Asn	Lys	Cys	Val	Asp	Gly	Glu	Gly	Thr
HM1 Bangladesh	GAC	GGT	TCT	GGA	AAT	AAA	TGC	GTC	GAT	GGG	GAA	GGT	ACT
		45					50					55	
HM1 St Lucia	CCG	AAG	CCT	AAG	AGC	CAG	ACT	GAA	GGC	GAT	TTC	GAA	GAA
aa	Pro	Lys	Pro	Lys	Ser	Gln	Thr	Glu	Gly	Asp	Phe	Glu	Glu
HM1 Bangladesh	CCG	AAG	CCT	AAG	AGC	CAG	ACT	GAA	GGC	GAT	TTC	GAA	GAA
				60					65				
HM1 St Lucia	ATC	CCA	GAT	GAA	GAT	ATA	TTG	AAT	TAA	CGAACGCATAT			
aa	Ile	Pro	Asp	Glu	Asp	Ile	Leu	Asn	End				
HM1 Bangladesh	ATC	CCA	GAT	GAA	GAT	ATA	TTG	AAT	TAA	CGAACGCATAT			

FIG. 2. — Comparison of the nucleotide and deduced amino acid sequences of the cDNAs of the hirudin polypeptide variant HM1 from leeches from St Lucia and from Sylhet, Bangladesh. The arrow points to the signal peptidase cleavage site. The deduced amino acid sequence corresponds to the complete amino acid sequence determined from leeches from Bangladesh by peptide mapping analysis published elsewhere (Scacheri *et al.* 1993).

aboard ship for medical purposes on the long journey from India to the West Indies.

Since Mauritius in the southern Indian Ocean was a common port of call for such ships, Sawyer searched through selected back issues of the colonial newspaper *Le Cernéen, Journal de L'Île Maurice*, from 1833 to 1872 looking for evidence for the importation of leeches into this island during this period. This research was conducted in the reading room of the National Archives, DBM Complex, Petite Rivière, Mauritius.

RESULTS

TAXONOMY OF LEECHES FROM PUERTO RICO, MARTINIQUE AND ST LUCIA

Hirudinaria manillensis, the most common and widespread of the "buffalo" leeches of Asia, was originally described as being from the Philippine island of Luzon by Lesson (1842) (see also Harding & Moore 1927). In 1986, Hechtel collected specimens from this same island. Figure 3A shows the large vaginal caecum characteristic of the Hirudinariinae, as well as the presence of ejaculatory bulbs and absence of an elongate "vagina" characteristic of the genus *Hirudinaria*. Following detailed morphological examination, numerous specimens obtained from Bangladesh proved unequivocally to be *Hirudinaria manillensis* (Fig. 3B). [Hechtel noted that *Hirudinaria manillensis* is polymorphic, occurring in two main colour phases: a green phase (darkish green dorsum and paler green venter) and a reddish phase (dark reddish brown dorsum and paler brick-red venter). Though both phases occur together, at least in Asia, one phase predominates overwhelmingly in each population.]

The type specimens of *Hirudinaria* (*Poecilob-*

della) *blanchardi* could not be located and are presumed lost. This being the case, dissections (Fig. 3C) of specimens collected live from Puerto Rico revealed no significant differences between them and the Luzon and Bangladesh leeches. Specimens collected later from St Lucia (Fig. 1A) and Martinique (not illustrated) also proved to be the same species. Specimens from Puerto Rico, Martinique and St Lucia all possess the large vaginal caecum, ejaculatory bulbs and lack an elongate "vagina". On morphological grounds, we have no hesitation in assigning medicinal leeches of these three islands to the species *Hirudinaria manillensis*.

Molecular studies focussed on an inter-population comparison of the genomic organisation of the leech polypeptide hirudin, a well-characterised inhibitor of thrombin. As part of another study the thrombin inhibitor secreted by *H. manillensis* from the Bangladesh population was partially purified (Electricwala *et al.* 1991). Two variants were eventually found and sequenced, called HM1 and HM2, differing in ten amino acids in the central part of the molecule (Scacheri *et al.* 1993). The protein structure of the two hirudin variants include sixty-four amino acids with six cysteine residues, plus twenty residues which constitute the signal peptide required for extracellular secretion. This signal peptide is identical in both isoforms. Based on this structural information Scacheri and her colleagues were able to isolate cDNAs for both HM1 and HM2 by extraction of leech head RNA, subsequent DNA synthesis and PCR amplification. Furthermore, by cloning the genomic fragments of both variants they were able to elucidate for the first time the gene organisation of hirudin-like antithrombins from leeches (Scacheri *et al.* 1993). Fully active recombinant HM2 was then produced in *Escherichia coli* cells following transformation with a synthetic gene.

Having characterised the hirudin gene from the Bangladesh population of *Hirudinaria manillensis* in another study (Scacheri *et al.* 1993), Scacheri compared the same gene in leeches from St Lucia with that from Bangladesh leeches. Working at the DNA level it was unnecessary to sequence the hirudin protein, thereby greatly reducing the number of leeches required. Furthermore, an important feature of this technical approach is the ability of isolating PCR-amplified clones from total RNA preparations extracted from very few leeches, sometimes even from one leech head. For the St Lucia population research focussed exclusively on the cDNA of the best characterised isoform of hirudin (HM1). By way of summary of these data, Scacheri found that the nucleotide sequence for the HM1 cDNA from the St Lucia population was identical to that from the Bangladesh population (Fig. 2). This applied also to the nucleotide sequence corresponding to the twenty amino acid signal peptide. In this context, it is very interesting to note in terms of the rate of evolution that, although the St Lucia and the Bengal populations have been isolated for approximately 150 years, the hirudin gene is very highly conserved.

In conclusion, based on comparative morphology, as well as on comparison of the nucleotide sequence of the hirudin gene, we hereby designate the leech described originally as *Hirudinaria* (*Poecilobdella*) *blanchardi* Moore, 1901 from Puerto Rico, and found also in St Lucia and Martinique, as the junior synonym of *Hirudinaria manillensis* (Lesson, 1842) of the Philippines and other parts of South-East Asia.

SYSTEMATICS

Family HIRUDINIDAE Whitman, 1886
Subfamily HIRUDINARIINAE Sawyer, 1986
Genus *Hirudinaria* Whitman, 1886

Hirudinaria manillensis (Lesson, 1842) (Figs 1A, 3)

? *Hirudo Martinicensis* Blainville, 1827: 250 (Martinique). (Not *Hirudo Martinicensis* Moquin-Tandon, 1826: 139).

Hirudo manillensis Lesson, 1842: 8 (Philippines, type material could not be located).

? *Hirudo Unicolor* Moquin-Tandon, 1846: 324 (new name for *Hirudo Martinicensis* preoccupied).

Limnatis (*Poecilobdella*) *granulosa* – Blanchard 1893: 28 (undissected); 1897: 345 (undissected).

Hirudinaria (*Poecilobdella*) *blanchardi* Moore, 1901: 214, pl. 12 (Puerto Rico, type material could not be located).

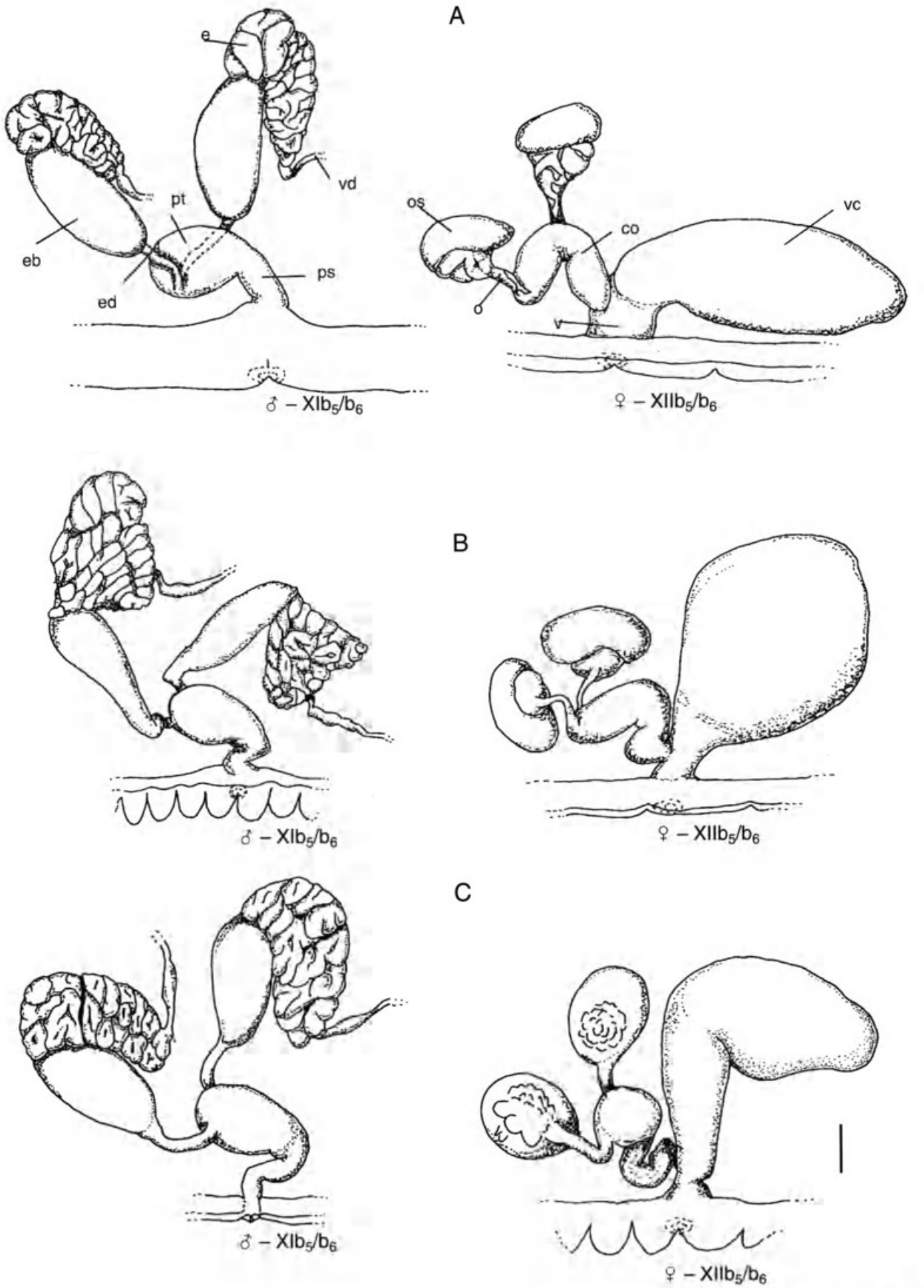


FIG. 3. — Comparison of taxonomically diagnostic features of the male (left) and female (right) reproductive systems of "buffalo" leeches collected from Asia and the West Indies. See "Methods" for specific localities. **A**, *Hirudinaria manillensis* from Luzon, Philippines (type locality); **B**, *Hirudinaria manillensis* from Bangladesh; **C**, *Hirudinaria manillensis* from Puerto Rico. Scale bar: 1 mm. See Fig. 1 for key to labelling and orientation.

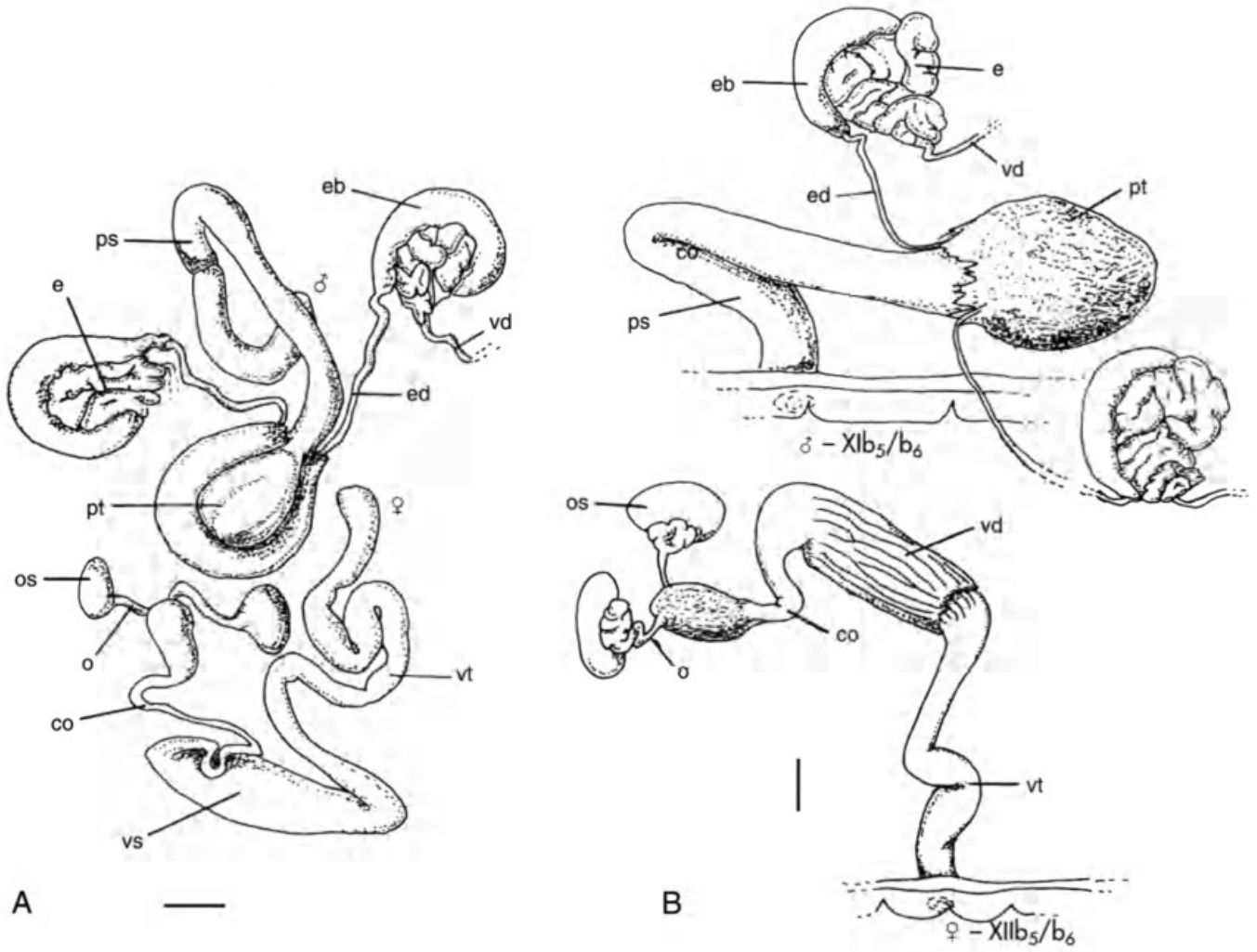


FIG. 4. — Comparison of taxonomically diagnostic features of the male (upper) and female (lower) reproductive systems of two species of the genus *Asiaticobdella*; **A**, *Asiaticobdella fenestrata* from Gambia, viewed from dorsal side, anterior to top; **B**, undetermined species of *Asiaticobdella* from Guadeloupe, viewed from the left side, anterior to left. See Discussion for specific localities. **vs**, vagina "*sensu stricto*"; **vt**, vaginal duct (or "stalk"). See Fig. 1 for key to other labelling. Scale bars: 1 mm. Note neither species has a vaginal caecum.

Limnatis granulosa – Oka 1934: 286, fig. (externals) (undissected).

Caribeobdella blanchardi – Ringuelet 1976: 13.

"*Poecilobdella*" *blanchardi* – Sawyer & Kinard 1980: 84 (Puerto Rico, dissected; Antigua and Haiti, undissected).

Hirudinaria manillensis – Sawyer 1986: 687, fig. 18.9E.

MATERIAL EXAMINED. — **Philippines.** Calumpang, Laguna, 14°10'N - 121°18'E, November 1986, collected by F. O. P. Hechtel.
Bangladesh. Sylhet, 24°53'N - 91°51'E.
Puerto Rico. SW Puerto Rico, Cartagena Lagoon, 27.VIII.1973, collected by J.W. Miller and I. Pomales, Department of Marine Sciences, U.P.R. Mayaguez, P.R. 00708.
St Lucia. Cattle pond 2/3 miles south of Micoud, 13°48.2'N - 60°55.8'W, September 1989, collected by R. T. Sawyer.
Martinique. Small stream, Tributary of Lazarde River, Route du Vert-Pré, Lamentin, 29.V.1998, collected by J. Vaubon.

Genus *Poecilobdella* Blanchard, 1893

Poecilobdella granulosa (Savigny, 1820)
(Fig. 1B)

Sanguisuga granulosa Savigny, 1820: 115 (type locality: Pondichéry, India).

Poecilobdella granulosa – Sawyer 1986: 687, fig. 17. 16B.

MATERIAL EXAMINED. — **India.** — Specimens supplied by a dealer in the "Madras area", 1984. — Specimens obtained in 1997 by Dr Ramesh Yadav from a Bombay dealer who reported they had been collected by the "Adivasi" people from the lakes near the city of Baroda, Gujarath State, India.

Subfamily HIRUDININAE Richardson, 1969
Genus *Asiaticobdella* Richardson, 1969

Asiaticobdella sp.
(Fig. 4B)

Hirudinaria blanchardi – Pointier, Théron & Imbert-Establet 1988: 38 (Guadeloupe, undissected).

MATERIAL EXAMINED. — **Guadeloupe.** Specimens purchased by R. T. Sawyer in the market at Pointe-à-Pitre, Guadeloupe, in August 1995. — Specimens collected alive on 6.II.1997 in little ponds to the north of the airport, west of Abmes, by N. Barré.

Asiaticobdella fenestrata (Moore, 1939)
(Fig. 4A)

Limnatis fenestrata Moore,1939: 343, pls 27, 28 (type locality: Botswana).

Asiaticobdella fenestrata – Sawyer 1986: 776, 777, fig. 18.14D.

MATERIAL EXAMINED.— **Gambia.** Live specimens acquired in July 1993 from a sacred crocodile pool at Katchikaeli (13°28'N - 16°40'W) in coastal Gambia, close to the southern bank of the Gambia River at its mouth, through the kindness of C. M. Moiser.

Researchers are cautioned that medicinal leeches in the West Indies cannot be distinguished from external characters alone and precise identifications must be based on dissection of the reproductive systems. To avoid confusion, researchers are advised to detail the nature of the reproductive system when making identifications, according to the following simplified key. It cannot be ruled out that more than one species of medicinal leech lives on any of the islands.

SIMPLIFIED KEY TO THE MEDICINAL LEECHES IN THE WEST INDIES

1. Vagina with a large caecum ("caecal pouch") (Fig. 1: vc) 2

— Vagina lacking a large caecum (Fig. 4B) ..... *Asiaticobdella* sp.
Known from Guadeloupe

2. Female reproductive system has a distinct "vagina" (elongate portion between the female gonopore and the common oviduct); male system lacking ejaculatory bulbs (Fig. 1B) ..... *Poecilobdella granulosa* (Savigny, 1820)
Not recorded from the West Indies

— Female reproductive system lacks an elongate "vagina"; male system with ejaculatory bulbs (Fig. 1A) ..... *Hirudinaria manillensis* (Lesson, 1842)
Known from Puerto Rico, Martinique and St Lucia

DISCUSSION

MECHANISM OF TRANSPORT OF LEECHES FROM INDIA TO THE CARIBBEAN

The leech on St Lucia, Martinique and Puerto Rico is actually the Asian medicinal leech *Hirudinaria manillensis* which appeared on the islands in the middle of the nineteenth century. To try to explain how the leech could have been introduced, we started looking for historic

connections, especially medical, between the West Indies and South-East Asia at about this time. We discovered a significant connection in the emigration of a large number of labourers from India into both the British and French islands (see Thomas 1985 for further background).

The economy of the West Indian colonies was largely built on sugar. This required heavy labour and African slaves were brought in for this purpose. In England the Emancipation Act of 1833 provided for the gradual freedom of the slaves in the colonies, this having been completed by 1838. To replace the slaves, the West Indian planters turned to India for immigrant labour. After some false starts amidst controversy with abolitionists, the Colonial Office in 1844 approved a scheme for indentured Indian emigration, wholly managed by the English government in order to protect the health and safety of the labourers. The emigrants were promised return passages to India after five years. In 1845 two shiploads of Indians reached British Guyana, and one ship each went to Jamaica and Trinidad. The voyage from Calcutta to Trinidad took between eighty-five and ninety-two days, typically stopping at Cape of Good Hope or St Helena. By further example, Captain J. H. Wilson, West India Emigration Agent, dispatched twelve ships in the 1845-1846 season and seventeen ships in 1846-1847, varying in passengers number from 203 to 423 (Public Record Office 1847: 158).

Because of a disruption following the Sugar Duties Act of 1846, large scale emigration from India was not again fully underway until 1851. In the 1850's the Windward Islands were allowed to recruit small numbers of Indian labourers on the usual terms, permission being granted to Grenada in 1856, St Lucia in 1858 and St Vincent in 1861. These small islands requested indentured labour only irregularly and in small numbers. For example, during the emigration period to St Lucia from 1859 to 1869, the English landed 4354 Indians from Calcutta.

The French emancipated their slaves in 1848 and an acute shortage of labour resulted in the colonies. The planters were very conscious of the example set by the English colonies (and the French island of La Réunion in the Indian Ocean). In 1852, an immigration law was passed providing officials to supervise recruiting and to look after the welfare of emigrants. Consequently the Compagnie Générale Trans-Atlantique artanged to supply 2000 or 3000 Indians each year. In 1854, an Immigration Committee was set up to control the whole operation. Subsequently, a full code of immigration regulations appeared as laws in 1855 and 1859 which made the rudimentary protective organization much more elaborate and efficient. The Compagnie Générale Maritime contracted to supply Martinique with 1500 Indians over four years.

The English government sought to persuade France to give up recruiting in Africa and in 1861 agreed to let the French colonies recruit labour in British India on much the same terms and under the same regulations as did the English colonies (Parliamentary Papers 1861). Some Indians had been brought in by the French in the 1850's, over 9500 into Martinique and perhaps 1000 into Guadeloupe from the French Indian territories of Pondichéry and Chandernagore. But these territories could supply only limited numbers, so British India became the recruiting ground. Altogether, between 1853 and the termination of the agreement with England in 1885, 25509 Indians were landed in Martinique, embarking mostly from Calcutta and Pondichéry. In Guadeloupe, until 1861, most of the migrants, mainly Tamil, originated from South India (mainly Pondichéry). From 1873 this stream became secondary compared with the Calcutta region (Centre d'Études 1982). From 1856 to 1889 over 40000 Indians landed in Guadeloupe.

In order to ensure the health of the emigrants, Her Majesty's Colonial Land and Emigration Commissioners enforced strict conditions and medical requirements onto the contractor of each shipload of emigrants (Public Record Office 1847). As shown below, each ship from India taking emigrants to the West Indies from the mid-1840's to the early 1870's was required to have leeches on board for medicinal purposes. Based on the following historical evidence, we propose this was the most probable mechanism by which *Hirudinaria manillensis* came to be in St Lucia and other islands of the West Indies.

From British India: Calcutta and Madras

The records of the Public Record Office (PRO) and the Oriental and India Office in London include the following observations, relevant to our study. For administrative reasons, the British ships transporting Indian emigrants to the West Indies embarked almost exclusively from either Calcutta or Madras (Public Record Office 1847). In order to ensure the health of the emigrants, Her Majesty's Colonial and Emigration Commissioners enforced strict conditions and medical requirements on the contractors (Public Record Office 1847). Each ship was required to have a list of medical supplies before embarkation. In 1847, this "List of Medicines and Medical Comforts" included one hundred leeches for up to 100 emigrants, to be increased by 50 for each 100 emigrants beyond 100 (Public Record Office 1847: 21). From the example of Captain J. H. Wilson given above, his twelve ships would have transported toward the West Indies a total of approximately 2 000 Indian leeches in the 1845-1846 season, and similarly his seventeen ships would have carried approximately 3000 leeches in the 1846-1847 season. Interestingly, these particular ships originated from Madras and were bound for British Guyana, Trinidad and Jamaica, none of which appears to harbour the leech today.

The leeches had to originate "fresh" at the port of embarkation of Calcutta or Madras and "not England". In a letter dated 10 March 1847 to the West India Emigration Office, Madras, the same Captain J. H. Wilson recommended "that a clause be introduced in the Charter strictly enjoining that vessels shall purchase every article of provision required by the regulations fresh at the port of embarkation" (Public Record Office 1847: 337). Similarly, in the Emigration Commissioners' official "Tender for the Conveyance of Indian Emigrants to the West Indies" dated June 1847, item eight records "[...] and also a supply of Medicine and Medical Comforts according to the annex [...]. Provided always, that all articles of Provisions for the use of the Emigrants shall be provided and put on Board in India and not in England" (Public Record Office 1847: 21). In other words the leech species in question originated in British India, *i.e. Hirudinaria* and therefore certainly would not have been the European medicinal leech *Hirudo medicinalis* which does not live in the Indian subcontinent (Sawyer 1986: 571).

Records show that medicinal leeches were required to be on board emigrant ships from 1847 to 1871. In the 1856 "Rules for Regulating all Matters Connected with Emigration from Madras to the West Indies" 500 leeches were required for 50-100 emigrants (India Office 1856: 17). The 1859 "Revised Rules Re Coolie Emigration Including a List of Medicines" required 50 leeches per 100 persons; 75 per 200 persons; 100 per 300 persons; and 100 per 350 persons (Public Record Office 1859: 36). The 1864 "Rules for the Guidance of the Protector of Emigrants in Calcutta" required 50 leeches per 100 persons; 75 per 200 persons; 100 per 300 persons; and 100 per 350 persons (India Office 1864: 4). The 1871 "Emigration from the Port of Madras. Rules under Act of 1871" required 50 leeches per 100 persons; 75 per 200 persons; 100 per 300 persons; and 125 per 400 persons (India Office 1874). In the same year the 1871'schedule 3 "The Medicines, Rules Under Act VII (The India Emigration Act)" required "leeches" but no numbers were specified (India Office 1872: 394). Interestingly, the 1883 "Rules Relating to Emigration from Calcutta" required "one sixteen oz blood porringer" but no mention of leeches (India Office 1884). We have not found any record of the actual medical use of leeches on board these emigrant ships, but such records are to be expected since each ship's surgeon was required to keep a medical diary.

A few records document that leeches were used medicinally in the Caribbean region about this time. Leeches were used successfully following arterial surgery in the Hospital of St Felipe and Santiago, Havana, in 1849 (Wills 1849: 148, 149). Dr Hector Gavin MD FRCS, Lecturer on Forensic Medicine at Charing Cross Hospital, London, in his 1851 report regarding a recent outbreak of Yellow Fever in Surinam, enclosed a translation of a report by the Dutch Medical Officer H. Schomnberg of 5 September 1851 on the treatment of Yellow Fever near Paramaribo, Surinam. Leeches were part of the treatment: "leeches [...] generally proved very

beneficial [...]" and "[...] Leeches produced a very satisfactory result" (Public Record Office 1851).
In France and England, the use of leeches reached a peak about 1820-1845 and gradually fell out of favour by the 1870's (Sawyer 1981). Bloodletting, but not necessarily leeching, continued on British ships up to the 1880's and 1890's and probably later, but the practice was becoming suspect. For example, Acting Assistant Surgeon M. Elphington Greany of HMS *Vestral* in 1869-1870 recorded the following: "[...] Dr. Bellot, a great Havana authority on Yellow Fever, is accustomed, I understand, to bleed in almost all cases, if seen in the early stage, and I myself have been advised in Port-au-Prince to use the lancet, but I saw no case in which it would be allowable to do so. I should rather fancy that such a proceeding would be fatal to any chance of a patient's recovery" (Public Record Office 1870).
Although we have documented that thousands of Indian medicinal leeches *Hirudinaria* were transported to the West Indies from the mid-1840's to the early 1870's, the final fate of these leeches is so far undocumented. We are aware that: "Ship's surgeon shall receive charge of medical stores. He must ascertain quality and that the supplies are not short. On arrival at the port of debarkation the surgeon is to deliver the balance of medical stores to the Emigration Agent at that port with a statement of issues during the voyage" (India Office 1864: 4). We propose that some of the *Hirudinaria manillensis* ended up in local water and established themselves.

From French India: Pondichéry

Apart from the account above of labourers going to Martinique and Guadeloupe from Pondichéry, and later from Calcutta in cooperation with the English emigration policy, we have not found direct evidence that leeches were put on board in Pondichéry for ships destined to the West Indies. Moquin-Tandon (1846: 341) did record that a medicinal leech, which he called "*Hirudo granulosa*" was "employed by the doctors of Pondichéry". In an 1857 report from the India Board to the British Colonial Office regarding Indian emigration on board British ships from Pondichéry to French colonies in the West Indies, a list of required medicaments did not specify leeches (Public Record Office 1857: 318). However, Leuckart and Brandes claimed, unfortunately without giving any further detail, that *Hirudinaria* at one time "was shipped out of India (Pondichéry) in large quantities to the islands of Bourbon and Mauritius" in the Indian Ocean (Leuckart & Brandes 1901: 879). Interestingly, under the Convention with the French, the British in 1862 transported over 4500 Indians into La Réunion from Calcutta and Pondichéry (Public Record Office 1862).

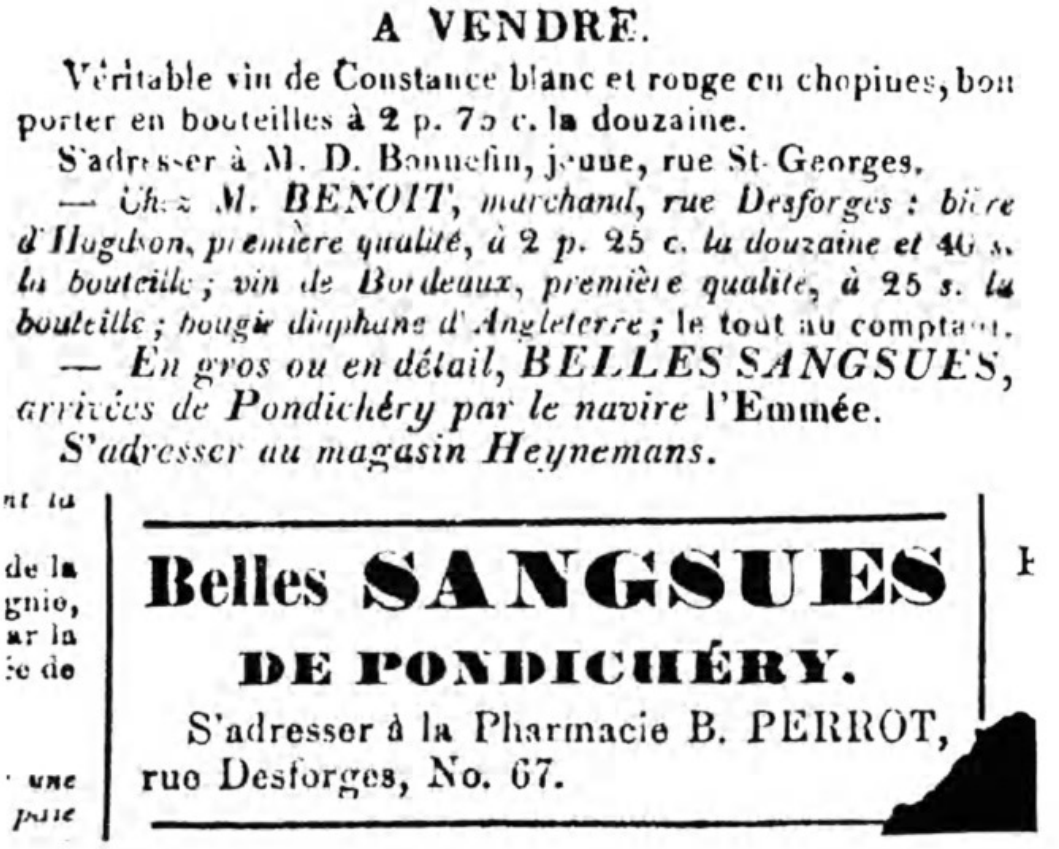
Leech Importation into Mauritius

The economic and social history of Mauritius in the southern Indian Ocean is remarkably similar to that of islands of the French West Indies. In 1997 Sawyer visited Mauritius to determine whether medicinal leeches had been imported into the island in the past and whether the leech may have escaped, as in the West Indies (Sawyer in press). By searching through advertisements in the colonial newspaper *Le Cernéen, Journal de l'Île Maurice*, clear evidence was found that for at least the forty year period from 1833 to 1872, large numbers of leeches were intentionally imported from Pondichéry into Mauritius by local pharmacists for medicinal purposes (Fig. 5). A selection of such advertisements follows:

31 mai 1833. "Chez M. Grosjeau neveu, rue St George : belles sangsues de l'Inde arrivées par l'*Antoinette*."
Note: on 11 June 1833 "Arrivages [...] La barque l'*Antoinette*, capit. Colin, partie de Madras, et de Pondichéry le 15 avril ; cargaison riz et diverses marchandises. Passagers vingt Indiens."

2 mars 1848. "Belles Sangsues de Pondichéry, à 1 p. la douzaine. S'adresser à M. Guiot ou à M. E. Fleurot."
Note: previously recorded ships from Pondichéry, reported on 22 February 1848: (a) Brig. "*Mauritius Packet*" from Pondichéry, 12 January, "with sundries for this port"; and (b) Bark "*East Anglian*" from Pondichéry, 18 January, "with sundries for this port".

25 avril 1872. "Belles Sangsues de Pondichéry s'adresser à la Pharmacie B. Perrot, rue Desforges, n° 67."
Note: this street now is Sir Seewoosagur Ramgoolan St, Port Louis.



A VENDRE.

Véritable vin de Constance blanc et rouge en chopines, bon porter en bouteilles à 2 p. 75 c. la douzaine.

S'adresser à M. D. Bonnefin, jeune, rue St-Georges.

— Chez M. BENOIT, marchand, rue Desforges : bière d'Hugdson, première qualité, à 2 p. 25 c. la douzaine et 40 s. la bouteille ; vin de Bordeaux, première qualité, à 25 s. la bouteille ; bougie diaphane d'Angleterre ; le tout au comptant.

— En gros ou en détail, BELLES SANGSUES, arrivées de Pondichéry par le navire l'Emmée.

S'adresser au magasin Heynemans.

Belles SANGSUES

DE PONDICHÉRY.

S'adresser à la Pharmacie B. PERROT, rue Desforges, No. 67.

FIG. 5. — Representative advertisements by pharmacists in Port Louis, Mauritius, in the colonial newspaper *Le Cernéen, Journal de L'Île Maurice*. Top: 6 December 1833. Bottom: 25 April 1872. Leeches sold in pharmacies in Mauritius in the southern Indian Ocean were imported from Pondichéry, India, for over forty years.

No evidence was found that some of the ships carrying leeches from Pondichéry went on to the French West Indies to supply medical demand, but that possibility must be left open. Unfortunately, the species of leech imported into Mauritius from Pondichéry in the nineteenth century remains as yet undetermined

Although many medicinal leeches were indeed imported into Mauritius, there is no evidence that the leech species in question escaped and established itself in the wild. Quite the contrary while several leech species were collected on the island, no bloodsucking species at all were encountered (Sawyer 1997, personal observation). Local people very familiar with the wildlife of Mauritius were unanimous in confirming that no bloodsucking leeches occur on the island today.

MEDICAL ETHNOLOGY

Leeches were enormously valued for medical purposes in the last century and practitioners were highly motivated to acquire them. Since the medical need for leeches undoubtedly motivated their importation into the Caribbean area in some numbers, an ethnological assessment of the current medical use of leeches in this region is relevant to this study. Sawyer carried out numerous interviews of local people on various West Indian islands, as well as French Guyana, Surinam and Mauritius. Of much value were the local markets where leeches were still being sold in recent times. Whenever possible such market leeches were purchased for later identification. A more formal medical ethnological study was undertaken in rural St Lucia, where in-depth interviews were conducted by Sawyer with six local people recognized as "healers" by the St Lucia National Trust. The latter study was carried out in French patois in September 1989 with the invaluable assistance of Mr. Laurent

Jean Pierre of the St Lucia National Trust, Castries. Historical evidence presented above suggested that the St Lucia leech may have originated from Bengal, where it had been used medicinally in the last century. To learn more Sawyer went to Dhaka, Bangladesh in July 1992, where he conducted extensive interviews with local street vendors who were still selling *Hirudinaria manillensis* for medicinal purposes in time immemorial tradition.

Locally collected leeches were still being sold for medicinal purposes on some of the islands of the West Indies, including the main markets in Castries, St Lucia (1989), Fort-de-France, Martinique (1993, but not by 1998) and Pointe-à-Pitre, Guadeloupe (1995). As late as 1976 medicinal leeches were being sold in at least one pharmacy in Cayenne, French Guyana, but by 1993 no pharmacist contacted in Cayenne was aware of anyone using leeches anymore in French Guyana (Sawyer personal observation).

In St Lucia (1989) much effort was made to interview market sellers, local practitioners and recipient users of leeches in urban as well as in remote regions. Today, these are almost exclusively people of African descent who speak French patois as their first or only language, even on this nominally "British" island. In the Castries market more than one vendor sold leeches ("sansi" corrupted from the french "sangsues"). Leeches, reportedly from Dennery, were purchased from one vendor and later identified definitely as *Hirudinaria manillensis*. The market leeches were in any sort of bottle, which invariably had a piece of charcoal at the bottom. One seller explained (erroneously) the leeches "ate the charcoal" which could be "dried and re-used". Most people seemed to be aware of leeches and their medicinal use, and usually knew a relative who had used them some time in the past. Several people made the comment that leeches were less commonly used now than a couple of generations ago. One young man said his grandmother "used to keep them around her house". Leeches were used sparingly, but for appropriate conditions, such as for "black eyes", "swollen feet", "boils", "blood poisoning" and "snake bite". Some were applied "to the back" for undiagnosed conditions, and one young woman's grandfather reportedly had leeches applied several times a week for a while for some undiagnosed conditions. Leeches apparently were not used for eye complaints except black eyes. They could be re-used by placing salt on them and squeezing out the blood. One intelligent old man recognised as a local "healer" volunteered that his grandmother told him that ethnic Indian people (*i.e.* from India) were "the best users of leeches". This same observation was made by a French scientist in St Lucia in reference to Guadeloupe. Several people observed that leeches were less abundant now than when they were young. They attributed this decline to the "pesticide being used to treat nematodes", and to "banana irrigation". It was reported several times that more than one species of leech lives in St Lucia ("one does not bite" by one account, and "one very aggressive but not so good; the slow sucking one better" by another account). Sawyer could not confirm a second hirudinid species in St Lucia from his limited field studies there. One well-traveled St Lucian observed that leeches were more abundant in St Lucia than in any of the other islands. Sawyer can certainly confirm that leeches, identified as *Hirudinaria manillensis*, were locally very common in St Lucia in September 1989. (Sawyer was reliably informed, but has not yet confirmed, that leeches occur and are also used medicinally on Dominica and Granada).

Most of the West Indies today is populated mainly by people of African descent, and many aspects of the culture reflect this African heritage. In a separate on-going study, Sawyer has found no evidence that live leeches were ever used in traditional medicine in black Africa. At the same time, it is well-documented that bloodletting and cupping were, and continue to be, widely practiced there (*e.g.* Livingstone 1857: 129, 130). In contrast, the medicinal use of leeches was commonplace to French and British colonists, as well as widely practiced by people of the Indian subcontinent. The so-called "buffalo" or "cattle" leeches have been used medicinally for over two thousand years in the Indian subcontinent, a practice which continues today. On the streets of Dhaka, Bangladesh, the species used is *Hirudinaria manillensis* (Sawyer 1992, personal observation). Leeches are still commonly used in

the traditional (Ayurvedic) hospitals and clinics of Bombay on the west coast of India. Some specimens of the leech used clinically in Bombay were sent to Hechtel for identification by Dr Ramesh Yadav and were found to be *Poecilobdella granulosa*. Leeches of an undetermined species are reportedly still being used in the villages in the hinterland of Sri Lanka (Sawyer 1995, personal observation).

The use of these large, aggressive leeches is described in considerable detail in Chapter XIII of the *Susruta Samita* which records the ancient Ayurvedic form of Indian medicine (Bhishagratna 1963: 98-105), dating back by some accounts to 200 BC. One would expect these people to bring this tradition with them to the West Indies, bearing in mind that the Europeans had already been using leeches there.

A CASE OF RECENT LEECH COLONISATION

The ability of a medicinal leech species to colonize an isolated pond very rapidly has been thoroughly documented during a fifteen year study from 1972 to 1987 in a small lake in Guadeloupe (Pointier *et al.* 1988). Lake Grand Étang is located in the rain forest at an altitude of 450 m and has "no permanent human habitation within a radius of 3 km". During a biological survey in 1972, there were no leeches in the lake, but in 1973 a locally common species of leech was introduced by local people. The leech population increased rapidly where they fed mainly on the tilapid fish *Oreochromis mossambicus* (Peters, 1844). The leeches became "an important new factor contributing to fish mortality; many dying fish were seen floating on the lake or stranded in the aquatic vegetation". This well-documented case may give us a clue to the success of this and possibly other leech species, *i.e.* their ability to thrive on the fish *O. mossambicus* which was introduced to the West Indies from Africa as a source of protein. (Note: this leech species which understandably was called *Hirudinaria blanchardi* is probably the same as the Guadeloupe "market leech" discussed below).

EVIDENCE FOR A SECOND INTRODUCED LEECH IN THE WEST INDIES: GUADELOUPE MARKET LEECH

Until recently, we had presumed in our investigation that all medicinal leeches found on the various islands of the West Indies represented a single species, *Hirudinaria manillensis*, which we had concluded came from India in the mid-1800's. Most of our morphological and molecular genetics data were based on specimens collected alive in St Lucia, and corroborated with morphological data from specimens collected alive in Puerto Rico and Martinique. The first hint that a second medicinal leech species is present in the West Indies resulted from dissecting specimens purchased by Sawyer in the market at Pointe-à-Pitre, Guadeloupe, in August 1995. To our surprise this "market leech", while looking similar externally to *Hirudinaria manillensis*, is quite different internally. The jaw structure and reproductive organs clearly demarcate it from all other hirudinid species (Macrobdellinae) of the New World. (To confirm that the "market leech" actually lives in the wild in Guadeloupe rather than purchased from outside the island, N. Barré kindly collected live specimens of the same leech species west of Abymes. Hechtel confirmed by dissection that these were the same as the "market" species).

Though in appearance very similar to *H. manillensis*, dissection of the reproductive systems of the Guadeloupe "market leech" (Fig. 4B) revealed it to be an undetermined species of the genus *Asiaticobdella*. This genus belongs to the Hirudininae, a subfamily distinguished from the Hirudinariinae by the absence of a spacious vaginal caecum. As currently defined (Sawyer 1986: 688), the genus *Asiaticobdella* occurs in both India and Africa (Harding & Moore 1927). Although the authors are unable to rule out an *Asiaticobdella* of Indian origin, historic and taxonomic evidence presented below leaves open the possibility that the Guadeloupe leech may be of African origin.

After failing in the last century to introduce the European medicinal leech *Hirudo medicinalis* into the French West Indies, M. Gerbidon, interim governor of Senegal, proposed in 1827 the idea of sending leeches from Senegambia on the north-west coast of Africa (*e.g.* Dupuy 1830; Calve 1830) to the Antilles, including to Cayenne, French Guyana. After at least one failed attempt, in June 1829, he successfully ship-

ped 50 000 leeches from Senegal, of which 34 000 survived. Of these the French authorities purposely released about 16 000 into the ponds and streams of Guadeloupe. In December 1829 it is recorded that "the Negroes have found them on their legs and on the legs of animals, and fishermen have seen several in their nets (nasses). Unfortunately, Negroes have sold a great number of them in Pointe-à-Pitre."

In order to elucidate the possibility that leeches may have been introduced from Senegambia, Hechtel acquired live specimens of a candidate hirudinid leech from coastal Gambia. After careful study of its external and internal characters (Fig. 4A) Hechtel confidently identified this Gambian leech as *Asiaticobdella fenestrata* (see Sawyer 1986: 774-778 for key to African Hirudiniformes). This study also confirmed that the Gambian leech was not the same as the Guadeloupe leech. They differ specifically in that *A. fenestrata* has a vaginal duct about 2.5 to 3 times the length of the vagina (*sensu stricto*) whilst the Guadeloupe leech has a vaginal duct about 1.5 times the length of the vagina. The penis sheath is also commensurately longer in *A. fenestrata*. To date we have not been able to match the Guadeloupe leech with any descriptions or specimens known to us. However, some very old specimens labelled "*Mare d'Issy, Sénégal, Bocall A811*" were obtained from the Muséum national d'Histoire naturelle. Unfortunately, they were too brittle for a definitive identification but the relative shortness of the vaginal duct distinguished them from *A. fenestrata* and leaves open the speculative possibility they are the same as the Guadeloupe "market leech".

The exact species of leech introduced from Senegambia in the 1820's is so far unclear from historic records. In fact, Virey (1829) records that "Senegal has several hirudinid species in its ponds, lakes and streams". One candidate, however, which should be eliminated, is a virtually unknown species described by Henry, Sérullas and Virey in 1829 as *Sanguisuga mysomelas* from "Senegal, particularly in lakes Mboroo and Nghier" (Virey 1829; Moquin-Tandon 1846: 14, 340), but apparently it has not been recorded since. Interestingly, it was noted about this species that doctors at the time "must always use double those of Europe for the same amount of blood drawn" (Virey 1829).

Erratic distribution of medicinal leeches on West Indian Islands

One of the inexplicable findings concerning medicinal leeches in the West Indies is their erratic distribution, being prolific on some islands but totally absent on others. For example, such leeches are known to occur on Martinique, Guadeloupe (Pointier *et al.* 1988), Dominica, St Lucia, Haiti, Antigua (Sawyer & Kinard 1980), and Puerto Rico (Moore 1901; Sawyer & Kinard 1980). At the same time, it appears to be absent from Jamaica, Barbados, St Maarten/St Martin, Surinam and French Guyana, as well as from Guyana, Trinidad, Bahamas and probably Cuba. It is still unclear whether the reason(s) for this unusual distribution are historical or ecological, or both.

It is almost certain that leeches have been shipped freely between islands for medicinal purposes for the past 150 years, a practice that is still going on. During periodic visits to the West Indies region from 1974 to 1998, Sawyer obtained credible oral evidence that in recent times leeches are still being shipped for medicinal purposes to certain leech-free islands, as well as to the mainland of South America. For example, local residents claim that a leech is still imported from time to time into St Martin/St Maarten from "another island", and into Trinidad reportedly from "Granada". As late as 1976, leeches were being shipped regularly from Martinique, reportedly "from the ponds near the airport", to Cayenne, French Guyana, but by 1993 no leeches were apparently being imported into French Guyana (Sawyer 1993, personal observation).

Acknowledgements

This study began over twenty-five years ago in 1974 during a trip by R. T. Sawyer to Puerto Rico where he first encountered and was perplexed by a large aggressive leech unlike any other in the New World. It took many years to prove, to our satisfaction, the true identity of the leech and to determine when and by what mechanism it had arrived in the West Indies.

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