Comp. Parasitol.
75(2), 2008, pp. 263–270

New Leeches and Diseases for the Hawksbill Sea Turtle and the West Indies

Lucy Bunkley-Williams,[1,7] Ernest H. Williams, Jr.,[2] Julia A. Horrocks,[3] Hector C. Horta,[4] Antonio A. Mignucci-Giannoni,[5] and Anthony C. Poponi[3,6]

[1] Caribbean Aquatic Animal Health Project, Department of Biology, University of Puerto Rico, P.O. Box 9012, Mayagüez, Puerto Rico 00861-9012 (e-mail: lwilliams@uprm.edu),
[2] Department of Marine Sciences, University of Puerto Rico at Mayagüez, P.O. Box 908, Lajas, Puerto Rico 00667-0908 (e-mail: ewilliams@uprm.edu),
[3] Barbados Sea Turtle Project, Department of Biological and Chemical Sciences, University of the West Indies, Cave Hill Campus, St. Michael, Barbados (e-mail: horrocks@uwichill.edu.bb; acpoponi@hotmail.com),
[4] Department of Natural and Environmental Resources, P.O. Box 1186, Fajardo, Puerto Rico 00738-1186 (e-mail: hhorta@coqui.net), and
[5] Caribbean Stranding Network, P.O. Box 361715, San Juan, Puerto Rico 00936 (e-mail: mignucci@caribe.net).
[6] Current address: c/o Sea Turtle Preservation Society, P.O. Box 510988, Melbourne Beach, Florida 32951, U.S.A.

ABSTRACT: The Green sea turtle leech, *Ozobranchus brachiatus*, infected a moribund hawksbill sea turtle (*Eretomochelys imbricata*) posthatchling juvenile at Farjardo, Puerto Rico. It usually infects green sea turtles, *Chelonia mydas*, and has not been reported from wild *E. imbriata*. A superinfection of the loggerhead sea turtle leech, *Ozobranchus margoi*, occurred on a stranded *E. imbricata* at Vieques Island, causing sea turtle leech erosion disease (SLED). We name and describe this disease for the first time. *Ozobranchus margoi* usually infects loggerhead sea turtles, *Caretta caretta*, and has not previously been reported either from the West Indies or confirmed from wild hawksbill sea turtles. In Barbados, *O. margoi* was first associated with a nesting female *E. imbricata* in 1997, and has been seen in other individuals since. SLED has not previously been reported from wild sea turtles or from the West Indies.

KEY WORDS: Green sea turtle leech, *Ozobranchus brachiatus*, loggerhead sea turtle leech, *Ozobranchus margoi*, hawksbill sea turtle, *Eretomochelys imbricata*, sea turtle leech erosion disease, Hirudinea, Puerto Rico, Barbados

The hawksbill sea turtle, *Eretomochelys imbricata* Linnaeus, (Table 1) is a critically endangered, medium-size (adult female carapace [shell] length 81–96 cm, 27–86 kg) sea turtle. It has been overexploited historically not only for meat and eggs, but for the richly patterned scutes (scales of the shell commercially called "tortoiseshell" or "bekko"), which at times has sold for more than ivory. Hawksbill sea turtle populations are declining or depleted in most parts of the West Indies, but some populations have exhibited increases in recent years (e.g., Mona Island, Puerto Rico and Barbados [IUCN, 2002]).

Ozobranchus brachiatus (Menzies) (Table 2) associates with the green sea turtle, *Chelonia mydas* (Linnaeus) (Table 1) worldwide in warmer waters (Sawyer et al., 1975). It may occasionally occur on black sea turtles, *Chelonia agassizi* Bocourt (McDonald and Dutton, 1990; Table 1) and olive ridley sea turtles, *Lepidochelys olivacea* (Eschscholtz), (Hernandez-Vazquez and Valadez-Gonzalez, 1998; Lazo-Wasem, 2002; Vivaldo et al., 2006; Table 1). We have seen it on green sea turtles in Puerto Rico, particularly associated with fibropapilloma tumors (Williams et al., 1994).

Ozobranchus margoi (Apathy) (Table 2) is most commonly associated with the loggerhead sea turtle, *Caretta caretta* (Linnaeus) (Table 1), and probably occurs worldwide in warmer waters primarily on this host, but records are sparser (Table 2).

In captive situations, the host specificity appears to break down and any species of sea turtle can be infected by either species of leech. Often the infections of captive sea turtles progress into epizootics that erode away all external tissues, including the plastron (upper or dorsal shell of a sea turtle) (Davies and Chapman, 1974), can totally remove the eyes (Schwartz, 1974), and often kill the host.

Sanjeeva Raj (1959) reported a superinfection of *O. margoi* from a live, wild hawksbill sea turtle in the Bay of Bengal at Ennore, 6.7 km north of Madras, India. However, he apparently did not examine the sea turtle and did not deposit any of the leech specimens in a museum. Thus, the identity of the host sea turtle must remain tentative, and the leech species unconfirmed. Loop et al. (1995) collected an undisclosed number of *O. margoi* specimens from 2 of 365 nesting hawksbill sea turtles they studied on Milman Island, Great Barrier Reef, Australia. They

[7] Corresponding author.

Table 1. Extant species of sea turtles (Reptilia: Testudines) and the general geographic distributions.

Species name	Common name	Geographic distribution
Family Cheloniidae		
Caretta caretta (Linnaeus)	Loggerhead sea turtle	Worldwide; tropical to temperate
Chelonia agassizi Bocourt	Black sea turtle	Eastern Pacific; tropical to subtropical
Chelonia mydas (Linnaeus)	Green sea turtle	Atlantic, Mediterranean, Indo-Pacific; tropical to subtropical
Eretmochelys imbricata Linnaeus	Hawksbill sea turtle	Tropical Atlantic, and Indo-Pacific
Lepidochelys kempii (Garman)	Kemp's ridley sea turtle	Gulf of Mexico
Lepidochelys olivacea (Eschscholtz)	Olive ridley sea turtle	Tropical Atlantic and Indo-Pacific; continental areas
Natator despressus (Garman)	Flatback sea turtle	Northern and northeastern Australia
Family Dermochelyidae		
Dermochelys coriacea (Vandelli)	Leatherback sea turtle	Atlantic and Indo-Pacific

did not note this as a new host record and the leech species was again not substantiated by museum deposition. Monroe and Limpus (1979) reported *Ozobranchus* sp. from a hawksbill sea turtle in Australia. Dobbs et al. (1999, 2004) found *Ozobranchus* sp. on wounds caused by cookie-cutter sharks, *Isistius brasiliensis* on hawksbill sea turtles, and on 25 nesting turtles (1,392 examined) at Milman Island, respectively. Dobbs (personal communication) lost all of the leech specimens reported above from Australia (Monroe and Limpus, 1979; Loop et al., 1995; Dobbs et al., 1999, 2004; Table 3) during a flood. We have been unable to obtain more specimens for identification. From the limited data in Table 3, turtles with leeches appear to have been more abundant in the summer nesting seasons of 1993 and 1994 on Milman Island ($N = 10$ and 12, respectively), than in 1991 (2), 1992 (0), and 1995 (1). When standardized per collecting day, these equal 0.024/d (1991), 0.000/d (1992), 0.127/d (1993), 0.121/d (1994), and 0.011/d (1995).

Many hundreds of hawksbill sea turtles have previously been carefully examined for epibionts and associates (Witzell, 1983; Frazier et al., 1985; Cintron-de Jesus, 2001, unpublished master's thesis, University of Puerto Rico, Mayagüez, Puerto Rico; Schärer, 2001, unpublished master's thesis, University of Puerto Rico, Mayagüez, Puerto Rico, Schärer, 2003; Frick et al., 2003) with only Frazier et al. (1985) finding an *Ozobranchus* sp., but the leech was not identified to species. Three of these studies were performed in the Caribbean relatively near our present study areas at Antigua (Frick et al., 2003), Puerto Rico and the U.S. and British Virgin Islands (Cintron-de Jesus, 2001 unpublished master's thesis, University of Puerto Rico, Mayagüez, Puerto Rico), and Mona (Schärer, 2001 unpublished master's thesis, University of Puerto Rico, Mayagüez, Puerto Rico) and Monito Islands (Schärer, 2001 unpublished master's thesis, University of Puerto Rico, Mayagüez, Puerto Rico).

We report *O. brachiatus* and *O. margoi* causing disease in a hawksbill sea turtle at Vieques Island, Puerto Rico; new host records for these leeches; and new locality records in Barbados and Puerto Rico.

MATERIALS AND METHODS

Leeches were collected arbitrarily from 3 sea turtles during recovery of the live animal or during necropsy or salvage efforts; standard protocols for sea turtle examinations were followed (Wolke and George, 1981). They were preserved in 70% ethanol. Smaller specimens of leeches may have been missed in the macroscopic examinations. In particular cases, standard bacterial and fungal isolates from the lesions were taken on brain–heart infusion agar. Standard chemical tests of subsequent isolations and growth of bacteria were only sufficient to identify genera. The Barbados nesting hawksbill was seen on 30 separate occasions over a period of 8 yr (1997–2005) in each of 4 successive nesting seasons, and was examined during each nesting attempt.

Turtle lengths were measured as curved carapace lengths (CCL) with the use of a measuring tape laid over the curve of the carapace and measuring from the nuchal notch to the tip of the supracaudal. The turtle from Barbados was tagged following examination with Inconel 681 tags T0043 (replaced in 2003 with WE 2685) and T0118. The moribund posthatchling juvenile and the stranded turtle in Puerto Rico died and were necropsied with the use of standard protocols.

We use the term "West Indies" to indicate the Caribbean region and the Bahamas. All authors were included in Barbados or U.S. federal and local permits to handle sea turtles. Each is detailed in the Acknowledgments.

RESULTS

Sea turtle leech erosion disease (SLED)

This is the death or severe disfigurement of sea turtles caused by erosion of their skin, muscle, and sometimes bone by a superinfection of leeches. We consider a superinfection to be 1,000 or more leeches

Table 2. Marine* species of *Ozobranchus* DeQuatrefages (Annelida: Clitellata: Rhynchobdellida), their sea turtle hosts, geographic distribution, captive (C) or wild (W) situation, disease condition, and reference.

Leech species	Host	Distribution	Situation	Disease	Reference
Ozobranchus branchiatus (Menzies)					
	Black	California	W	F†	McDonald and Dutton (1990)
	Green	Tropical Pacific	W	–	Menzies (1971)
		Australia	W	–	Baird (1869)
		Japan	W	–	Oka (1910)
		Florida	W	–	MacCallum and MacCallum (1918)
			W	F	Nigrelli (1942), Nigrelli and Smith (1943)
			W	–	Sanjeeva Raj and Penner (1962)
		Malaya and Sarawak	W	F	Hendrickson (1958)
			W	–	deSilva and Fernando (1965)
		La Reunion	C	FS?	Reme (1980)
		Hawaii	W	–	Balazs (1980)
			C	S?	Choy et al. (1989)
		Brazil	W	–	Peralta et al. (2003)
			W	–	Pereira et al. (2006)‡
		Puerto Rico	W	F	Williams et al. (1994)
		West Central Africa	W	F	Formia et al. (2007)§
	Hawksbill	Puerto Rico	W	S	This study
	Olive ridley	Mexico	W		Hernandez-Vazquez and Valadez-Gonzalez (1998), Lazo-Wasem (2002), Vivaldo et al. (2006)
Ozobranchus jantseanus Oka‖	Green	China	W	–	Oka (1912a)
		Japan	W	–	Yamauchi and Itoh (2001)
Ozobranchus margoi (Apathy)	Green	Australia	W	–	Richardson (1969)
		Florida	C	S	Davies and Chapman (1974)
		North Carolina	C	S	Schwartz (1974)
		Hawaii	C	S?	Choy et al. (1989)
		Southwest Atlantic	W	–	Celini et al. (2002)
	Hawksbill	India	W	S?	Sanjeeva Raj (1959)¶
		Florida	C	S	Davies and Chapman (1974)
		Australia	W	–	Loop et al. (1995)#
		Puerto Rico	W	S	This study
	Kemp's ridley	Japan	W	–	Oka (1912b)
		Florida	C	S	Davies and Chapman (1974)
	Loggerhead	Italy	W	S?	Apathy (1890)
			W	–	Sanjeeva Raj (1954)
			W	–	Violani et al. (2001)
		Uruguay	W	–	Cordero (1929)
		Florida	C	S	Davies and Chapman (1974)
		Indian Ocean	W	–	Sanjeeva Raj (1959)
		Southwest Atlantic	W	–	Celini et al. (2002)
		Brazil	W	–	Peralta et al. (2003)

* Freshwater species have rarely been reported in Africa and South America.

† Disease condition: F = presence of fibropapillomas; S = sea turtle leech erosion disease.

‡ Leech only tentatively identified (“likely”) and not deposited.

§ Not recognized as valid by all taxonomists.

‖ Leech was not identified in their paper, but an enlargement of their excellent photograph suggests that at least 1 specimen is *O. branchiatus*.

¶ Sea turtle specimen was not seen by author and leech specimens were not deposited. This superinfection may have been causing sea turtle leech erosion disease.

Leech specimens were lost.

on a host specimen (Williams and Bunkley-Williams, 1996). We found more than 1,000 leeches on an infected turtle, Davies and Chapman (1974) found 800–900 leeches per turtle, and Schwartz (1974) mentions “Large masses of leeches clung over all the body including the carapace.” Davies and Chapman (1974) found only excavation and destruction of the plastron, whereas Schwartz (1974) found massive erosion of all surfaces down to bone including loss of eyes. Despite attempts to treat or eradicate the

Table 3. ***Ozobranchus*** **sp. found on 25 specimens of nesting hawksbill sea turtles,** ***Eretmochelys imbricata*** **Linnaeus, at Milman Island, Northern Great Barrier Reef, Australia.***

Dates observed	CCL† (cm)	Turtle tag number	Location on turtle
Feb–Mar 1991	82.3	T 55695	–
17 Mar 1991	88.2	T 55719	–
22 Jan 1993	82.1	T 72359	Carapace
26 Jan 1993	85.0	T 72459	On cloaca
27 Jan 1993	81.5	T 72434	–
29 Jan 1993	75.9	T 72495	Neck
Jan–Feb 1993	86.9	T 72334	–
Jan–Feb 1993	83.0	T 72432	Neck
Jan–Feb 1993	81.0	T 72480	On cloaca
18 Feb 1993	74.4	T 72676	On cloaca
Jan–Mar 1993	82.1	T 72230	–
24 Mar 1993	81.5	T 72785	–
Jan–Feb 1994	78.2	T 48267	–
Jan–Mar 1994	85.8	T 74261	–
Feb 1994	85.0	T 48234	–
Nov–Dec 1994	81.4	T 77941	–
Nov 1994–Jan 1995	79.8	T 77928	On cloaca
Nov 1994–Jan 1995	82.0	T 77936	–
Nov 1994–Jan 1995	74.6	T 77942	–
Nov 1994–Feb 1995	79.4	T 77912	On cloaca
Dec 1994–Jan 1995	83.5	T 55331	–
Dec 1994–Jan 1995	81.7	T 77923	–
Dec 1994–Jan 1995	81.7	T 77955	–
Dec 1994–Jan 1995	76.5	T 77958	–
Jan–Feb 1995	74.6	T 78186	–

* Dobbs (personal communication) provided these data. These are the leeches listed by Loop et al. (1995), Dobbs et al. (1999, 2004), but these details were not given. Collection dates were 11 January–27 March 1991, 4–18 February 1992, 15 January–3 April 1993, 14 January–22 March 1994, and 25 November 1994–14 February 95 (Dobbs et al., 1999).

† Curved carapace length.

leeches, all of these cases resulted in mortalities of some of the infected sea turtles. Previous cases of SLED occurred in captive sea turtles (Davies and Chapman, 1974; Schwartz, 1974; Table 2). We report it for the first time in a wild one. Although this disease is well known (Choy et al., 1989), it has not, to our knowledge, been named. We suggest calling it sea turtle leech erosion disease (SLED).

Posthatchling juvenile mortality

A moribund 8.5-mm-long, 8.2-mm-wide CCL, posthatchling juvenile male hawksbill sea turtle was found 24 March 1996 floating at the surface of the water off Playa de Fajardo, Bahía de Fajardo, Fajardo, Puerto Rico (18°20.2′N, 65°37.7′W). Ten leeches were recovered from its body. These specimens were identified as *O. brachiatus* and were deposited in the United States National Parasite Collection (USNPC 97048). This is the first record of this leech on a hawksbill. One of the leeches was an immature 1.2-mm-long specimen. Five amphipods (Crustacea: Amphipoda: Gammaridea) were also found (USNPC 97049). These were apparently free-living scavengers and were not identified. They were not *Podocerus chelonophilus* (Gammaridea: Podoceridae), a common associate of sea turtles.

Turtle stranding

A 88.2-cm CCL male hawksbill sea turtle was found stranded in Ensenada Honda on the south coast of Vieques Island, Puerto Rico (18°7.7′N, 65°21.4′W) on 7 August 1996. A superinfection of leeches occurred on the body and carapace of the turtle. External lesions and erosion of skin and muscle tissues appeared to be associated with the presence of the leeches. A subsample of 25 leech specimens were identified as *O. margoi* (USNPC 97027). One of the larger leech specimens had a small (~2 mm, body curled up) leech attached. The number of leeches (1,000+) on the turtle was only a conservative, or minimum, estimate of adult specimens. Very likely many more adult leeches were present. Many more juvenile and developing leeches, too small to be a part of the estimate, were also present. Because most leeches are lost from sea turtles once they become desiccated out of the water, many more adult leeches were probably present on the sea turtle prior to stranding on shore. Bacteria were isolated from some of the external lesions and identified as *Vibrio* sp. All macroscopically visible leech specimens were removed from the turtle and its wounds treated with an antibiotic. Standard rehabilitation procedures were begun, but the turtle died in a few hours. A necropsy revealed no other parasites or signs of disease. Because of the severe damage associated with the leeches, the cause of death was attributed to SLED.

Nesting female turtle

A 88.7-cm CCL female hawksbill sea turtle appeared to be weak and lethargic during each of 5 nesting attempts in August and September of 1997 in Barbados. She made feeble attempts at digging nest chambers, and often returned to the sea after laying only a few eggs or none at all, instead of the average of about 150 eggs typical for hawksbill clutches in Barbados. She had a distended cloaca and gray-colored skin. When the sea turtle attempted to nest on 15 September 1997 at Needhams's Point (13°4.7′N, 59°36.5′W), 2 leeches removed from the lesions were identified as *O. margoi* and were deposited (USNM 180093). This turtle was seen again in 2000, when 4 emergences resulted in 3 clutches. Her cloaca was examined on 3 occasions, but no leeches were observed. In 2003, she emerged on 16 occasions. On 1 occasion she laid only 5 eggs. Her cloaca was very distended, measuring 10 cm in diameter. The cloaca was checked for leeches on 7 occasions in 2003, but again none were visible. The shells of her eggs were, however, unusually thick, very smooth, and harder than normal. After laying she was observed to rub her cloaca with sand using her hind flippers. In 2005, she was seen on 5 occasions but successfully laid only 2 clutches. Her cloaca was still distended (8 cm diameter), and no leeches were found. In each nesting season that she has been seen in Barbados since 1997, she has exhibited a highly swollen cloaca and great difficulty with laying eggs, but no external signs of leech infestation.

DISCUSSION

Posthatchling juvenile mortality

Hewavisenthi (2001) noted "a marine leech which [sic] attacks the abdominal slit of the hatchlings" released from hatcheries in Sri Lanka. This appears, circumstantially, to be *O. brachiatus* attacking green sea turtles; however, neither the sea turtle nor the leech was identified. The extent of the damage to hatchlings was also not explained. This does suggest that hatchlings or juveniles can be routinely and frequently attacked by leeches. The immediate infection of hatchlings as they swim offshore also suggests that *Ozobranchus* spp. might have free-swimming infective stages. Spread of these leeches has often been surmised, without evidence, to be only by direct contact between turtles. Williams et al. (1994) noted small, free-swimming *O. branchiatus* attaching to humans (AAMG was 1 of them) in a seawater pool (USNM 132423), which confirms that they can swim.

Alternatively, if the eggs are dug up and incubated in hatcheries, as occurs in Sri Lanka, the eggs may have been attacked by insects before they were reburied. JAH (unpublished data) has seen hatchlings with large numbers of maggots coming out of the abdominal slit. They appear soon after the turtles are placed in seawater. The maggots are in the remnants of the yolk sac and die quickly once in seawater. These could have been confused with leeches (JAH, unpublished data).

Possibly more leech specimens occurred on our host specimen before it began dying. However, 9 adult leeches and 1 juvenile leech is a severe infection for a juvenile. Others may have been lost when the host was taken from the water and transferred to the laboratory. No other disease sign or parasites were present. The immature 1.2-mm *O. brachiatus* specimen among 9 adult specimens may indicate that reproduction may have been occurring on the juvenile. However, this cannot be confirmed. The leeches could have at least contributed to the death. This is the first record of *O. brachiatus* in a wild hawksbill sea turtle. The amphipods were probably free living. We expect that they were attracted to the dying turtle. Vivaldo et al. (2006) reported an amphipod, *Caprella* sp., on olive ridley sea turtles nesting on the southwestern Pacific coast of Mexico.

Turtle stranding

The extent of the infection and lesions confirm the sea turtle was killed by SLED. This represents the first case out of captivity and the first in the West Indies. This is the first confirmed record of *O. margoi* in a wild hawksbill sea turtle and the first report of this leech in the West Indies. Sanjeeva Raj (1959) reported this leech from this turtle in India, and Loop et al. (1995) in Australia, but they did not deposit specimens of the leech.

Smaller leeches, such as the ~2 mm one we found attached to a larger leech specimen, were probably overlooked in the macroscopic field examination. The presence of this small specimen may indicate that the leeches were reproducing on this turtle also.

Nesting female turtle

Many more leech specimens may have occurred on this turtle when it was in the water. Many leeches probably dried up and fell off during the time the turtle was on the beach. Others were probably scraped off as the turtle crawled through the sand and threw sand on top of its shell attempting to dig a nesting cavity. The turtle was appeared to be in a weakened condition during the nesting period in 1997. This may have made it more susceptible to leech infection. This is the second confirmed record of *O. margoi* in a wild hawksbill sea turtle.

All leeches we found on this host were attached to the cloaca. Despite external examination of the exterior of the animal, and the cloaca in particular, on numerous subsequent occasions, neither leeches nor lesions have been seen on this animal since the 1997 nesting season. This does not preclude the possibility that leeches were either so small that they were overlooked or that they were not visible outside of the cloaca. However, many other nesting hawksbills have been found with leech infestation since 1997 (Horrocks, unpublished data), suggesting that leech infestation is rarely missed when it does occur.

The cloaca of this female was consistently reported to be grossly distended, perhaps because of blockage by eggs that the female was unable to lay, or because of leech infestation inside. The turtle was observed to use her back flippers to rub her cloaca with sand, perhaps to ease the passage of eggs or to relieve the irritation. She has returned to nest at the 2–3-yr remigration intervals typical of hawksbills, but her capacity to lay eggs has clearly been compromised. On 1 emergence she attempted to dig a nest chamber, but abandoned her efforts, 7 times before leaving the beach without nesting. Whether she produced normal clutch counts but could not lay all the eggs she produced was unknown. The turtle's body condition was probably already lower, as the normal result of diversion of resources into egg production and the often long migration to the nesting beach, and her many unsuccessful efforts to lay would probably have caused her more than normal exertion. Whether this individual was in a weakened state already and became vulnerable to leech infestation or whether her condition is attributable to the leech infestation is not possible to separate at this time.

Infestation by leeches is no longer a rare phenomenon in hawksbill sea turtles nesting in Barbados. For instance, in 2003, 39 nesting females were found to have leeches, all associated with the cloaca (Horrocks, unpublished data). The breakdown in host specificity of 2 leech species on hawksbill sea turtles is interesting. *Ozobranchus margoi* appears to be in the process of spreading to this new host species. More specimens and more case reports are necessary to determine if the report of *O. branchiatus* on this new host represents a rare accident or a trend similar to that occurring in *O. margoi*.

Ozobranchus margoi has probably not been previously reported in the West Indies because its primary host, the loggerhead sea turtle, is not very common in the insular Caribbean. The difficulty in finding the primary host could explain its crossing over to a different host.

The amphipod *P. chelonophilus* is known to associate with epidermal lesions of at least the loggerhead sea turtle (Moore, 1995) and occurs on hawksbill sea turtles (e.g., Frick et al., 2003). The amphipods collected from the moribund juvenile in this study were not this species. The other 2 turtles may not have been examined closely enough in the field to find associates as small as amphipods.

In each of the cases we describe, the host was infested with a leech not previously confirmed to associate with that turtle in the wild. Parasites new to a host often do much more damage than they do to their natural host. This could explain SLED occurring in 1 of the cases.

Marine ich, *Cryptocaryon irritans* Brown (Ciliophora: Prorodontida: Cryptocaryonidae), and slime-blotch disease (SBD), *Brooklynella hostilis* Lom and Nigrelli (Ciliophora: Dysteriida: Hartmannulidae), were once only found in captive marine fishes, but now they affect wild marine fishes as well (Bunkley-Williams and Williams, 1994), often in mass mortalities (Williams and Bunkley-Williams, 2000). SBD is now enzootic throughout the West Indies (Williams and Bunkley-Williams, 2000). A large number of previously unknown or minor diseases of marine organisms have become epizootic in the last few years in the West Indies, including sea turtle fibropapillomas (Williams et al., 1994). West Indian sea turtles should be examined to ensure that another new disease, sea turtle leech erosion disease is not becoming a new enzootic disease.

Greenblatt et al. (2004) suggested that "*Ozobranchus* leeches" transmit fibropapillomas, although they, curiously, did not identify the leech species (Williams et al., 2006). This makes the presence of these leeches more important and, in these cases, more interesting. *Ozobranchus branchiatus* occurs commonly on green sea turtles and *O. margoi* on loggerhead sea turtles. Both turtle species suffer from fibropapillomas. Hawksbill sea turtles do not have these leeches and rarely have fibropapillomas. If these leeches are spreading to hawksbill sea turtles, then the frequency of fibropapillomas may increase in this species.

ACKNOWLEDGMENTS

We thank Kirstin A. Dobbs, Institute of Marine Life Sciences, Texas A & M University, Galveston, Texas, U.S.A., for the Australian leech information; Jennifer Beggs, Kirtis Luke, Linda Reinhold and many other volunteers of the Barbados Sea Turtle Project, University of the West Indies, for recording the presence of leeches and describing the disease condition; Caribbean Stranding Network participants and volunteers in the salvage and necropsy of the stranded sea turtle; Eugene M. Burreson, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, U.S.A., for reviewing early version of this paper; Patricia Pilitt and Eric P. Hoberg, U. S. National Parasite Collection (USNPC), Biosystematic Parasitology Laboratory, and William E. Moser, Division of Worms, U.S. National Museum (USNM) of Natural History, Washington, District of Colombia, U.S.A., for depositing specimens and providing museum numbers. Sea turtle rescue, carcass salvage, and specimen collection were conducted under the authority of a cooperative agreement with Puerto Rico's Department of Natural and Environmental Resources (DNER); and the Ministry of Agriculture and Rural Affairs, Barbados. This research was funded in part by Wallop-Breaux Sportfish Restoration Funds F-28-13 to EHW and LBW; the Earthwatch Institute and volunteers of the Barbados Sea Turtle Project to JAH; corporate donations; and a grant from the Commonwealth of Puerto Rico Legislature to the Caribbean Stranding Network and AAMG.

LITERATURE CITED

Apathy, St. 1890. *Pseudobranchellion margoi* (Nova familia Hirudinearum). Orvos-Termeszettudomany Eresito 15:122–127.

Baird, W. 1869. Descriptions of some new suctorial annelids in the collection of the British Museum. Proceedings of the Zoological Society of London, pp 310–318.

Balazs, G. H. 1980. Synopsis of biological data on the green turtle in the Hawaii Islands. National Oceanographic and Atmospheric Administration Technical Memorandum NOAA-TM-NMFS-SWFC-7. 141 pp.

Bunkley-Williams, L., and E. H. Williams, Jr. 1994. Diseases caused by *Trichodina spheroidesi* and *Cryptocaryon irritans* (Ciliophora) in wild coral reef fishes. Journal of Aquatic Animal Health 6:360–361.

Celini, A. A. O. S., J. M. R. Soto, and T. Z. Serafini. 2002. First record of *Ozobranchus margoi* (Apathy, 1890) (Annelida, Hirudinea) ectoparaziting *Chelonia mydas* and *Caretta caretta* in the southwest Atlantic. Proceedings of the 22nd Annual Symposium on Sea Turtle Biology and Conservation, poster No. 146 (abstract). NOAA Technical Memorandum NMFS-SEFSC-503: 299. www.seaturtle.org/symposium/program/poster_session_2.pdf

Choy, B. K., G. H. Balazs, and M. Dailey. 1989. A new therapy for marine turtles parasitized by the piscicolid leech, *Ozobranchus brachiatus*. Herpetological Review 20:89–90.

Cordero, E. H. 1929. Notes sur les Hirudinées. I. Quelques observations sur la morphologie externe d'*Ozobranchus margoi* (Apathy). Annales de Parasitologie 7:209–217.

Davies, R. W., and C. G. Chapman. 1974. First record from North America of the piscicolid leech, *Ozobranchus margoi*, a parasite of marine turtles. Journal of the Fisheries Research Board of Canada 31:104–106.

De Silva, P. D. H., and C. H. Fernando. 1965. Three marine leeches (Piscicolidae, Hirudinea) from the Malay Peninsula. Spolia Zeylan. Bulletin of the National Museum of Ceylon 30:227–232.

Dobbs, K. A., A. M. Landry, and J. D. Miller. 2004. Commensals on nesting Hawksbill turtles (*Eretmochelys imbricata*), Milman Island, Northern Great Barrier Reef, Australia. Memoirs of the Queensland Museum 49:674.

Dobbs, K. A., J. D. Miller, C. J. Limpus, and A. M. Landry. 1999. Hawksbill turtle (*Eretmochelys imbricata*) nesting at Milman Island, Northern Great Barrier Reef, Australia. Chelonian Conservation and Biology 3:344–361.

Formia, A., S. Deem, A. Billes, S. Ngouessono, R. Parnell, T. Collins, G.-P. Sounguet, A. Gibudi, A. Villarubia, G. H. Balazs, and T. R. Spraker. 2007. Fibropapillomatosis confirmed in *Chelonia mydas* in the Gulf of Guinea, West Africa. Marine Turtle Newsletter 116:20–22. www.seaturtle.org/mtn/archives/mtn116/mtn116p20.shtml

Frazier, J. G., D. Margaritoulis, K. Muldoon, C. W. Potter, J. Rosewater, C. A. Ruckdeschel, and S. Salas. 1985. Epizoan communities on marine turtles I. Mollusca. Marine Ecology 6:127–140.

Frick, M. G., P. A. Mason, K. L. Williams, K. Andrews, and H. Gerstung. 2003. Epibionts of hawksbill turtles in a Caribbean nesting ground: a potentially unique association with snapping shrimp (Crustacea: Alpheidae). Marine Turtle Newsletter 99:8–11. www.seaturtle.org/mnt/archives/mnt99/mnt99p8.shtml

Greenblatt, R. J., T. M. Work, G. H. Balazs, C. A. Sutton, R. N. Casey, and J. W. Casey. 2004. The *Ozobranchus* leech is a candidate mechanical vector for the fibropapilloma-associated turtle herpesvirus found latently infecting skin tumors on Hawaiian green turtles (*Chelonia mydas*). Virology 321:101–110.

Hendrickson, J. R. 1958. The green sea turtle, *Chelonia mydas* (Linne.) in Malaya and Sarawak. Proceedings of the Zoological Society of London 130:455–535.

Hernandez-Vazquez, S., and C. Valadez-Gonzalez. 1998. Observations of the epizoa found on the turtle *Lepidochelys olivacea* at La Gloria, Jalisco, Mexico. Ciencias Marinas 24:119–125.

Hewavisenthi, S. 2001. Turtle hatcheries in Sri Lanka: Boon or bane? Marine Turtle Newsletter 60:19–22. www.seaturtle.org/mnt/archives/mnt60/mnt60p19.shtml

IUCN. 2002. Hawksbill turtles in the Caribbean region: Basic biological characteristics and population status. CITES Wider Caribbean Range State Hawksbill Turtle Dialogue meetings. www.cites.org.

Lazo-Wasem, E. A. 2002. Marine turtle epibionts. Invertebrate Zoology, Yale University. www.yale.edu/inverts/imagegall/turtlepix.html

Loop, K. A., J. D. Miller, and C. J. Limpus. 1995. Nesting by the Hawksbill turtle (*Eretmochelys imbricata*) on Milman Island, Great Barrier Reef, Australia. Wildlife Research 22:241–251.

Menzies, A. 1791. Description of three new annelids found in the Pacific Ocean. Transactions of the Linnaean Society of London 1:187–188.

MacCallum, W. G., and G. A. MacCallum. 1918. On the anatomy of *Ozobranchus branchiatus* (Menzies). Bulletin of the American Museum of Natural History 38:395–408.

McDonald, D., and P. Dutton. 1990. Fibropapillomas on sea turtles in San Diego Bay, California. Marine Turtle Newsletter 51:9–10.

Monroe, R., and C. J. Limpus. 1979. Barnacles on turtles in Queensland waters with descriptions of three new species. Memoirs of the Queensland Museum 19:197–223.

Moore, P. G. 1995. *Podocerus chelonophilus* (Amphipoda: Podoceridae) associated with epidermal lesions of the loggerhead turtle, *Caretta caretta* (*Chelonia*). Journal of the Marine Biological Association of the United Kingdom 75:253–255. www.seaturtle.org/mnt/archives/mnt101/mnt101p18.shtml

Nigrelli, R. F. 1942. Leeches (*Ozobranchus branchiatus*) on fibroepithelial tumors of marine turtles (*Chelonia mydas*). Anatomical Record 84:539–540.

Nigrelli, R. F., and G. M. Smith. 1943. The occurrence of leeches *Ozobranchus branchiatus* (Menzies) on fibro-epithelial tumours of marine turtles *Chelonia mydas* (L.). Zoologica 28:107–111.

Oka, A. 1910. Synopsis der Japonischen Hirudineen, mit Diagnosen der Neuen Species. Annotationes Zoologicae Japonenses 7:165–183.

Oka, A. 1912a. Eine neue *Ozobranchus*—Art aus China (*Oz. jantseanus* n. sp.). Annotationes Zoologicae Japonenses 8:1–4.

Oka, A. 1912b. Sur la presence de l'*Ozobranchus margoi* au Japan, et description de cette Hirudinée. Proceedings Imperial Academy 3:470–473.

Peralta, A. S. L., M. R. Werneck, E. Matos, and J. H. Becker. 2003. Ocorrência do parasitismo em *Chelonia mydas* e *Caretta caretta* (Testudines, Cheloniidae) por *Ozobranchus branchiatus* e *O. margoi* (Hirudinea, Ozobranchidae) no litoral norte de São Paulo. Proceedings of the 30th Brazilian Congress of Veterinary Medicine, Volume 1. (Abstract.)

Pereira, S., E. H. S. M. Lima, L. Ernesto, H. Mathews, and A. Ventura. 2006. Epibionts associated with *Chelonia mydas* from northern Brazil. Marine Turtle Newsletter 111:17–18. www.seaturtle.org/mtn/archives/mtn111/mtn111p17.shtml

Reme, A. 1980. Ouelques problemes sanitaires et pathologiques dans l'elevage intensif de la tortue marine (*Chelonia mydas* L.) a La Reunion. Revue Elevage et de Medecine Veterinaire des Pays Tropicaux 33: 177–192.

Richardson, L. R. 1969. The family Ozobranchidae redefined, and a novel Ozobranchiform leech from Murray River turtles (class Hirudinoidea order Rhynchobdelliformes). Proceedings of the Linnaean Society of New South Wales 94:61–80.

Sanjeeva Raj, P. J. 1954. A synopsis of the genus *Ozobranchus* (de Quatrefages), 1852 (Hirudinea: Annelida). Journal of the Bombay Natural History Society 52:473–480.

Sanjeeva Raj, P. J. 1959. Occurrence of *Ozobranchus margoi* Apathy (Hirunea: Annelida) in the Indian seas. Current Science 28:496.

Sanjeeva Raj, P. J., and L. R. Penner. 1962. Concerning *Ozobranchus branchiatus* (Menzies, 1791) Piscicolidae: Hirudinea) from Florida and Sarawak. Transactions of the American Microscopical Society 81: 364–371.

Sawyer, R. T., A. R. Lawler, and R. M. Overstreet. 1975. Marine leeches of the eastern United States and Gulf of Mexico with a key to the species. Journal of Natural History 9:633–677.

Schärer, M. T. 2003. A survey of the epibiota of *Eretmochelys imbricata* (Testudines: Chelonidae) of Mona Island, Puerto Rico. Revista de Biologia Tropical 51(supplement 1):87–90.

Schwartz, F. J. 1974. The marine leech *Ozobranchus margoi* (Hirudinea: Pisciocolidae) epizootic on *Chelonia* and *Caretta* sea turtles from North Carolina. Journal of Parasitology 60:889–890.

Violani, C., B. Zava, and G. Insacco. 2001. New records of *Ozobranchus margoi* (Apáthy, 1890) on *Caretta caretta* for the Mediterranean Sea (Hirudinea, Ozobranchidae). Pianura 13:167–168.

Vivaldo, S. G., D. S. Sarabia, C. P. Salazar, A. G. Hernández, and J. R. Lezama. 2006. Identificación de parásitos y epibiontes de la tortuga Golfina (*Lepidochelys olivacea*) que arribó a playas de Michoacán y Oaxaca, México. Veterinaria México 37:431–440. redalyc.uaemex.mx/redalyc/pdf/423/42337403.pdf

Williams, E. H., Jr., and L. Bunkley-Williams. 1996. Parasites of offshore, big game sport fishes of Puerto Rico and the western North Atlantic. Puerto Rico Department of Natural and Environmental Resources, San Juan, Puerto Rico, and Department of Biology, University of Puerto Rico, Mayagüez, Puerto Rico. 384 pp. www.caribjsci.org/publications.html

Williams, E. H., Jr., and L. Bunkley-Williams. 2000. Marine major ecological disturbances of the Caribbean. Infectious Disease Review 2:110–127.

Williams, E. H., Jr., L. Bunkley-Williams, and E. M. Burreson. 1994. Some new records of marine and freshwater leeches from Caribbean, southeastern U.S.A., eastern Pacific, and Okinawan animals. Journal of the Helminthological Society of Washington 61:133–138.

Williams, E. H., Jr., L. Bunkley-Williams, and J. W. Casey. 2006. Early fibropapillomas in Hawaii and occurrences in all sea turtle species: the panzootic, associated leeches wide-ranging on sea turtles, and species of study leeches should be identified. Journal of Virology 80:4643–4644.

Williams, E. H., Jr., L. Bunkley-Williams, E. C. Peters, B. Pinto-Rodríguez, R. Matos-Morales, A. A. Mignucci-Giannoni, K. V. Hall, J. V. Rueda-Almonacid, J. Sybesma, I. Bonnelly de Calventi, and R. H. Boulon. 1994. An epizootic of cutaneous fibropapillomas in green turtles, *Chelonia mydas* of the Caribbean: Part of a panzootic? Journal of Aquatic Animal Health 6:70–78.

Witzell, W. N. 1983. Synopsis of biological data on the hawksbill turtle, *Eretmochelys imbricata* (Linnaeus 1766). FAO Fisheries Synopsis 137:1–78.

Wolke, R. E., and A. George. 1981. Sea turtle necropsy manual. NOAA Technical Memorandum NMFS-SEFC-24. 20 pp.

Yamauchi, T. and T. Itoh. 2001. New Record of *Ozobranchus jantseanus* in Shimane Prefecture (Annelida: Hirudinea: Ozobranchidae). Bulletin of the Hoshizaki Green Foundation 5:309–310.