

Cetaceans in the Maldives: a review

R. CHARLES ANDERSON¹, SHAHAAMA A. SATTAR² AND M. SHIHAM ADAM²

Contact e-mail: anderson@dhivehinet.net.mv or charles.anderson11@btinternet.com

ABSTRACT

The cetaceans of the Maldives were poorly known until relatively recently, but have received increased attention over the past decade. Twenty-three species of cetacean have now been recorded. A number of sightings surveys, and one acoustic survey, have been completed. The species most frequently seen is the spinner dolphin (*Stenella longirostris*). A national system for reporting cetacean strandings has been in place since 2000, although some earlier strandings were also reported; approximately 160 strandings of 16 species have been recorded to date. The species most commonly reported stranding is the sperm whale (*Physeter macrocephalus*). Ambergris has been exported from the Maldives since ancient times; recent export statistics are reviewed. All cetaceans are protected by law within Maldivian waters. More significantly, most forms of net-fishing, including gill-netting and purse-seining are banned in the Maldives to protect the traditional pole and line tuna fishery. Cetacean-watching is becoming increasingly popular, with spinner dolphins being the main attraction, although other species are also sought after on specialist trips.

KEYWORDS: INDIAN OCEAN; SANCTUARIES; WHALING – HISTORICAL; INCIDENTAL SIGHTINGS; SURVEY – VESSEL; STRANDINGS; WHALEWATCHING

INTRODUCTION

The Republic of Maldives is a small island nation in the central Indian Ocean, to the southwest of India and Sri Lanka. It lies at the heart of the International Whaling Commission's (IWC) Indian Ocean Sanctuary and has an abundant and diverse cetacean fauna. Until recently, however, it had received relatively little attention from cetologists.

The Maldives consists of a chain of atolls running north-south from about 7°N to 0.5°S. The atoll chain is single in the north and south but double in the central part of the archipelago. Maximum depths within the atolls are typically 50–60m but vary from about 10–100m. Outside the atolls the reef slopes drop steeply away to the ocean floor, at about 2,000–3,000m. An exception is found in the area between the double chain of atolls in the central Maldives, where bottom depths are of the order of 200–500m.

The waters of the northern Indian Ocean surrounding the Maldives are strongly influenced by the monsoons. The southwest monsoon (SW or boreal summer monsoon) extends from about May to October, while the northeast monsoon (NE or boreal winter monsoon) lasts from about December to March. Under the influence of the SW monsoon, ocean currents flow predominantly to the east, while during the NE monsoon they flow predominantly to the west (Hydrographic Office, 2007; Molinari *et al.*, 1990; Shankar *et al.*, 2002; Wyrki, 1973). The southern Maldives (south of about 2–3°N) is less affected by the monsoons, and more influenced by equatorial currents.

There has been one previous review of information on cetaceans in the Maldives (De Boer *et al.*, 2002), but that was brief and much new information has been become available since then. The aim of this paper is to provide an updated overview of information on cetaceans in the Maldives.

HISTORICAL WHALING

There were two periods of commercial whaling in the region of the Maldives. During the mid-19th century, sperm whales (*Physeter macrocephalus*) were hunted throughout much of the tropical Indian Ocean, mostly by 'Yankee' whalers from New England (Bannister *et al.*, 2007; Clark, 1887; Townsend, 1935; Wray and Martin, 1983). Blyth (1859) reported the following from one Rev. H. Baker who wrote to him from Kerala, India: 'Whales are very common on the coast. American ships, and occasionally a Swedish one, call at Cochin for stores during their cruises for them ... The Maldives and Seychelles are said to be the headquarters of the whalers who seek for these Whales.' Clark (1887, map of whaling grounds) charted a sperm whaling ground in the north of Maldives. Wray and Martin (1983) considered the area between Sri Lanka and Maldives to be an important sperm whaling ground in the 1840s and 1850s, and noted one particular case of sperm whales being taken east of the Maldives (in February 1847).

During the 1960s there was a brief but intense period of commercial whaling in the Arabian Sea by Soviet whaling fleets (Berzin, 2008; Clapham and Ivashchenko, 2009; Yablokov, 1994). Large numbers of blue, Bryde's, humpback and sperm whales were taken in the region, including waters that are now within the Maldivian EEZ (Mikhalev, 1996; 1997; 2000). Some older inhabitants of islands in the north and centre of Maldives report that whale blows were a common sight on fishing trips in the 1950s and early 1960s, but were rare thereafter (Anderson, 2005; unpublished data). In Sri Lanka there were similar reports from fishermen of many whales, possibly humpback whales, off the NE coast in the 1950s and 1960s, but apparently not in the 1970s (Reeves *et al.*, 1991: Table 1).

Maldivians themselves have never undertaken commercial whaling (Anderson *et al.*, 1999). There is no evidence that large whales were ever hunted in Maldives as suggested by

¹ PO Box 2074, Malé, Republic of Maldives.

² Marine Research Centre, H. Whitewaves, Malé, Republic of Maldives.

Table 1
Cetaceans recorded from the Maldives.

Species	English name	Strandings	Encounters	Numbers	
Mysticeta		Baleen whales			
1	<i>Balaenoptera musculus</i>	Blue whale	8	0.7%	0.0%
2	<i>Balaenoptera edeni</i>	Bryde's whale	1	2.8%	0.1%
3	<i>Megaptera novaeangliae</i>	Humpback whale	0	0.1%	0.0%
Odontoceta		Toothed whales			
4	<i>Physeter macrocephalus</i>	Sperm whale	57	0.5%	0.1%
5	<i>Kogia sima</i>	Dwarf sperm whale	0	4.2%	0.2%
6	<i>Steno bredanensis</i>	Rough-toothed dolphin	0	0.3%	0.2%
7	<i>Grampus griseus</i>	Risso's dolphin	2	11.4%	7.0%
8	<i>Tursiops truncatus</i>	Bottlenose dolphin	0	6.6%	2.4%
9	<i>Tursiops aduncus</i>	Indo-pacific bottlenose dolphin	0	6.6%	2.4%
10	<i>Stenella attenuata</i>	Pantropical spotted dolphin	1	3.5%	14.5%
11	<i>Stenella longirostris</i>	Spinner dolphin	2	34.8%	53.2%
12	<i>Stenella coeruleoalba</i>	Striped dolphin	0	2.4%	2.9%
13	<i>Lagenodelphis hosei</i>	Fraser's dolphin	1	0.9%	5.0%
14	<i>Peponocephala electra</i>	Melon-headed whale	12+	0.6%	4.7%
15	<i>Feresa attenuata</i>	Pygmy killer whale	2	0.2%	0.1%
16	<i>Pseudorca crassidens</i>	False killer whale	0	0.5%	0.6%
17	<i>Orcinus orca</i>	Killer whale	1	0.5%	0.1%
18	<i>Globicephala macrorhynchus</i>	Short-finned pilot whale	1	4.2%	1.9%
19	<i>Indopacetus pacificus</i>	Longman's beaked whale	1	0.2%	0.0%
20	<i>Mesoplodon densirostris</i>	Blainville's beaked whale	1	0.5%	0.0%
21	<i>Mesoplodon ginkgodens</i>	Ginkgo-toothed beaked whale	1	–	–
22	<i>Mesoplodon hotaula</i>	Atoll beaked whale	1	–	–
23	<i>Ziphius cavirostris</i>	Cuvier's beaked whale	2	1.2%	0.1%

Notes

Strandings: number of strandings from Anderson *et al.* (1999) plus additional unpublished records held at MRC; excludes specimens deliberately captured.

Encounters: is the percentage of *records* of each species among 1921 on-effort encounters reported by Anderson (2005: Table 4). Numbers: is the percentage of *individuals* of each species seen among 71,276 cetaceans by Anderson (2005: Table 7), and gives a very crude measure of relative abundance. Percentages do not add up to 100 since unidentified cetaceans are excluded here.

Tursiops species were not distinguished by Anderson (2005); together they accounted for 13.2% of encounters and 4.9% of numbers sighted in that study; we have split those figures equally between these two species for the purposes of this table.

Phillips (*in Hill*, 1958, p.9). A harpoon gun was apparently imported to Malé by the first President, Amin Didi, in about 1952 with the object of catching cetaceans for export, but it was never used (N.T. Hasen Didi, formerly of the President's Office, pers. comm., 1990 and 1998).

There was a traditional fishery for tiger sharks (*Galeocerdo cuvieri*) in the Maldives. Large tiger sharks have enormous livers, from which oil was obtained for treating wooden fishing boats. Dolphins were used as bait in this fishery, and they were caught by harpoon while bow-riding (Anderson and Ahmed, 1993; Didi, 1983; Ibrahim, 1991). The scale of the tiger shark fishery, known locally as *maa keyolhu kan*, is unknown. However, given that there are some 200 inhabited islands in the archipelago, it might perhaps have involved an annual take of many tens to a few hundred dolphins per year (species unknown, but likely including spinner dolphins). The tiger shark fishery and associated catching of dolphins died out in the early 1960s, when the more efficient method of longlining for sharks was introduced (Anderson and Ahmed, 1993) and other sources of oil became available. Although this fishery was undoubtedly an ancient one, before its demise fishermen were using toggle-head harpoons. This style of harpoon was invented in New England in 1848, and soon became widely used in the Yankee sperm whale fishery. It seems possible that New England whalers introduced it to the Maldives.

SIGHTINGS

Until relatively recently, reports of cetacean sightings from the Maldives were of limited scope. They included sightings by the Dutch sea captain Willem Mörzer Bruyns, who passed through or by the Maldives on several occasions in the 1950s and 1960s (Mörzer-Bruyns, 1971); Captain Jacques-Yves Cousteau, who visited the Maldives on board his famous ship *Calypso* in 1967 (Cousteau and Diolé, 1971; 1972); Stephen Leatherwood and fisheries worker Charles Peters who visited the Maldives separately during 1980–83 (Leatherwood *et al.* 1984) with additional information on some sightings in Gilpatrick *et al.* (1987), Leatherwood, (1986), Leatherwood *et al.* (1991) and Wilson *et al.* (1987); Japanese whaling researchers who passed through the Maldives on two scouting vessels in March 1982 (Kasuya and Wada, 1991); cetologists on the research yacht *Tulip* who visited Maldives in late 1983 and early 1984 (Alling *et al.*, 1984; Whitehead *et al.*, 1983) during the course of their research elsewhere in the Indian Ocean Sanctuary (Alling, 1986; Gordon, 1991; Whitehead, 1989); and some miscellaneous sightings by the senior author and colleagues (Anderson, 1990; 1996; Anderson *et al.*, 2006; Anderson and Shaan, 1998; 1999; Shaan, 2001). Sightings of whales from global surveys by British and Dutch merchant seamen, including some records from the vicinity of Maldives, were reported by Brown (1957) and Slijper *et al.* (1964) respectively. Popular accounts of the seasonality of

baleen whales around the Maldives were given by Buttress (2001) and Anderson (2002a).

There are several reports of dolphins from travellers, but without specific detail. For example, conchologist Alan Kohn visited the Maldives as part of the Yale Seychelles Expedition in 1957 (Kohn, 1964). He noted ‘In the lagoon of Mulaku Atoll, where we anchored [probably on 9 October 1957] in 14m in a *velu* [shallow lagoon], a large number of small porpoises, which made very short, high jumps, were observed.’ These were probably spinner dolphins, which still regularly occur in large numbers in this atoll. Travel writer Gavin Young sailed to Maldives (Young, 1981) and recorded bowriding dolphins accompanying his vessel in to Malé.

More systematic sightings surveys started with marine biologists Lisa Ballance and Robert Pitman who passed through Maldivian waters in April and June 1995 during the course of a cetacean survey of the western Indian Ocean (Ballance and Pitman, 1998; Ballance *et al.*, 1996). They recorded relatively large numbers of blue whales (*Balaenoptera musculus*) in the vicinity of Maldives. A 20-day cetacean survey in the north-eastern part of the Maldives was carried out during April 1998, with one aim being to obtain tissue samples from blue whales (Ballance *et al.*, 2001). That survey recorded 267 sightings of 16 cetacean species, with the spinner dolphin (*Stenella longirostris*) being the most commonly observed.

Subsequently, Anderson (2005) published a review of some 1,979 sightings of 20 cetacean species (plus 129 strandings), mostly recorded during 535 days at sea between August 1990 and June 2002. Again, spinner dolphins were the most abundant species recorded. They showed a clear diurnal pattern of behaviour, with many schools entering the atolls in the early morning, and leaving in the late afternoon. Spinner dolphins regularly occurred with pantropical spotted dolphins (*Stenella attenuata*) and both species associated with yellowfin tuna. Bryde’s whales (*Balaenoptera edeni*) also associated with yellowfin tuna and appeared to be most common in Maldivian waters during El Niño Southern Oscillation events. Blue whales were only recorded during November to April. Dwarf sperm whales (*Kogia sima*) were especially difficult to locate in rough weather but relatively common, making up one sixth of all sightings in flat-calm conditions. Melon-headed whales (*Peponocephala electra*) were particularly common in the south of the Maldives, but rare in the centre and north. It was noted that several species of cetacean were especially abundant along the steep atoll slopes. A summary of sightings is presented in Table 1.

Anderson (2005) recorded bottlenose dolphins as *Tursiops* sp. He noted that most appeared to be common bottlenose dolphins (*T. truncatus*), but that the possibility that some were Indo-pacific bottlenose dolphins (*T. aduncus*) could not be discounted. In particular he noted differences between bottlenose dolphins seen inside atolls, and those seen out in the ocean. Subsequently, one of us (RCA) has confirmed from close observations and photographs, that both species occur in the Maldives. As suspected by Anderson (2005), *T. truncatus* is commoner outside of the atolls, tends to occur in larger groups, and often associates with other species. In contrast, *T. aduncus* occurs inside the atolls, or only just outside, tends to occur in small groups or singly, and rarely associates with other species.

Clark *et al.* (2012) report on two visits to the Maldives, in 2003 and 2004, by the research yacht *Odyssey* (Ocean Alliance, 2009). 157 cetacean sightings were recorded.

STRANDINGS

Some 16 species have been recorded from strandings so far, with the sperm whale being the most frequently recorded (Table 1) (Anderson *et al.*, 1999; Dalebout *et al.*, 2003; MRC, unpublished data). The relatively large number of sperm whale strandings, in comparison to the relatively few sightings recorded (Table 1) largely reflects the relatively little amount of survey effort conducted offshore. Many ‘stranded’ cetaceans are actually found floating dead at sea by fishermen (who may tow them to their islands in order to recover oil for treating wooden boats, and to search for valuable teeth and ambergris). Most of those carcasses that do wash up on islands or reefs appear to be dead at the time of stranding. Dead whales drift with the monsoon currents, so are found most frequently on the eastern sides of atolls and islands during the NE monsoon, and on the western sides of atolls and islands during the SW monsoon (Anderson *et al.*, 1999).

Two species, both beaked whales, have been so far been positively recorded in Maldives only from strandings: ginkgo-toothed beaked whale, *Mesoplodon ginkgodens* (cf Anderson *et al.*, 1999) and atoll beaked whale, *Mesoplodon hotaula* (Deraniyagala, 1963). The latter name is based on a single stranded female from Sri Lanka, and was relegated to the synonymy of *M. ginkgodens* by Moore and Gilmore (1965). However, genetic studies have shown that *M. hotaula* is a valid species, close to but distinct from *M. ginkgodens* (Dalebout *et al.*, 2007). More details of the single mature male stranded in the Maldives will be published separately (Dalebout *et al.*, in prep.). Another ziphiid, the previously little-known Longman’s beaked whale, *Indopacetus pacificus*, was redescribed in part on the basis of a Maldivian stranding (Dalebout *et al.*, 2003). Popular accounts of this ‘re-discovery’ were given by Anderson (2004), Dalebout (2002) and Pitman (2002), both of the latter two accounts being illustrated with photos of live animals from the Maldives (that in Pitman (2002) being mislabelled as from the Pacific).

Until early 2000 there was no standard scheme for reporting cetacean strandings in the Maldives. Reports of cetacean strandings were occasionally sent to the Government’s Marine Research Centre (MRC), in the capital Malé, and MRC staff collected information on other strandings during field trips. In late 2000, a more formal stranding reporting scheme was initiated. Each inhabited island has a government office and government-appointed island Chief (elected island Councillor since 2009). MRC sent recording forms to each island office, with instructions on how to report every marine mammal stranding. The main aim of the scheme is to obtain basic biological information about cetaceans in the Maldives. The recent spread of telecommunications to all islands is contributing to the more frequent reporting of strandings, while the increasingly widespread use of digital cameras is improving the frequency of reliable identifications.

There are few known instances of live strandings to date. This, combined with the geography of the country (numerous

small islands and reefs spread over a vast area of ocean, with consequent transport and communication difficulties), means that a network focusing on the welfare of live stranded cetaceans (as occurs elsewhere) is unlikely to develop in the foreseeable future.

Some other strandings were documented by Deraniyagala (1956), Leatherwood *et al.* (1984), Anderson (1990; 1996) and Branch *et al.* (2007). Gulland *et al.* (2001) provided a brief summary of the strandings reporting scheme. Anderson (2002b) provided a popular account of Maldivian whale strandings. Anderson *et al.* (1999) summarised all available strandings data up to 1998 ($n = 82$, of which 56 had not been previously reported). More than 80 additional strandings have been recorded since; these should be published in due course.

AMBERGRIS

Ambergris is occasionally recovered from some sperm whale strandings, and is also found floating at sea by Maldivian fishermen (Anderson, 1990; Godfrey, 1996; Klinowska, 1991; Whitehead, 1989).

Ambergris is known in Maldives as *maavaharu*. Maldivians recognise two types of ambergris: white (*hudhu maavaharu* or *hudanvaru*) and black (*kalhu maavaharu*). On Minicoy island, which was historically part of the Maldives but is now part of the Indian Lakshadweep islands, the same distinction has been reported.

Small quantities of ambergris are used in local medicines, but most is exported. This trade has been conducted since ancient times, as was noted by several early travellers, including: Arab traders from the 9th century onwards (Gray, 1890); the Chinese who accompanied the great admiral Cheng Ho (Zheng He) on his seven voyages into the Indian Ocean in the early 15th century (Ma Huan, 1970); and Portuguese adventurers from the early 16th century onwards (Gray, 1890). In 1753 Malé was attacked by an invading force from Malabar sent by the Ali Raja of Cannanore (present day Kannur in Kerala). Assistance was sought from the French in Pondicherry (now Puducherry, India), who sent a fleet of four ships, and saw off the Malabar. The French remained until the following year, when they were apparently paid for their mercenary services with a piece of ambergris weighing 337½ lb (153kg) (Bell, 1940). Hockley (1935) noted that a small quantity of ambergris was included in the (by then largely ceremonial) annual tribute paid by the Maldives to the colonial Governor of Ceylon. He also noted three grades of ambergris; that trade in ambergris was a monopoly of the government; and that most was exported to Bombay (now Mumbai), since at that time foreign trade was dominated by Borah merchants from Bombay. Other relevant reports include Heyd (1879), Gode (1949) and Yamada (1955).

Fishermen who find ambergris normally sell it to middlemen in Malé (in practice there is one Maldivian company that dominates this minor trade). Most now goes to the Middle East where its reputed properties as an aphrodisiac are highly valued. Ambergris is unique among Maldivian marine products in that it is the only one subject to an export tax (amounting to 50% of the export price). Perhaps for this reason there may be some temptation to avoid declaring exports. Certainly the quantity and frequency

of ambergris exports has declined as unit price has increased (Tables 2 and 3).

Most pieces of ambergris found are of relatively modest size. But occasional large pieces are recovered, the largest in recent years being:

- (1) 214kg, 1983, location unknown;
- (2) 231kg, January 1989, K. Gaafaru;
- (3) 187kg, March 1995, H.A. Kelaa.

Table 2

Declared exports of ambergris from the Maldives (MRf=Maldivian rufiyaa).

	Quantity (kg)	Value (MRf)	Unit value (MRf/kg)	Value (US\$)
1974	190	21,000	100	–
1975	40	9,000	200	–
1976	150	66,000	400	–
1977	40	110,000	2,800	–
1978	130	534,000	4,100	–
1979	137.330	462,335	3,400	–
1980	121	1,610,043	13,300	–
1981	13	154,270	11,900	\$44,077
1982	90.602	627,278	6,900	\$104,546
1983	226.030	2,643,129	11,700	\$377,590
1984	43.742	483,956	11,100	\$68,646
1985	23.690	322,900	14,200	\$45,479
1986	26.058	535,370	20,500	\$74,877
1987	2.24	22,330	10,000	\$2,422
1988	0	0	–	–
1989	231	5,111,064	22,100	\$565,383
1990	0	0	–	–
1991	0.145	2,465	17,000	\$240
1992	0	0	–	–
1993	16.48	223,980	13,600	\$20,436
1994	21	222,000	10,600	\$19,154
1995	180	2,688,726	14,900	\$228,439
1996	10.50	189,000	18,900	\$16,058
1997	0	0	–	–
1998	0	0	–	–
1999	3.23	57,130	17,700	\$4,446
2000	0	0	–	–
2001	0	0	–	–
2002	3.10	93,000	30,000	\$7,237
2003	0	0	–	–
2004	1.21	36,300	30,000	\$2,825
2005	0	0	–	–
2006	0	0	–	–
2007	0	0	–	–
2008	0	0	–	–

Sources

Maldives Customs data 1974–78 from Anon (1979); 1979–2008 compiled annually by Ministry of Fisheries and Agriculture. Exchange rates from Anon (1992; 1997).

Notes

Data for 1974–78 were reported to the nearest 10kg and MRf 1,000. Unit prices given to nearest MRf 100. MOFA recorded 1991 quantity as 0.145MT, apparently in error. UNDP (1966) recorded exports of 24cwt (1,222kg) worth MRf 12,000 in 1963, and 17cwt (865kg) worth MRf 17,000 in 1964; it seems likely that the quantities are incorrect.

Table 3

Average price and frequency of export of ambergris, by decade.

Period	Av. annual export	Av. unit value	% years with exports
1974–79	114.6 kg/y	1,750 MRf/kg	100%
1980–89	77.6 kg/y	14,800 MRf/kg	90%
1990–99	23.1 kg/y	14,700 MRf/kg	60%
2000–08	0.5 kg/yr	30,000 MRf/kg	22%

CETACEAN SPECIMENS

Relatively few cetacean specimens have been collected from the Maldives.

The 19th century French merchant-shipowner and naturalist Jean-Jacques Dussumier collected several cetacean specimens from the Indian Ocean (Arvy, 1972). These appear, from watercolour illustrations by Dussumier reproduced in Arvy (1972), to have included a pregnant female striped dolphin taken '1°N, 100 leagues to the east of the Maldivian Islands', and a female spinner dolphin 'caught a few leagues to the east of the Maldivian Islands, 73°E, on 31st July 1829.' Wilson *et al.* (1987) list both these records as *Stenella coeruleoalba*. (French leagues have been of different lengths at different times, but 19th century nautical leagues were usually of 4.448 km).

During his stay in Addu Atoll in 1958–59, W.W.A. Phillips collected one melon-headed whale and five spinner dolphin specimens, which he donated to the Natural History Museum in London (Anderson *et al.*, 1999). These specimens were noted in the data catalogues of Leatherwood (1986) and Gilpatrick *et al.* (1987), and referred to in the reviews of Dawbin *et al.* (1970), Perrin *et al.* (1989) and Perrin (1990).

In recent years it has become something of a trend among resort owners to have whale skulls and skeletons on display. A partial list of specimens on resort islands was given by Anderson *et al.* (1999). The National Museum in Malé holds a single ginkgo-toothed beaked whale tooth (Anderson *et al.*, 1999). The Marine Research Centre in Malé also has a small collection of cetacean specimens, including a complete skeleton of Longman's beaked whale.

Biopsy samples were collected by Robert L. Pitman during the survey carried out in April 1998 (Ballance *et al.*, 2001) and again during one leg of the Voyage of the *Odyssey* in 2004 (Clark *et al.*, 2012). Other Maldivian biopsy samples were taken by the crew of the *Odyssey* in both 2003 and 2004, mainly for a global assessment of pollutants in sperm whales (Ocean Alliance, 2009). Wise *et al.* (2009) reported on chromium levels in these sperm whales. In addition, some tissue samples have been collected from strandings by the senior author. Galver (2002) included six Maldivian biopsy samples in her unpublished study of the molecular ecology of spinner dolphins. Dalebout *et al.* (2003) incorporated genetic analysis of tissue samples from one Maldivian stranding in their reappraisal of Longman's beaked whale. LeDuc *et al.* (2007) included two Maldivian biopsy samples in their investigation of (mostly) Southern Hemisphere blue whale population structure. Chivers *et al.* (2007) included one biopsy sample from the Maldives (Susan Chivers, pers. comm., 28 August 2007) in their study of genetic population structure of false killer whales (*Pseudorca crassidens*), mainly in the north Pacific. Six pilot whale biopsy samples were confirmed as shortfinned pilots (*Globicephala macrorhynchus*) (Susan Chivers, US NMFS, pers Comm, October 2002).

ACOUSTICS

Little acoustic surveying has been carried out in the Maldives. Attempts were made to record blue whale vocalisations in 1998 (Ballance *et al.*, 2001), but without success. During the Voyage of the *Odyssey* in 2003–04 (Clark *et al.*, 2012) a total of 2,341 acoustic stations were

conducted, during 72 days at sea, with cetaceans recorded during 1612 (69%). This acoustic detection rate in Maldivian waters was 2.5 times higher than in areas of the eastern Indian and tropical Pacific also surveyed by the *Odyssey*. Cetacean detections consisted of delphinid species ($n = 1,260$), sperm whale ($n = 196$), killer whale ($n = 7$) and humpback whale (*Megaptera novaeangliae*) ($n = 1$).

WHALE AND DOLPHIN WATCHING

Spinner dolphins are particularly common in the Maldives (Anderson, 2005; Ballance *et al.*, 2001) and have become the focus of small-scale dolphin-watching ventures from tourist resorts. There are currently 95 resort islands in the Maldives. At least 20 offer excursions to see spinner dolphins. These excursions take advantage of the fact that many spinner dolphin schools (which feed out in the ocean at night) rest inside the atolls by day. They therefore enter through reef channels in the morning, and exit in the afternoon, on a fairly predictable schedule, which greatly increases the chances of successful encounters. Some excursions are run in the mornings, but most are offered in the afternoon, sometimes being marketed as a sunset cruise with the chance to see dolphins. One operator also offers multiday whale-watching cruises. These typically see several thousand individuals of anything up to 12 or more cetacean species during 7–10 days at sea (RCA, pers. obs.).

A recent global review of whale-watching (IFAW, 2009) estimated that over 14,000 tourists took part in dolphin and whale watching excursions in Maldives during 2008, spending over US\$580,000. This was up from an estimated revenue of US\$149,000 in 1998 (Hoyt, 2001).

FISHERIES INTERACTIONS AND PROTECTIVE MEASURES

There is no fishery for cetaceans in the Maldives today. Indeed, the capture of all cetaceans is specifically banned under Maldivian law (Fisheries Law, no. 5/87, iulaan no. FA-A1/29/93/14, 15 May 1993) as is the export of cetacean products (under the Import-Export Law, no. 31/79). The main fishing methods now used in the Maldives (pole and line for tuna and handline for reef fish and tuna) do not catch cetaceans. The lack of cetacean bycatch in the Maldivian tuna fishery was briefly noted by Lal Mohan (1994). There is also some pelagic longlining, although this is currently at a very low ebb following not only a recent ban on shark fishing and shark product exports, but also the current phasing out of licenses for foreign longliners. It is possible that there may have some cetacean entanglement by the longline fisheries, but there was no monitoring by observers and no data are available.

Pelagic gillnets, purse seines and trawls have never been used commercially in the Maldives, and have been banned for many years (Fisheries Law no. 5/87), mainly to protect the livelihoods of traditional pole and line tuna fishermen. Occasionally cetaceans entangled in bits of netting are stranded, but these are believed to have drifted into Maldivian waters from outside (Anderson *et al.*, 1999). There has also been some illegal pelagic gillnet fishing within the Maldivian EEZ by Sri Lankan vessels, but the extent of any cetacean bycatch is unknown.

A handline fishery for large yellowfin tuna (*Thunnus albacares*), aimed at the export market, started in Maldives in the mid-1990s. Fishermen use the presence of dolphins to locate the schools of yellowfin (Adam and Jauharee, 2009; Anderson, 2005; Anderson and Shaan, 1998; 1999). The species most commonly associated with yellowfin tuna is the spotted dolphin, although spinner dolphins do also associate. Yellowfin tuna and dolphins also regularly associate in Sri Lanka (De Silva and Boniface, 1991) and Omani waters (Ballance and Pitman, 1998).

ACKNOWLEDGEMENTS

We are grateful to the many Maldivian fishermen, and staff of the Marine Research Centre, who have provided information on cetaceans. We particularly thank Ibrahim Faizan and Zaha Waheed for their assistance with collecting information on cetacean strandings. We thank Hal Whitehead and an anonymous referee for critically reviewing this paper.

REFERENCES

- Adam, M.S. and Jauharee, A.R. 2009. Handline large yellowfin tuna fishery of the Maldives. *Indian Ocean Tuna Commission Working Party on Tropical Tunas* 15: 1–14.
- Alling, A., Gilligan, P.R., Gordon, J.C.D. and Papastravrou, V. 1984. Report to WWF/IUCN Indian Ocean Sperm Whale Project, Interim Rep., Jan–May 1984. Unpublished. [Available from the author].
- Alling, A.K. 1986. Records of odontocetes in the northern Indian Ocean (1981–1982) and off the coast of Sri Lanka (1982–1984). *J. Bombay Nat. Hist. Soc.* 83(2): 376–94.
- Anderson, R.C. 1990. Report of a pygmy killer whale from Maldivian waters with notes on other whales. *Rasain* 10: 148–56.
- Anderson, R.C. 1996. First records of Fraser's dolphin (*Lagenodelphis hosei*) from the Maldives. *J. South Asian Nat. Hist.* 2: 75–80.
- Anderson, R.C. 2002a. Barrier to the north. pp.58–60. In: Kiefner, R. (eds). *Whales and dolphins: cetacea world guide*. IKAN, Frankfurt, Germany.
- Anderson, R.C. 2002b. The Maldives whale net. pp.99–101. In: Kiefner, R. (eds). *Whales and dolphins: cetacea world guide*. IKAN, Frankfurt, Germany.
- Anderson, R.C. and Ahmed, H. 1993. Shark fisheries of the Maldives. Ministry of Fisheries and Agriculture, Maldives and FAO, Rome, 73pp.
- Anderson, R.C. 2004. Rare whale surfaces. *BBC Wildlife Magazine* 22(1): 25.
- Anderson, R.C. 2005. Observations of cetaceans in the Maldives, 1990–2002. *J. Cetacean Res. Manage.* 7(2): 119–36.
- Anderson, R.C. and Shaan, A. 1998. Association of yellowfin tuna and dolphins in Maldivian waters. *Rasain* 18: 149–58.
- Anderson, R.C. and Shaan, A. 1999. Association of yellowfin tuna and dolphins in Maldivian waters. *Indian Ocean Tuna Commission Proceedings*, 1:156–159. [Available from <http://www.iotc.org>].
- Anderson, R.C., Clark, R., Madsen, P.T., Johnson, C., Kiszka, J. and Breyse, O. 2006. Observations of Longman's beaked whale (*Indopacetus pacificus*) in the western Indian Ocean. *Aquat. Mamm.* 32: 223–31.
- Anderson, R.C., Shaan, A. and Waheed, Z. 1999. Records of cetacean 'strandings' from the Maldives. *J. South Asian Nat. Hist.* 4(2): 187–202.
- Anon. 1979. *Introduction to Maldivian commercial fishery*. Ministry of Fisheries, Malé, Maldives. 8pp.
- Anon. 1992. *Statistical yearbook of Maldives 1992*. Ministry of Planning and Environment, Malé, Maldives. 288pp.
- Anon. 1997. *Statistical yearbook of Maldives 1997*. Ministry of Planning, Human Resources and Environment, Malé, Maldives. 366pp.
- Arvy, L. 1972. Jean-Jacques Dussumier, master mariner and cetologist (1792–1883). *Invest. Cetacea* 4: 263–69.
- Ballance, L.T., Anderson, R.C., Pitman, R.L., Stafford, K., Shaan, A., Waheed, Z. and Brownell, R.L., Jr. 2001. Cetacean sightings around the Republic of the Maldives, April 1998. *J. Cetacean Res. Manage.* 3(2): 213–18.
- Ballance, L.T. and Pitman, R.L. 1998. Cetaceans of the western tropical Indian Ocean: Distribution, relative abundance, and comparisons with cetacean communities of two other tropical ecosystems. *Mar. Mammal Sci.* 14(3): 429–59.
- Ballance, L.T., Pitman, R.L., Reilly, S.B. and Force, M.P. 1996. Report of a cetacean, seabird, marine turtle and flying fish survey of the western tropical Indian Ocean aboard the research vessel *Malcolm Baldrige*, March 21–July 26, 1995. *NOAA Technical Memorandum NMFS NOAA-TM-NMFS-SWFSC-224*: 132pp.
- Bannister, J., Josephson, E.A., Reeves, R. and Smith, T. 2007. There she blew! Yankee sperm whaling grounds, 1760–1920. pp.109–32. In: Starkey, D., Holm, P. and Barnard, M.G. (eds). *Oceans past: management insights of marine animal populations*. Earthscan, London.
- Bell, H.C.P. 1940. *The Maldive Islands. Monograph on the history, archaeology and epigraphy*. Ceylon Government Press, Colombo. 204pp. 81 plates.
- Berzin, A.A. 2008. The truth about Soviet whaling. *Mar. Fish. Rev.* 70(2): 4–59.
- Blyth, E. 1859. On the great rorqual of the Indian Ocean, with notices of other cetals, and of the Syrenia or marine pachyderms. *J. Asiatic Soc. Bengal* 28: 481–98.
- Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B.G., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, M.N.M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell, R.L., Childerhouse, S., Findlay, K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljungblad, D.K., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F., Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K. and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales in the Southern Hemisphere and northern Indian Ocean. *Mammal Rev.* 37(2): 116–75.
- Brown, S.G. 1957. Whales observed in the Indian Ocean. Notes on their distribution. *Mar. Obs.* 27(177): 157–65.
- Buttress, S. 2001. Rhythm of the blues. *BBC Wildlife Magazine* 19(2): 19.
- Chivers, S., Baird, R.W., McSweeney, D.J., Webster, D.L., Hedrick, N.M. and Salinas, J.C. 2007. Genetic variation and evidence for population structure in eastern North Pacific false killer whales (*Pseudorca crassidens*). *Can. J. Zool.* 85: 783–94.
- Clapham, P. and Ivashchenko, Y. 2009. A whale of a deception. *Mar. Fish. Rev.* 71: 44–52.
- Clark, A.H. 1887. The whale fishery. Part XV. In: Goode, G.B. (eds). *The Fisheries and Fishery Industries of the United States. Section V. History and methods of the fisheries. Vol. II*. Prepared through the co-operation of the Commissioner of the Fisheries and the Superintendent of the Tenth Census. Government Printing Office, Washington DC. 2 vols, with an atlas of 225 plates.
- Clark, R.A., Johnson, C.M., Johnson, G., Payne, R., Kerr, I., Anderson, R.C., Sattar, S.A., Godard, C.A.J. and Madsen, P.T. 2012. Cetacean sightings and acoustic detections in the offshore waters of the Maldives during the northeast monsoon seasons of 2003 and 2004. *J. Cetacean Res. Manage.* 12(2): 227–234. [This volume].
- Cousteau, J.Y. and Diolé, P. 1971. *Life and Death in a Coral Sea*. Doubleday and Co, New York. 302pp. [English translation from the French].
- Cousteau, J.Y. and Diolé, P. 1972. *The Whale*. Doubleday and Co, New York. 304pp. [English translation from the French].
- Dalebout, M. 2002. Bare bones and beaked whales. *Nature Australia* 27(6): 64–71.
- Dalebout, M.L., Baker, C.S., Steel, D., Robertson, K.M., Chivers, S.J., Perrin, W.F., Mead, J.G., Grace, R.V. and Schofield, T.D. 2007. A divergent mtDNA lineage among *Mesoplodon* Beaked whales: Molecular evidence for a new species in the Tropical Pacific? *Mar. Mammal Sci.* 23(4): 954–66.
- Dalebout, M.L., Ross, G.J.B., Baker, C.S., Anderson, R.C., Best, P.B., Cockcroft, V.G., Hinsz, H.L., Peddemors, V. and Pitman, R.L. 2003. Appearance, distribution and genetic distinctiveness of Longman's beaked whale, *Indopacetus pacificus*. *Mar. Mammal Sci.* 19(3): 421–61.
- Dawbin, W.A., Noble, B.A. and Fraser, F.C. 1970. Observations on the electra dolphin, *Peponocephala electra*. *Bull. Br. Mus. Nat. Hist. Zool.* 20(6): 175–201.
- De Boer, M.N., Baldwin, R., Burton, C.L.K., Eyre, E.L., Jenner, K.C.S., Jenner, M.N.M., Keith, S.G., McCabe, K.A., Parsons, E.C.M., Peddemors, V.M., Rosenbaum, H.C., Rudolph, P. and Simmonds, M. 2002. Cetaceans in the Indian Ocean Sanctuary: A review. Paper SC/54/O5 presented to the IWC Scientific Committee, April 2002, Shimonoseki, Japan (unpublished). 60pp. [Paper available from the Office of this Journal].
- De Silva, J. and Boniface, B. 1991. The study of the handline fishery on the west coast of Sri Lanka with special reference to the use of dolphin for locating yellowfin tuna (*Thunnus albacares*). *IPTP Coll. Vol. Work. Docs.* 4: 314–24.
- Deraniyagala, P.E.P. 1956. Zoological collecting in the Maldives. *Spolia Zeylan.* 28: 79–85.
- Deraniyagala, P.E.P. 1963. Mass mortality of the new subspecies of little piked whale *Balaenoptera acutorostrata thalmaha* and a new beaked whale *Mesoplodon hotaula* from Ceylon. *Spolia Zeylan.* 30: 80–84.
- Didi, A.M. 1983. Maa keyolhu kan. *Rasain* 3: 42–45. [In Dhivehi].

- Galver, M.A. 2002. The molecular ecology of spinner dolphins, *Stenella longirostris*: genetic diversity and population structure, University of California, San Diego.
- Gilpatrick, J.W., Perrin, W.F., Leatherwood, S. and Shiroma, L. 1987. Summary of distribution records of the spinner dolphin, *Stenella longirostris*, and the pantropical spotted dolphin, *S. attenuata*, from the western Pacific Ocean, Indian Ocean and Red Sea. *NOAA Technical Memorandum NMFS NOAA-TM-NMFS-SWFC-89*: 42pp.
- Gode, P.K. 1949. History of ambergris in India between about AD 700 and 1900. *Chymia (Annual Studies in the History of Chemistry, Philadelphia)* 2: 51–56.
- Godfrey, T. 1996. *Dive Maldives: a guide to the Maldives Archipelago*. Atoll Editions, Melbourne, Australia. 136pp.
- Gordon, J.C.D. 1991. The World Wildlife Fund's Indian Ocean sperm whale project: An example of cetacean research within the Indian Ocean Sanctuary. pp.219–39. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. UNEP Marine Mammal Technical Report No. 3, Nairobi, Kenya. 287pp.
- Gray, A. 1890. *The voyage of Francois Pyrrard of Laval to the east Indies, the Maldives, to the Moluccas and Brasil: translated into English from the third French edition of 1619, and edited with notes by Albert Gray assisted by H.C.P. Bell*. Vol. 3. Hakluyt Society, London.
- Gulland, F.M.D., Dierauf, L.A. and Rowles, T.K. 2001. Marine mammal stranding networks. pp.45–68. In: Dierauf, L. and Gulland, F.M.D. (eds). *CRC Handbook of Marine Mammal Medicine*. CRC Press, Boca Raton, USA.
- Heyd, W. 1879. *Histoire du commerce du Levant au moyen-age. Volume 2. Leipzig*. New edition Leipzig 1936, Leipzig.
- Hill, J.E. 1958. Some observations on the fauna of the Maldives Islands, Part II: Mammals. *J. Bombay Nat. Hist. Soc.* 55: 3–10.
- Hockley, T.W. 1935. *The Two Thousand Islands: a short account of the people, history and customs of the Maldivian Archipelago*. Witherby, London. 191pp.
- Hoyt, E. 2001. Whale watching 2001 – worldwide tourism, numbers, expenditures and expanding socioeconomic benefits. Report to IFAW, Crowborough, Sussex, UK. 157pp. [Available from www.ifaw.org].
- Hydrographic Office. 2007. *West coast of India pilot*. Fifteenth ed. Hydrographic Office, Taunton, UK. 354pp.
- Ibrahim, S. 1991. Maa keyolhu kan. *Rasain* 11: 27–30. In Dhivehi.
- IFAW. 2009. Whale Watching Worldwide: Tourism numbers, expenditures and economic benefits. A special report from IFAW. 295.
- Kasuya, T. and Wada, S. 1991. Distribution of large cetaceans in the Indian Ocean: data from Japanese sightings records, November–March. pp.139–70. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. United Nations Environment Programme Marine Mammal Technical Report No. 3, Nairobi, Kenya. 287pp.
- Klinowska, M. 1991. *Dolphins, Porpoises and Whales of the World. The IUCN Red Data Book*. IUCN, Gland, Switzerland and Cambridge, UK. viii + 429pp.
- Kohn, A.J. 1964. Notes on Indian Ocean atolls visited by the Yale Seychelles Expedition. *Atoll Res. Bull.* 101: 1–13.
- Lal Mohan, R.S. 1994. Review of gillnet fisheries and cetacean bycatches in the northeastern Indian Ocean. *Rep. int. Whal. Commn (special issue)* 15: 329–43.
- Leatherwood, S. 1986. *Whales, Dolphins and Porpoises of the Indian Ocean Cetacean Sanctuary: A Summary of Available Information*. UNEP, Nairobi. 264pp.
- Leatherwood, S., McDonald, D., Prematunga, W.P., Girton, P., Ilangakoon, A. and McBrearty, D. 1991. Records of the 'Blackfish' (killer, false killer, pilot, pygmy killer and melon-headed whales) in the Indian Ocean, 1772–1986. pp.33–65. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. UNEP Marine Mammal Technical Report No. 3, Nairobi, Kenya. 287pp.
- Leatherwood, S., Peters, C.B., Santerre, R., Santerre, M. and Clarke, J.T. 1984. Observations of cetaceans in the northern Indian Ocean Sanctuary, November 1980–May 1983. *Rep. int. Whal. Commn* 34: 509–20.
- LeDuc, R.G., Dizon, A.E., Goto, M., Pastene, L.A., Kato, H., Nishiwaki, S., LeDuc, C.A. and Brownell, R.L. 2007. Patterns of genetic variation in Southern Hemisphere blue whales, and the use of assignment test to detect mixing on the feeding grounds. *J. Cetacean Res. Manage.* 9(1): 73–80.
- Ma Huan. 1970. *Ying-yai Sheng-lan, the overall survey of the ocean's shores (1433), translated from the Chinese text edited by Feng Ch'eng Chun, with introduction, notes and appendices. Translated by J.V.G. Mills*. The Hakluyt Society, Cambridge. 393pp.
- Mikhalev, Y.A. 1996. Pygmy blue whales of the northern-western Indian Ocean. Paper SC/48/SH30 presented to IWC Scientific Committee, June 1996, Aberdeen, UK (unpublished). 30pp. [Paper available from the Office of this Journal].
- Mikhalev, Y.A. 1997. Humpback whales, *Megaptera novaeangliae* in the Arabian Sea. *Mar. Ecol. Prog. Ser.* 149: 13–21.
- Mikhalev, Y.A. 2000. Whaling in the Arabian Sea by the whaling fleets *Slava* and *Sovetskaya Ukraina*. pp.141–81. In: Yablokov, A.V., Zemsky, V.A. and Tormosov, D.D. (eds). *Soviet Whaling Data (1949–1979)*. Centre for Russian Environmental Policy, Moscow. 408pp.
- Molinari, R.L., Olsen, D. and Reverdin, G. 1990. Surface current distribution in the tropical Indian Ocean derived from compilations of surface buoy trajectories. *J. Geophys. Res.* 95(C): 7217–38.
- Moore, J.C. and Gilmore, R.M. 1965. A beaked whale new to the western hemisphere. *Nature* 205: 1239–40.
- Mörzer-Bruyns, W.F.J. 1971. *Field Guide of Whales and Dolphins*. C.A. Meese, Amsterdam. 258pp.
- Ocean Alliance. 2009. *The voyage of the Odyssey*. Ocean Alliance, Gloucester, Maine. 176pp.
- Perrin, W.F. 1990. Subspecies of *Stenella longirostris* (Mammalia: Cetacea, Delphinidae). *Proc. Biol. Soc. Wash.* 103(2): 453–63.
- Perrin, W.F., Miyazaki, N. and Kasuya, T. 1989. A dwarf form of the spinner dolphin (*Stenella longirostris*) from Thailand. *Mar. Mammal Sci.* 5(3): 213–27.
- Pitman, R.L. 2002. Alive and whale: a missing cetacean resurfaces in the tropics. *Nat. Hist.* 111(7): 32–36.
- Reeves, R.R., Leatherwood, S. and Papastavrou, V. 1991. Possible stock affinities of humpback whales in the northern Indian Ocean. pp.259–69. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. United Nations Environment Programme, Nairobi, Kenya. 287pp.
- Shaan, A. 2001. Humpback whale in Maldives. *Rasain* 21: 212–16.
- Shankar, D., Vinachandran, P.N. and Unnikrishnan, A.S. 2002. The monsoon currents in the north Indian Ocean. *Prog. Oceanogr.* 52: 63–120.
- Slijper, E.J., van Utrecht, W.L. and Naaktgeboren, C. 1964. Remarks on the distribution and migration of whales, based on observations from Netherlands ships. *Bijdr. Dierkd.* 34: 3–93.
- Townsend, C.H. 1935. The distribution of certain whales as shown by logbook records of American whalships. *Zoologica (NY)* 19(1–2): 1–50+6 maps.
- UNDP. 1966. *Report on a mission to the Maldivian Islands*. UNDP. 124pp.
- Whitehead, H. 1989. *Voyage to the Whales*. Robert Hale, London. xi+195pp.
- Whitehead, H., Gilligan, P., Smyth, C., Weilgart, L. and Converse, C. 1983. WWF/IUCN Indian Ocean Whale Project. Interim Report, Oct–Dec. 1983. (Unpublished.) 34pp. [Available from the author].
- Wilson, C.E., Perrin, W.F., Gilpatrick, J.W., Jr. and Leatherwood, J.S. 1987. Summary of worldwide locality records of the striped dolphin, *Stenella coeruleoalba*. *NOAA Tech. Mem. NMFS SWFSC* 90. 65pp.
- Wise, J.P., Payne, R., Wise, S.S., Lacerte, C., Wise, J., Gianios, C., Thompson, W.D., Perkins, C., Zheng, T., Zhu, C., Benedict, L. and Kerr, I. 2009. A global assessment of chromium pollution using sperm whales (*Physeter macrocephalus*) as an indicator species. *Chemosphere* 75(11): 1461–67.
- Wray, P. and Martin, K.R. 1983. Historical whaling records from the western Indian Ocean. *Rep. int. Whal. Commn (special issue)* 5: 213–41.
- Wyrtrik, K. 1973. Physical oceanography of the Indian Ocean. pp.18–36. In: Zeitschel, B. and Gerlach, A. (eds). *The Biology of the Indian Ocean*. Springer-Verlag, Berlin. 549pp.
- Yablokov, A.V. 1994. Validity of Soviet whaling data. *Nature, Lond.* 367(6,459): 108.
- Yamada, K. 1955. A short history of ambergris and its trading by the Arabs and Chinese in the Indian Ocean. *Kinki Daigaku Sekai Keizai Kenkyujo Kenkyu Hokoku (Report of the Institute of World Economics, Kinki University)* 8.
- Young, G. 1981. *Slow Boats to China*. Hutchinson, London. 488pp.

Date received: May 2010.

Date accepted: October 2010.

