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Nesting and Stranding of the Loggerhead Sea Turtle on the Pacific Coast of the Boso Peninsula, Central Japan, in 2007

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Abstract Nesting and stranding events of loggerhead sea turtles, *Caretta caretta*, were investigated along the Pacific coast of the Boso Peninsula, from Choshi to Katsuura, Japan, from May to November 2007. The 90 km coast line, represents the northernmost nesting site for the species in Japan, with three major nesting locations: Hiari-Izumiura beach, Isumi; Nakazato-Kouji beach, Shirako; and Kidohama beach, Yokoshibahikari. Seventeen nesting events were recorded, of which the presence of 12 nests was confirmed. Twenty-four stranded individuals, 14 of which were subadults and juveniles, were recorded. The low nesting activity compared with other areas in Japan might be attributed to the relatively short period appropriate for nesting and hatching given the temperate latitude. The unusually high stranding rate of subadult and juvenile turtles may suggest that the region is a feeding ground for immature loggerhead sea turtles.

Key words: *Caretta caretta*, loggerhead sea turtle, nesting observation, stranding survey, subadult and juvenile turtles, Boso Peninsula.

The Japanese Archipelago is the major nesting ground for the loggerhead sea turtle *Caretta caretta* in the North Pacific, with beaches primarily located along the central and southern coast of the archipelago. There is substantial information on the nesting habitat in the southern part of the Japanese archipelago, i.e., Kagoshima, Miyazaki, Shizuoka, Okinawa, and Wakayama (Kamezaki *et al.*, 2003), but data from the northern sites still remain scarce. Since 1990, the numbers of nests and of nesting females has been rapidly declining at several nesting sites (Sato *et al.*, 1997), although factors behind such changes remain unclear. Accumulation of fundamental data is therefore important for management and conservation of this endangered species.

The primary purpose of this investigation was to ascertain nesting activity of loggerhead sea turtles at the northernmost nesting location in Japan. In succeeding the pre-investigation from 2000 to 2006 at Isumi, the author developed the study work during the summer of 2007, assisted by the presence of the Sea Turtle Protection Regulation of Isumi. In this paper, the author reports nesting, hatching, and stranding of the loggerhead turtles investigated in 2007 along the Pacific coast of the Boso Peninsula, from Choshi to Katsuura. The study sites represent the northernmost localities of nesting grounds of the species in the Northwestern Pacific.

Materials and Methods

The study area ranged from Choshi to Katsuura (about 90 km), involving a long sandy beach line at Kujyukuri-hama (Figs.1, 2). The coastal area from Isumi to Kujyukuri is characterized by the presence of a shallow shelf extending 10–40 km offshore. A shallow shelf (about 20–50 m deep) extends up to 25–30 km offshore of the region. There are three major breeding sites for loggerhead turtles: Hiari-Izumiura beach, located at the mouth of Isumi River (Isumi); Nakazato-Kouji beach, located at the mouth of Nabaki River (Shirako); and Kidohama beach located at the mouth of Kuriyama River (Yokoshibahikari).

Observations at Isumi, were made via daily patrols and seashore cleanup work. From May to November, members of the Hiari-Izumiura Sea Turtle Protection Society and Caretta Isumi made regular patrol and observations from 04 : 30 to 07 : 30 hr and from 17 : 00 to 18 : 30 hr every day. Collaborative works were made with the members of the Division of Agriculture, Forestry and Fisheries of Isumi City (DAFFI) for records of landing, nesting and hatching events.

Sea turtle landings were confirmed through tracks made by adult females. Nestings were generally recognized from the presence of body pits and/or sand

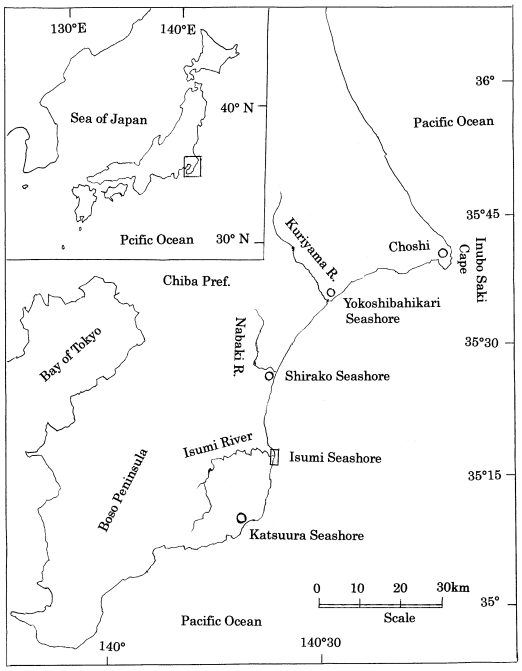

Fig. 1. Map of the nesting area of loggerhead turtle of Boso Peninsula, central Japan.

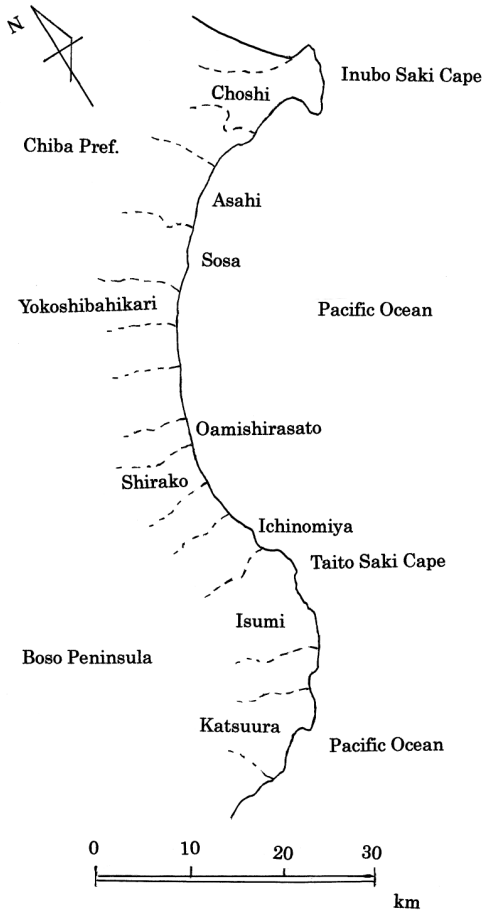

Fig. 2. Location map of the surveyed area.

covers over the clutches made by adult female turtles. Positions of nests were confirmed by the members of DAFFI by searching for and locating a few eggs at the top of each clutch, followed by the placement of protective enclosures or barricades with the identification placards around the nest.

Hatching was primarily confirmed by the presence of excavation marks and tracks of emerged hatchlings. In order to detect subsequent juvenile's hatchings after initial emergence, all previous hatchling tracks on the sand were cleared around the enclosure during each evening patrol. This made us possible to confirm subsequent emergence of juveniles for succeeding 10 days. Hatching success or emergence success was confirmed by excavating the clutches after more than 10 days from the initial hatching emergence.

Data on stranded sea turtles was examined from a database accumulated by Chiba Prefecture, which maintains three different size measurements depending on the local governments involved, namely straight carapace length (SLCnt), maximum carapace length (SLCmax), and total body length (measured from the top of the head to the posterior end of the carapace, TBD). The straight carapace length was used as a standard measurement, and values made by other methods were translated to this format where possible. The data provided by Ever Lasting Nature of Asia (2007) was referred for two individuals stranded at Oamishirasato (STOA701 and 702).

Results

Landing and nesting at Isumi to Kujyukuri

Landing and nesting of the loggerhead sea turtles in 2007 is summarized in Table.1. The total number of the landings was 17, including one at Sosa, two at Yokoshibahikari, one at Oamishirasato, five at Shirako and eight at Isumi. The total number of nestings was 12, including two at Yokoshibahikari, one at Oamishirasato, three at Shirako and six at Isumi.

Observations at Isumi

A total of six nests were observed (Table 1). One clutch (IS0705) was moved to a sand mound 2 m

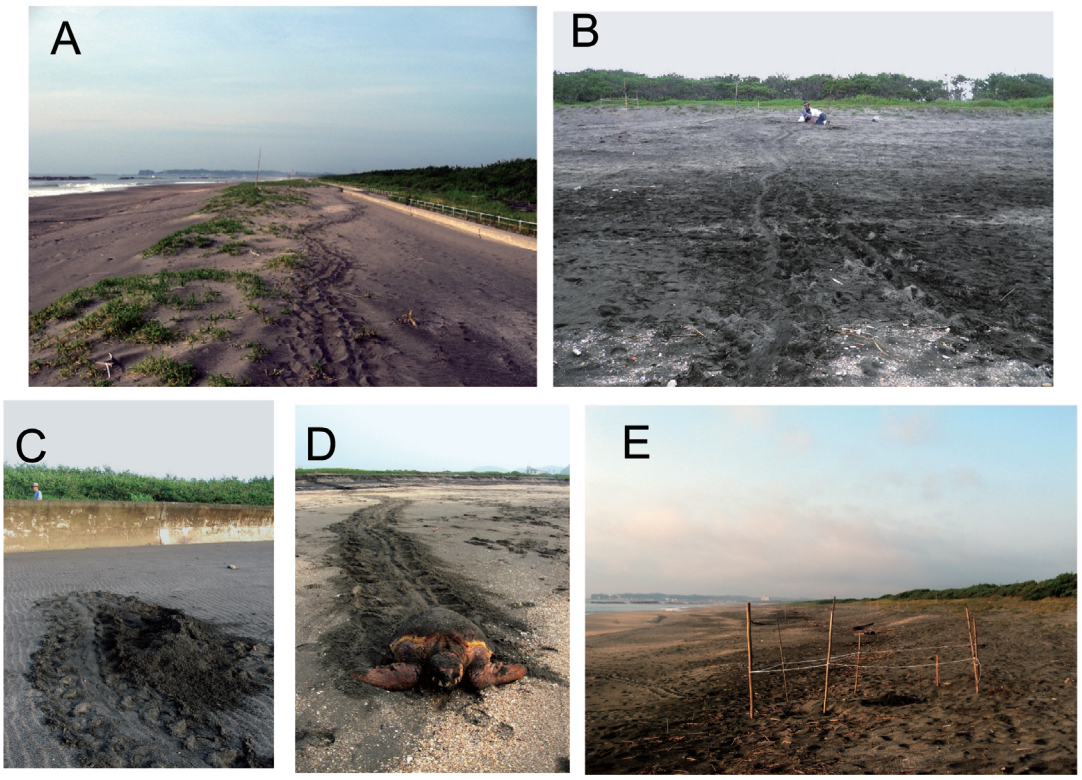

Fig. 3. A, Long landing tracks of a loggerhead sea turtle (*Caretta caretta*) along concrete embankment, Izumiura Beach, 19 June 2007 ; B, preparation of protective enclosure (landing tracks seen on the foreground), Izumiura Beach, 29 June 2007 ; C, body pit and tracks in front of concrete embankment, Hiariura Beach, 5 July 2007 ; D, adult female oviposited (CCL = 82.5cm), North Beach, 29 July 2007 ; E, nest with enclosure, Izumiura Beach, 26 August 2007.

Table 1. Data of landing and nesting of the logger head turtles found in Isumi to Kujyukuri area in 2007.

Locality	Nest Id. No.	Date of landing	Nesting	Location	Clutch size	Date of emergence	Emergency rate (%)	Remarks
Sosa	SS0701	2007/7/20	Unidentified	Notehama	unidentified	—	37.1	Egg searchinhg was not made.
Yokoshibahikari	YH0701	2007/8/3	Yes	Naritasanshita	unidentified	—	no precise data	Nest was lost by typhoon.
	YH0702	2007/8/4	Yes	Kidohama east	124	2007/10/11	87.5	—
Oamishirasato	OA0701	Unknown	Yes	Shirasatochuo	unidentified	2007/10/18	—	30 juveniles and 9 unhatched eggs were
Shirako	SH0701	2007/6/20	Yes	Washi	120	2007/8/27	no data	found
	SH0702	2007/7/14	No	Nakazato	—	—	88.4	—
	SH0703	2007/7/23	Yes	Hmajyuku	unidentified	2007/9/21	—	—
Isumi	SH0704	2007/7/25	Yes	Kouji	112	2007/9/14	61.3	Mischieves after emergence
	SH0705	2007/8/14	No	Sorigane	—	—	95.4	Moved on 5 September
	IS0701	2007/6/10	Yes	Izumiura	119	2007/8/18	32.8	—
	IS0702	2007/6/19	Yes	Izumiura	108	2007/8/26	—	—
	IS0703	2007/6/29	Yes	Izuimiura	131	2007/8/26	82.1	—
	IS0704	2007/7/5	No	North beach	—	—	94.4	—
	IS0705	2007/7/5	Yes	Hiariura	112	2007/8/31	0	—
	IS0706	2007/7/29	Yes	North beach	126	2007/9/22	—	Moved
	IS0707	2007/8/26	Yes	Izuimiura	119	—	—	Oviposit female was found.
	IS0708	2007/9/2	No	Hiariura	—	—	—	Killed by typhoons.

higher than the original position, while the remaining five clutches were preserved *in-situ*. Of the five *in-situ* clutches, IS0707 was inundated and did not hatch, while the remaining four clutches, IS0701, IS0702, IS0703 and IS0706 hatched successfully. The average emergence success rate for these clutches was 69.8%. The highest emergence success rate was seen in nest IS0702 (95.4%), while the lowest was seen in nest IS0703 (32.8%). The moved clutch IS0705 (deposited on 5 July 2007 and moved to a mound 600 m north and 2 m higher from the original position, to avoid inundation by typhoons and high tides) had an emergence success rate of 82.1%.

At Isumi, the hatching investigation for all six

Table 2. Duration of emergence of hatchlings observed at Isumi in 2007.

Clutch	Date of	Date of initial incubation		No. of emerging individuals											Remarks
	nesting	emergence	duration	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	9th day	10th day	Total	
CL0701	61007	81807	70 days	58	0	0	7	1	5*	0	1	1	0	73	*1 individual dead on beach
CL0702	61907	82607	70 days	102	1	0	0	0	0	0	0	0	0	103	
CL0703	62907	82607	62 days	25*	5	2	6	0	0	0	0	4	1	43	*hatched at 4 a.m.
CL0704	70507	83107	57 days	81	5	0	6	0	0	0	0	0	0	92	moved
CL0705	72907	92207	56 days	116	0	0	1	1	1	0	0	0	0	119	

Table 3. Records of stranding of sea turtles in the Pacific coast of Boso Peninsula from Choshi to Katsuura in 2007.

City	No.	Date	Species	Location	SCLnt(cm)	SCLmax(cm)	SCW(cm)
Choshi	STCH0701	2007/5/28	*Caretta caretta*	Naarai	—	85*	—
Asahi	STAS0701	2007/6/21	*Caretta caretta*	Nonaka	90	—	65
	STAS0702	2007/6/21	*Caretta caretta*	Nonaka	65	—	60
	STAS0703	2007/8/16	*Caretta caretta*	Mikawa	90	—	65
Sosa	STSS0701	2007/7/20	*Caretta caretta*	Kayatahama	55	—	—
	STSS0702	2007/7/20	*Caretta caretta*	Kayatahama	65	—	—
Yokoshibahikari	STYH0701	2007/8/4	*Caretta caretta*	Yakata SB	80	—	60
Oamishirasato	STOA0701	2007/6/3	*Caretta caretta*	Shitengi	82.2	110*	—
	STOA0702	2007/6/4	*Caretta caretta*	Shitengi	70.5	90*	59.7
	STOA0703	2007/8/12	*Chelonia mydas*	Shitengi	53.2	70*	—
	STOA0704	2007/8/15	*Caretta caretta*	Kitaimaizumi	83.3	110*	—
Shirako	STSH0701	2007/6/26	*Caretta caretta*	Hamajyuku	—	90	60
	STSH0702	2007/6/29	Unidentified	Hatto	—	45	40
	STSH0703	2007/7/10	*Caretta caretta*	Sorigane	—	60	45
	STSH0704	2007/7/17	*Caretta caretta*	Nakazato	—	100	50
Isumi	STIS0701	2007/8/13	*Chelonia mydas*	North Beach	—	38	32
	STIS0702	2007/8/25	*Chelonia mydas*	Hiariura	—	60	35
	STIS0703	2007/9/3	*Caretta caretta*	Hiariura	—	70	50
	STIS0704	2007/10/12	*Caretta caretta*	Shiota	—	75	58
	STIS0705	2007/10/12	*Caretta caretta*	Misaki WKC	—	70	50
	STIS0706	2007/10/12	*Caretta caretta*	Hiariura	—	75	55
Katsuura	STKU0701	2007/5/16	*Caretta caretta*	Moriya	68	—	57
	STKU0702	2007/5/16	*Caretta caretta*	Okitsu	73	—	65
	STKU0703	2007/5/26	*Caretta caretta*	Kushihama	70	—	65
	STKY0704	2007/6/13	*Caretta caretta*	Moriya	80	—	60
	STKU0705	2007/6/13	*Caretta caretta*	Ubara	76	—	60
	STKU0706	2007/6/14	*Caretta caretta*	Kushihama	70	—	58
	STKY0707	2007/7/26	*Chelonia mydas*	Ubara	48	—	37
	STKU0708	2007/8/6	*Eretmochelys imbricata*	Kushihama	35	—	28
	STKU0709	2007/9/6	*Caretta caretta*	Okitsu	85	—	67

clutches was made on 30 November 2007. The ovipositing female (CCL 83.0cm, CCW 82.5 cm) of clutch IS0706 was found in the early morning of 29 July 2007 (Fig. 3D). Emergence of hatchlings subsequent to initial emergence was observed for all five hatched nests. It ended from two to 10 days after each initial emergence, although the number of individuals was low (Table 2).

All 119 eggs of clutch IS0707 (deposited on 26 August 2007) were lost because of inundation caused by two typhoons (Typhoon No. 9 on 7 September 2007 and Typhoon No. 20 on 27 October 2007). The nest was immersed for 12 and 20 hours, respectively, during the two typhoons.

The overall mean emergence success rate for all six clutches was 60.1%. The average emergence success rate of the five surviving clutches was 72.1%. For clutch IS0707 (deposited on 26 August 2007), the developmental stages of more than half of unhatched embryos were considered to have reached 22nd to 29th stages (*sensu* Miller 1985). This indicates that development of embryos was fairly advanced until death in spite of hatching failure of this clutch.

Observations at Yokoshibahikari

There were only two nestings observed at Yokoshibahikari. In clutch YH0702 (124 eggs), only 46 eggs hatched, with 78 eggs unhatched (emergence success rate 37.1%). All eggs of clutch YH0701 were washed away by Typhoon No.9 on 5 September 2007 (K. Ohki, personal communication).

Observations at Oamishirasato

Only one nesting (clutch OA0701) was recorded at Shirasato-Chuo Beach, although the exact date of landing or nesting was unknown. This clutch was not observed in detail. Nevertheless, about 30 tracks from emerged hatchlings were found by local people on 18 October 2007 (M. Kajiro, personal communication).

Observations at Shirako

Although three nests were recorded at Shirako, the emergence success rate could be measured only for two clutches (SH0701, 87.5% ; SH0704, 88.4%). Hatchlings emerged from the nest SH0701 naturally. All eggs of clutch SH0704 were moved 42 days after oviposition (S. Misono, personal communication). Clutch SH0703 was disturbed by villagers after the hatchling emergence was confirmed; however, there were no precise information on the number of eggs and emergence success rate.

Strandings of sea turtles from Choshi to Katsuura

Twenty-four stranded loggerhead sea turtles were recorded along the coast from Choshi to Katsuura in 2007, as follows: one individual at Choshi, three at Asahi, two at Sosa, one at Yokoshibahikari, three at Oamishirasato, three at Shirako, four at Isumi and seven at Katsuura. In addition, there were stranding records of other sea turtle species, including four green sea turtles *Chelonia mydas*, one hawksbill *Eretmochelys imbricata* and one unidentified species.

The measurements of the stranded loggerhead turtles are summarized in Table 3. SCLnt values for Asahi, Sosa, Yokoshibahikari, Oamishirasato and Katsuura (n = 16) ranged from 55 to 90 cm with an average of 75.1 cm. SCLmax values for Shirako and Isumi (n=7) ranged from 60 to 100 cm with an average of 77.1 cm. At Oamishirasato (n=3), SCLnt values measured for two individuals at Oamishirasato were 82.2 cm for STOA0701 and 70.5 cm for STOA0702, while the estimated value of SCLnt from photograph was 83.3cm (TBL=110cm) for STOA0704.

It is worth mentioning that the ratio of the number of subadults and juveniles to adults was greater compared with other major nesting areas in Japan (see Kamezaki *et al*., 2003).

Discussion

A total of 12 nests were recorded during the study. The area represents the northernmost nesting locality of the species, and thus the number of nests was considerably lower than that found at other Japanese localities (see Matsuzawa *et al*., 2002 ; Sato *et al*., 1997). The relatively lower nesting activity compared with other areas in Japan might be attributed to various factors including the high latitudinal position (resulting in a relatively short period suitable for nesting, and low atmospheric temperatures). Furthermore, in the last 20 years, beaches from Isumi to Kujyukuri have been reduced in size because of the loss of sand to erosion (Uda and Seino, 2001), and this may also affect the frequencies of nesting. The major cause of death to embryos was attributed to inundation following typhoon storm surge and high tides (Foley *et al*., 2006).

Recent studies have shown that the loggerhead turtles may prefer nesting environments with low salt contents (Wood *et al*., 2000). In this study, 12 nests were all found near the river mouth, where salinity of surrounding waters and substratum is relatively low, supportig the observation by Wood *et al*. (2000).

In addition to the present report of 30 stranded sea turtles along the coast from Choshi to Katsuura in 2007, there were 84 stranded sea turtles (including 41 loggerheads, 36 greens, etc.) were reported in the Kanto District, including Chiba, Ibaraki, Kanagawa and Tokyo, according to the data gathered by Ever Lasting Nature of Asia (2007). Various factors causing stranding of sea turtles have been reported (Virginia Institute of Marine Science, 2008). Studies at Baja California Sur, Mexico, indicated high mortality rate of juvenile loggerheads due to bycatch of small-scale fisheries, e.g., bottom-set gillnet and longline fleets (Peckham et al., 2007). However, we have little information on the causes of stranding and bycatch of sea turtles at Boso Peninsula (Ever Lasting Nature of Asia, 2007, 2008). During this study, we did encounter individuals, which were possibly killed either by water bike or boat propeller accident, at Oamishirasato and Isumi beaches.

It is well known that the loggerhead turtles hatched in Japanese beaches, reaching the vicinity of Baja California in the eastern Pacific, and as they grow, they return and recruit to feeding grounds

around Japan (Bowen *et al*., 1995 ; Hatase *et. Al*., 2002 ; Seminoff *et al*., 2004 ; Polovina *et al*., 2002, 2004, 2006 ; Peckham *et al*., 2007). Although the occurrence of young individuals between 29.5 ℃N and 43 ℃N and 150 ℃E and 154 ℃W has been confirmed (Polovina *et al*., 2002, 2004, 2006; Parker *et al*., 2005), they are scarce in Japanese waters (Matsuzawa *et al*., 2002; Nobetsu *et al*., 2004, 2005).

Among the 24 loggerhead turtles stranded from Isumi to Kujyukuri in 2007, 10 individuals (CCL 70–79 cm ; 41.7%) were classed as subadults possibly waiting for sexual maturity (Limpus et al., 2003) ; and four individuals (CCL 55–65cm; 16.7%) were classed as juveniles based on their small size (Bjorndal *et al*., 2001, 2000). The combined ratio of subadults and juveniles was 58.4% of the total stranded loggerhead turtles.

Considering the scarcity of the stranding records of subadults and juveniles of the loggerhead turtles at other Japanese localities, the comparatively high rate of stranded young sea turtles in the study area is remarkable. Based on the small size of these individuals, it is possible that the marine habitat near the Boso Peninsula act as feeding grounds for young loggerheads. In fact, the northern half of the Pacific side of the Boso Peninsula has shallow shelf extending to 10–40 km offshore, which provides an important fishery ground in local waters, and likely provides valuable food resources for loggerheads in the area.

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2007 年度房総半島におけるアカウミガメの産卵および漂着死骸について

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房総半島はアカウミガメ*Caretta caretta*の北太平洋域における繁殖北限域として知られているが，筆者はいすみ市における 2000〜2006 年度の観察・基礎調査を拡充する形で，2007 年度に九十九里海岸（銚子〜勝浦間約 90 km）でアカウミガメの繁殖状況（上陸・産卵・孵化）と漂着死骸について調査し，その結果を集約した．アカウミガメの上陸は 17 回，うち産卵 12 回で，そのうち孵化確認は９回であった．いすみ市における観察において，子ガメが孵化した５例のすべてにおいて初期脱出日の後，2〜10 日かけて子ガメが孵化し自力脱出したことが観察された．またアカウミガメの漂着死骸数は 24 頭で、うち 14 頭は甲サイズ測定の結果から幼体と亜成体であることが判明した．わが国の主要アカウミガメ繁殖地（鹿児島，宮崎等）では幼体と亜成体の出現頻度はきわめて少ないことが知られており，本調査において幼体と亜成体の割合（58.4%）が突出して大きかったことは，アカウミガメ繁殖北限域である九十九里地域が繁殖年齢到達前の亜成体や幼体が生育・摂餌する海域となっていることを示唆するものと考えられる．