Aquatic Mammals 1988, **14.2**, 49–62

Twenty-two months in the life of a juvenile wild bottlenose dolphin

R. J. Morris

Institute of Oceanographic Sciences, Wormley, Godalming, Surrey, GU8 5SU

and C. Lockyer

Sea Mammal Research Unit, c/o British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET

Introduction

There have been several detailed records of the lifestyles and habits of schools of wild dolphins (Caldwell, 1955; Conner & Smolker, 1985; Gruber, 1981; Shane, 1977; Shane & Schmidly, 1978; Saayman & Tayler, 1979; Saayman, Tayler & Bower, 1973; Wells, 1978; Wells, Irving & Scott, 1980; Wursig & Wursig, 1979, 1980). Only when an animal (or animals) is in permanent residence in a marine area accessible to man can concise observations be made over any extended period of time. Dobbs (1977, 1981, 1984, 1987), Hussenot (1980), Lockyer (1978), Lockyer *et al.* (1978), Lockyer & Morris (1985*a*, 1986), Pelletier (1985), Webb (1978*a*,*b*) have given accounts of solitary resident dolphins.

This paper is a record of observations and data acquired over a 22-month period from January 1984. During that time a juvenile, male bottlenose dolphin (*Tursiops truncatus*), 'Simo', was a resident of a sea area off Solva on the west coast of Wales.

1. Observations

(a) Species and Sex

Simo was identified as a male bottlenosed dolphin, *Tursiops truncatus Montagu*. Local swimmers first observed the exposed penis briefly during a 'play' session in September 1984 (D. Carnby-Lewis, personal comment). The body was grey, paling to white ventrally. From a large number of photographs taken during August–September 1984 his length was then estimated to be 2.286 m (7 ft 6 in). The animal was clearly young and had initially an extremely tear-free, unblemished skin all over and sharp teeth, numbering approximately twenty each side of the lower jaw, all of which were intact.

(b) Size and Growth

From March–October 1985 regular length and mid-girth (anterior (G_1) and posterior (G_2) to dorsal fin) measurements were made (Lockyer & Morris, 1987*a*) and the dolphin was found to be growing at a linear rate of 3.2 cm.month^{-1}. Increase in G_2 was found to be linearly related to length, but G_1 was much more variable showing a distinct fattening phase in early autumn. These variations may have been related either to changes in local fish abundance or changes in the animal's activity.

The girth G_1 parameter may be a useful measure of an animal's condition (i.e. fatness). Lockyer & Morris (1987*a*) formulated a weight/length/girth relationship whereby a prediction of body weight could be made for Simo. It was predicted that the animal increased his body weight from <200 kg in August 1984 to 294 kg in October 1985 with a peak of 307 kg in late June 1985. On average this would represent a net weight increase of approximately 0.24 kg day^{-1}.

From previously published data on birth size and early growth rates of captive *Tursiops*, Lockyer and Morris (1987*a*) estimated that Simo was 2–3 years of age in August 1984 when he was 2.286 m in length. He was actually first seen alone in the area eight months previously. From our previous work on *T. truncatus* in this area (Lockyer & Morris, 1986), Simo might be expected to grow anything up to 4.1 m when fully mature. Thus, although definitely juvenile, Simo had clearly been fully weaned to survive independently well before January 1984. The estimated age of weaning in captive *Tursiops* is *18–20 months* (McBride & Kritzler, 1951; Tavolga & Essapian, 1957; Tavolga, 1966) but recent data on a wild, resident group of animals off W. Australia (Conner & Smolker, 1985) suggest that nursing between young and mother could continue until well beyond the age of three years old. In the case of Simo we believe he

Figure 1. Distinctive mark of Simo's dorsal fin.

Figure 2. Displaced tooth in the dolphin's jaw.

had become fully independent well before he was two years old.

(c) Appearance

Although the animal was relatively free of major scars, several wounds were acquired during the study period. These were documented and provide valuable information on healing rates and the re-pigmentation of scar tissue (see later), indirect evidence for contacts with other animals (see later) and, finally, identifying marks for the animal itself. Of the latter, the most useful was a large deep cut on the right side of the dorsal fin. This was seen as an open wound during the early summer of 1984 (D. Carnby-Lewis, J. Sendall, pers. comm.) which quickly healed, leaving a prominent white patch (Fig. 1). This mark was clearly evident on the dorsal fin throughout the remainder of the study period (i.e. fifteen months). The other important distinguishing feature, first observed on 22 May 1985, was a slight forward dislocation of one of the teeth towards the back of the lower right-hand jaw (Fig. 2). Prior to the beginning of May, the

Figure 3. Discolouration around the blowhole which lasted for several days.

animal's teeth had appeared completely intact and were all in their correct positions.

The eyes and the blowhole were in good condition, although the animal acquired a number of deep scratches close to both eyes and blowhole during the Spring and Summer of 1985. Particularly puzzling was a grey discolouration which appeared around Simo's blowhole at the beginning of July (Fig. 3). The discolouration was quite distinct and extended in a radius of approximately 5–6 cm. It lasted for 3–4 days and during that time the animal appeared to be extremely lethargic and did not allow anyone to approach him closely (J. Sendall, pers. comm.). The photographs of the discolouration have been shown to a number of colleagues working with captive dolphins but they had seen nothing like this previously and the discolouration did not appear to be the result of sun exposure. Another possibility is that the discolouration may be a reaction of the skin to contamination by an oil spill which occurred some ten miles offshore on 18 June although neither detergents used during the clean-up operations nor floating oil was reported in the dophin's home territory.

2. Home Range and Movements

Simo was first sighted by a local National Trust Warden, Mr J. C. T. James, on 19 January 1984, appearently fishing at high tide close to rocks at Aber Dwrain (east of Pen Dinas) midway between Solva and Newgale, Pembrokeshire. From March 1984 onwards he was observed by many locals (fishermen, walkers, sailing people, etc.) and during the period March 1984–March 1985 appears to have kept almost exclusively to the area between Caer Bwdy Bay (51°52.5′N, 5°12′W) and Newgale (51°51′N, 5°07′W) (Fig. 4), a distance of some 10 km, never being seen further than 400–500 m offshore. This would give him a home territory of no more than 10 km^2 during this period and probably 6–8 km^2.

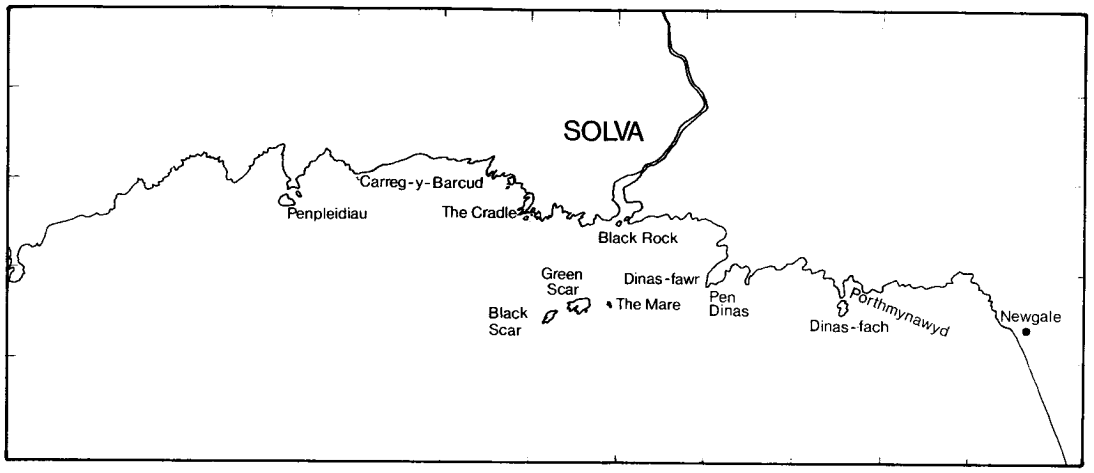

Figure 4. Map of the area where Simo was resident.

From April 1985 there were several reports of his going up to 2–3 km offshore although he did not appear to extend his range along the coast. Thus we would estimate his range during the latter part of 1985 had increased to approximately 25 km^2. There is only one possible sighting of Simo outside this area, an unconfirmed report from Mr T. Lewis (a fisherman at Solva) that he believes he saw Simo around St David's Head during June 1985. Certainly, from our previous work (e.g. Lockyer & Morris, 1985*a*,*b*) occasional excursions outside the home range by a resident bottlenose dolphin could be expected. Simo's home range was considerably less than that reported by Lockyer & Morris (1986) for an adult, resident bottlenose dolphin off N. Cornwall, UK (77 km^2) or by Irvine *et al.* (1979) for groups of bottlenose dolphins in the western N. Atlantic. Wells *et al.* (1980) however, report a mean home range for adult bottlenose dolphins off Florida as 20.8 km^2. Maturity, adult size and type of geographical area must all be key parameters in determining home range and, in the case of Simo, we believe the most relevant home range data is that for the adult animal off N. Cornwall (Lockyer & Morris, 1986). The nature of the two home ranges were very similar and the adult size of the two animals we would expect to be the same. The major difference is the animal's maturity and this, we suggest, is the reason for the much smaller home range observed for the juvenile dolphin.

Within Simo's home range were a number of sites which appeared to be more favoured and were continually revisited. These include primarily the area between Dinas Fach and Pen Dinas, an area just east of Dinas Fach and the northern end of Newgale beach, close inshore and often only just outside the breaker zone. All of these areas, we believe, were important fishing sites for the dolphin and throughout his residence he appears to have regularly returned to some or all of these sites on a daily basis throughout the year, after spending up to an hour circling and diving at a particular location. Although the animal's fishing activities did not appear to be directly related to the state of the tide, his numerous visits to these various sites made it possible for us to carry out many observations from cliff-top vantage points on both diving behaviour and swimming speeds (Lockyer & Morris, 1987*b*; and see later).

Two of the fishing sites were at the foot of steep cliffs, around rocks in depths of 5–15 m. The bottom in these areas was a mixture of sand, kelp weed and rocks and the preferred fishing time appeared to be about two hours before low water. The site at the northern end of Newgale was an open sandy beach, running up to a steeply shelving pebble bank. Fishing often occurred within 10 m of the shore in depths of no more than 2 m of water. Here the preferred fishing time was close to high water when the sea was well up the pebble bank.

During the summer months, as the amount of human activity in the Solva area increased (boats, canoes, surfers, swimmers, etc.), Simo spent a lot more time in the area off Solva and often in the outer harbour. Boats and particularly people in the water were clearly a source of great interest and resulted in considerable interaction between the dolphin and humans (see later). Some days during this period he spent virtually the whole time from early morning (0700–0800 hr) until evening (1900–2000 hr) in or around Solva's outer harbour.

We were particularly interested in where Simo spent the night, if indeed he did spend it in any one site. We were able to follow his movements fairly completely throughout a number of days starting

from dawn to dusk. On these occasions he was seen in the vicinity of Dinas Fach, both at dawn and dusk. Dinas Fach is a major feature of the coastline in the area and provides excellent shelter from most weather apart from the strong southerly gale. It may be that this was at least one site where Simo spent his nights. Unfortunately, we have no information on his activity after dark.

The nature of the coastline around Simo's territory is mainly steep, inaccessible rocky cliffs with numerous peninsulas and sheltered inlets. The southern limits of his territory comprise part of pebble-strewn Newgale beach. The shoreline is generally steeply shelving or drops off abruptly, with the exception of Solva where a narrow river valley cuts through the cliffs to give a relatively shallow-water outer harbour. The area is weather-exposed with heavy swells and surf for much of the year although a lee shelter can generally be found behind one of the main peninsulas. The territory occupied by this dolphin has many similarities with the areas chosen by 'Beaky' (Lockyer, 1978; Dobbs, 1977) and 'Percy' (Lockyer & Morris, 1985*a*, 1986), common features appearing to include exposed, rocky, steep coastlines with rocky peninsula outcrops and offshore islands and the occasional sheltered bay where human activity may be found in the form of fishing boats and water leisure activities.

A range of marine wildlife with which Simo might be expected to have had contact is documented to occur locally in his territory and includes grey seals (*Halichoerus grypus*), pilot whales (*Globicephala melaena*), killer whales (*Orcinus orca*), bottlenose dolphins (*Tursiops truncatus*), porpoises (*Phocoena phocoena*), basking sharks (*Cetorhinus maximus*), bass (*Discentrarchus labrox*), mackerel (*Scomber scombrus*) and pollock (*Pollachius virens*) (A. Marks, J. Sendall & R. James, pers. comm.).

The dolphin was last seen in October 1985 in his home territory and, in spite of a report of his being sighted further north with a resident group of dolphins off New Quay, this has unfortunately proved to be unfounded.

3. Basic Behaviour

(a) Feeding

(i) *Prey type:* Feeding was observed on a number of occasions. The animal was seen several times with large bass in his mouth (J. Sendall, T. Lewis, pers. comm.) and on one occasion he was seen by divers to drive a school of bass into rocks at one of his favoured fishing sites near Dinas Fach. The fish came together into a tight rock then the dolphin went into the group the caught one individual. The dolphin was then seen to hit the bass on a rock repeatedly whilst holding it in its jaws, breaking the fish up, and the major portions were then eaten (J. Sendall, pers. comm.). Simo was also seen several times at the surface with mackerel in his jaws (J. Sendall, pers. comm.).

Bass are plentiful in the dolphin's territory, particularly off Newgale Beach. (In addition, large numbers of pollock and coley are found inshore around the rocks and mackerel are abundant in season. Several attempts were made to hand-feed Simo with live pollock and freshly-dead mackerel (G. Phillips, B. John, J. Sendall, pers. comm.). On each occasion the proffered fish was refused, even if the fish was thrown into the water beside the animal. The refusal to accept fish, either living or dead, is consistent with our experience with other solitary, resident dolphins around the UK coast (Lockyer, 1978; Lockyer *et al.*, 1978; Lockyer & Morris, 1986) and we believe this is the norm for most wild dolphins. To our knowledge, the only instances where this is not true is in Moreton Bay, off Brisbane, where the resident bottlenose dolphins regularly feed on dead and dying fish thrown back in from fishing boats and at Monkey Mia, Shark Bay, Western Australia, where a resident population of bottlenose dolphins comes into the beach daily to be hand-fed by tourists.

(ii) *Chemical composition of diet and faeces:* Simo defaecated regularly whilst swimmers and divers were in the water with him and a number of samples were collected with a sieve for biochemical analysis. The samples rarely contained any identifiable remains, such as fish bones, from which his diet could be further documented and were generally in the form of unconsolidated yellowish-brown aggregations which quickly broke up in the water. A quatitative analysis of the major biochemical constituents (lipid, protein, carbohydrate) was made and the lipids extracted and examined by TLC in order to estimate the main lipid fractions present (see Morris, 1984, for methods). The results show that the faeces contain very low levels of carbohydrate ($<2.5\%$ dry weight) and lipid ($<6.0\%$ dry weight) and to be mainly composed of protein. Traces of medium polar carotenoids were found in the lipids which comprised mainly triglyceride, diglyceride, sterols and small amounts of polar compounds. At the time the faeces samples were taken, the dolphin had been seen taking bass and mackerel and, therefore, his diet might be expected to be rich in lipid and protein as these fish are both lipid-rich. The low levels of carbohydrate in the faeces are therefore to be expected but the low levels of lipid suggest the dolphin has a metabolism strongly biased towards dietary lipid and, therefore, may preferentially select fish with a high fat content. Certainly, a preference for oily/fatty fish by bottlenose dolphins has been noted during work at Sea World, Australia (R. Clapp, pers. comm.) and in Moreton Bay off Brisbane (P. Corkeran, pers. com.).

Although identifiable remains were rarely seen in the faeces samples collected, an extremely unusual

ring-like item was seen to be defaecated by Simo on two separate occasions (D. Carnby-Lewis, pers. comm.) and regurgitated on one occasion, together with some fish vertebrae (J. Sendall, pers. comm.). One of the objects is shown in Figure 5a, and, having been cut to show a cross-section containing many fine regular laminae (Fig. 5b). The inner surface appeared to show a 7 or 9 radial pattern. Its texture was extremely tough and it felt like dense elastic. A biochemical analysis indicated it was composed mainly of protein. The other two objects were very similar and we concluded that they had a biological origin and represented a fairly regular item of Simo's diet.

(b) Diving, blowing and swimming

From the cliffs overlooking the dolphin's main fishing areas we have been able to collect a large amount of data, including video sequences, in the animal's diving and swimming behaviour (Lockyer & Morris, 1987*b*).

The results indicated a mean dive duration of 55 seconds during swimming and feeding with occasional long dives during fishing activities extending up to 140 seconds. The dives duration was directly related to the number of blows following the dive, the blow interval not appearing to be reduced below a certain level. Thus the longer the dive, the longer the subsequent total period of blowing and the greater the number of blows. A typical dive/blow sequence of the animal whilst feeding is shown in Figure 6.

Swimming speeds of up to 54 km hr^{-1} were recorded for Simo over a few seconds and short distances (0.5 km) but, over longer distances, sustained speeds fell between 4–20 km hr^{-1}, the speed declining linearly with duration during periods up to 4 minutes.

Concerning exhalation, the strength appeared to vary considerably. In bad weather in particular, Simo appeared to blow much more forcibly than normal. This may be an adaptation to the sea conditions when it is necessary to blow water well away from the blowhole area in order to be able to inhale clearly. Alternatively, it may be the result of increased physical exertion.

(c) Object investigation

Most objects or persons in the water were regarded with great interest by Simo and investigated in a similar manner to that described for 'Percy' (Lockyer & Morris, 1986). Arms, legs, hands, hydrophones, surfboards, swimming fins, etc., were often taken into his open mouth and sometimes given a slight squeeze. The tip of the lower jaw was generally rested on a new object for a short period and the examination of the yellow-handled diving knife belonging to R. Morris (Fig. 7) was carried out in exactly the same way by Simo as by 'Percy'—the first opening the mouth directly in front of the knife for a few seconds then gently resting the tip of the lower jaw on the handle. A similar behaviour was seen during the examination of a yellow underwater camera. As we have discussed previously (Lockyer & Morris, 1986), the habit of opening the jaw directly in front of or actually taking an object into the mouth and resting the tip of the lower jaw on an object are, we suggest, associated with the use of a close-range acoustic system for target analysis at close range, inside the far field of the normal echo-location emissions.

One particular sequence of open-mouth target investigation was recorded on video and at least the low frequency spectrum of the acoustic emission recorded on tape. On this occasion the target object was an underwater video housing. This will be discussed further in a later section.

On one occasion a lifebelt was being used to tow swimmers through the water from a boat. Simo showed a great interest in this activity and on several occasions put his head right up into the lifebelt (J. Sendall, pers. comm.). On another occasion a white pole, 9 ft long, was being used as a measuring stick for checking the dolphin's length. The dolphin, after an initial inspection of the pole, tucked one end of it under his pectoral fin and with some force pulled the other end free from the hands of R. Morris and proceeded to swim around with the pole sticking out forward of him like a lance. The dolphin could hold the pole firmly between his body and pectoral fin.

The colour of objects seemed to be an important factor concerning the extent of Simo's interest. Yellow and orange objects were particularly favoured with a close inspection (e.g. yellow diving knives, cameras, aqualungs, fins, surfboards, oranges, bananas). We noticed the same colour preference during our previous work on other solitary dolphins. The reason for such colour preference is unknown but yellow and orange/red carotenoids, particularly yellow β-carotene, are the most common pigments present in fish and this may be of relevance.

(d) Hearing and underwater vocalization

The hearing of dolphins in air is a subject of some debate (for example, see Morris, 1986) and is difficult to quantify by field experiment. The sensitivity of their hearing underwater is well proven and during our studies on Simo we observed a number of examples of just how good is this sensory faculty. On one occasion Simo was observed swimming some few hundred yards offshore when a fishing boat, approximately half-a-mile away from him and completely hidden behind a cliff, started its engines. Instantly, the dolphin changed direction and swam rapidly to the boat in question. During another occasion, Simo was some 300 yards offshore in the company of some divers when two holidaymakers ran down a nearby beach and splashed into the waves. Hardly had the

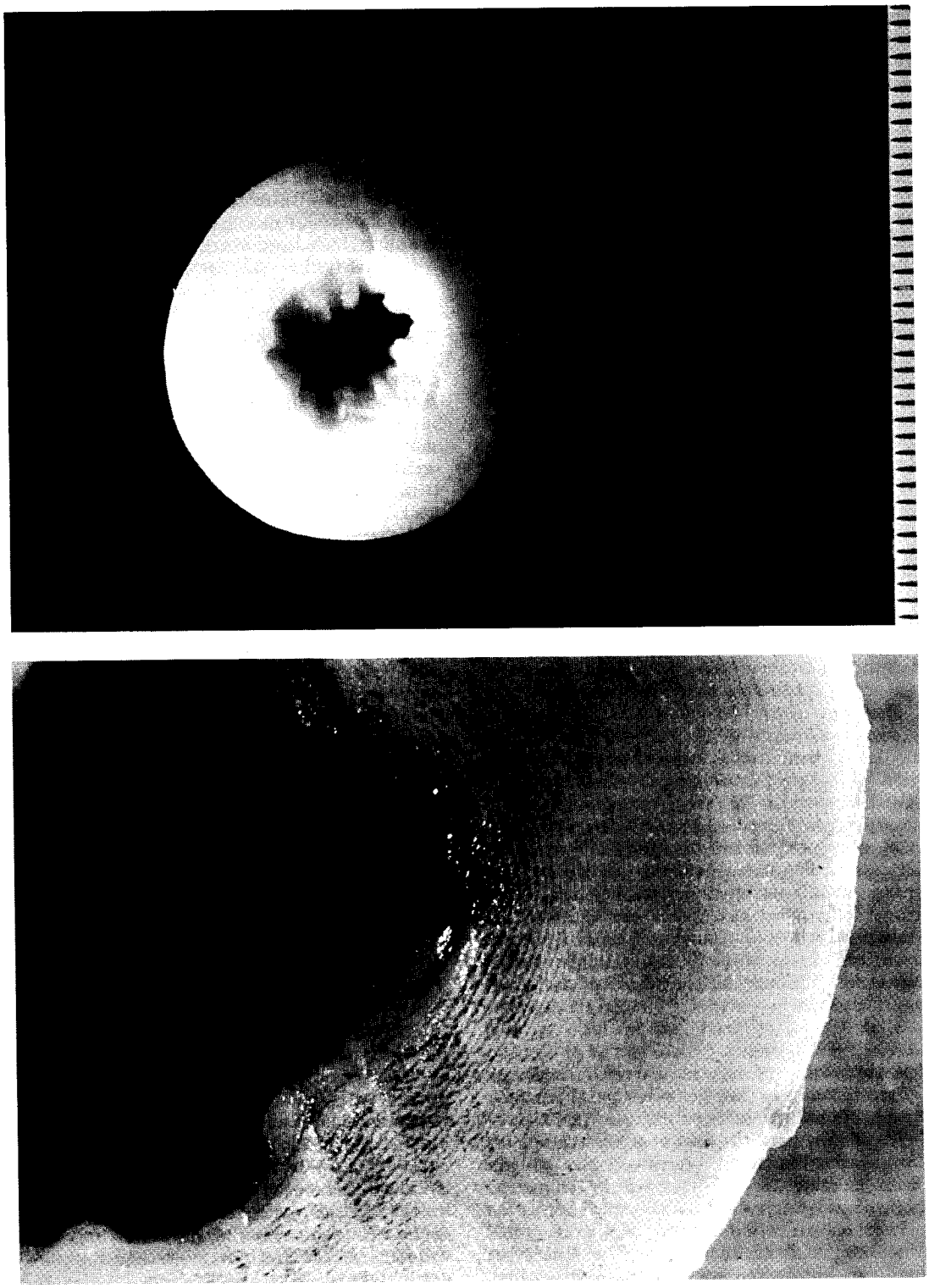

Figure 5a and b. Unusual object found in the faeces.

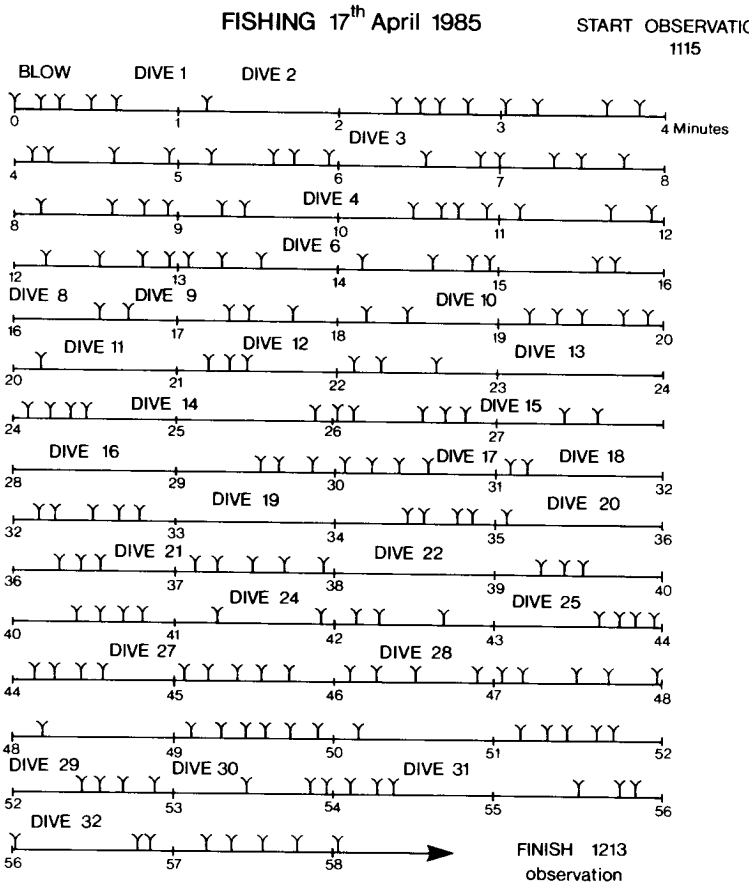

Figure 6. Typical dive-blow sequence during a period of fishing.

Figure 7. Dolphin inspecting diving knife with the tip of its jaw.

swimmers entered the shallows when Simo left the divers and swam, submerged, inshore at very high speed, meeting the swimmers in a depth of no more than three feet of water.

A further example was provided when R. Morris entered the water some 50 yards from the dolphin, who was in the company of another swimmer, with a small high frequency (15–20 kHz) buzzer inside one of his wet suit gloves. The dolphin immediately swam straight to him, stopping directly in front of the hand where the transmitter was hidden. When the diver moved his hand, the dolphin followed, his jaw half-open directly over the hand. A final example occurred when two of the investigators were in the water with him. The weather conditions were calm but very foggy. Suddenly, a helicopter was heard moving slowly somewhere offshore and apparently quite low. The dolphin immediately left the investigators, travelling fast in the direction of the helicopter noise. Some 15 minutes later, when the helicopter could no longer be heard, the dolphin returned.

Simo was very vocal, both underwater and at the surface, and a large number of different sounds were clearly heard by swimmers and people in boats. Underwater, echo-locating clicks, buzzes and mews predominated but at the surface a variety of quite

loud sounds were regularly heard. During our study period with Simo, a range of underwater recordings were made of the animal's underwater acoustic emissions. The bulk of this data and equipment details will be presented elsewhere (Goodson *et al.*, 1988) but a summary of some of the more interesting findings is presented here. The use of a high-resolution speech spectrograph to examine some of the recorded data has enabled the structure of the dolphin's echo-locating pulses to be examined in detail. Of particular interest were acoustic recordings made when underwater visibility was poor. Under such conditions, we believe acoustic perception would be the animal's main sensory faculty. During a typical approach and examination of a new target, three specific acoustic pulse emissions were recorded (Goodson *et al.*, 1988). First, a loud click occurring at a slow repetition rate, and not always present, was recorded during some short-range target investigation. This was found to be a complex, structured, broad-band pulse containing most energy between 6–24 kHz and was thought to be used to make a local geographical map of the area and determine the presence of any new targets within that area: Second, varying clicks which have a regular click rate. The click rate increases steadily as a target range decreases. This type of acoustic emission is frequently used during an approach to a target, the click rate at any one time indicating the range at which interest is focussed. Of particular interest was that the pulse train was often constructed from pulse pairs. Third, the 'mewing' recorded close to a target. We believe this is a technique by which the dolphin can excite a characteristic response from a particular target, i.e. to cause the target to 'ring' out and give as an echo its normal resonance pattern. We suggest this may have evolved partly as a 'tagging' technique for the identification of individual targets, i.e. a single fish in a shoal of fish. If this resonant echo was to be repeated by the dolphin at high source level and close range then the possibility must exist for sonar interference in the target motor activity as a result of strongly-induced resonance in one or more vital organs. Such a technique would provide a highly-sophisticated and very energy-efficient method of temporarily disabling a prey just prior to capture.

(e) Chemosensory faculty (underwater scent)

The chemosensory and gustatory powers of dolphins are not well understood (see discussion in Lockyer & Morris, 1986), even though what appear to be 'taste buds' have been described in the tongue (Suchowskaja, 1972). Kuznetsov (1978) first reported responses by dolphins to certain genital exudates and, during our own studies with bottlenose dolphins (1976–1986), we have seen numerous occasions when the dolphin concerned has reacted strongly to female swimmers, particularly those who were menstruating (Lockyer & Morris, 1986; Lockyer & Morris, unpublished). Simo was no exception and we have five separate reports of menstruating females being treated very roughly by the dolphin. From a series of simple tests it was clear that he also reacted to a number of other scents underwater. One such test involved the opening of an orange underwater in front of Simo. He reacted very positively, appearing to shy away several feet. We suspect this was a direct response to the release of the aromatic/acid juices into the water. Other tests involved the release of small amounts (*ca.* 0.1 ml) of three alcohol-based and three oil-based perfumes underwater by a diver. The tests were carried out at random over a period of three months. In each case a definite reaction was observed, the dolphin spending some time investigating either an ankle band or wrist band from which the scent had been released. On three other occasions fresh urine was released underwater by a diver and a positive reaction was observed. Finally, two formal experiments involving a series of test bags were carried out (Klinowska *et al.*, 1987; Klinowska, in preparation) and in both we recorded a high percentage of positive reaction to the test scent. Our conclusion is that the bottlenose dolphin does indeed have a well-developed, and sensitive, chemosensory faculty although none of the experimental test scents are quantifiable in terms of concentration in sea water.

4. Solitary Behaviour-play

Apart from the diving/feeding behaviour described before, there were many other aspects of Simo's observed behaviour when alone in the water. Some of these we can only describe as play. He would regularly leave what he was doing to bowride or slipstream a speeding boat, breaking off now and again to make series of leaps clear of the water just ahead or to the side of the boat. On two occasions we have reports of him actually jumping right over the moving boat, an unnerving experience for the occupants. Similar behaviour has been reported for other resident, solitary bottlenose dolphins (Lockyer, 1978; Lockyer & Morris, 1986). On one occasion, Simo was seen to jump over 5 m (measured against a known mast height) into the air alongside a fishing vessel.

This leaping behaviour was often commonly seen when the dolphin was completely alone, and normally occurred inshore around rocks in the surf zone. He appeared at times to be actually deliberately jumping over a particular rock or rocks time and again. Similarly, when swimming in a straight line offshore, Simo would often be seen to leap clear of the water. Such behaviour seems to be very characteristic of bottlenose dolphins (Leatherwood *et al.*, 1982; Lockyer & Morris, 1986).

5. Interactive Behaviour

(a) Specific interaction with people in boats, divers and swimmers

Simo, on his initial appearance during the early part of 1984, appeared very wary of close contact with people. He did not approach boats or swimmers closely but merely followed boats from some distance and observed fishing operations, such as the retrieval of pots, etc. By May, he was allowing people to touch him with oars but still did not allow swimmers to approach him. By July, he was regularly closely following fishing boats and leisure craft and would tolerate people in the water with him, provided they did not try to come too close. By August, any sign of reserve had gone and Simo would seek to make close contact with swimmers and divers alike. He would often come into shallow water (*c.* 0.6–0.7 m), swimming between people's legs, and allow himself to be stroked, patted and at times would turn on his back for his belly to be rubbed. That summer he took an active part in the local Annual Rowing Race at Solva, swimming in and out between the oars and causing some considerable disruption. He would also play with canoeists, resting his head on the boats and biting the paddle-blocks. As more people joined him in the water, he became more boisterous and, towards the end of the summer, there were a number of reports of his giving swimmers an apparently unprovoked hard butt with his snout or rearing up and pushing a swimmer down into the water quite roughly. With only a few people in the water he would, however, generally be quite gentle and occasionally would give certain individuals short rides if they hung on to his pectoral fins, but not his dorsal fin which he appeared not to have liked being touched.

During this whole period up to September 1984, the dolphin's penis had not been displayed at all. The first brief observation was during September during a play period inshore with a number of swimmers who were actually swinging the dolphin around in the water by his tail; something which the dolphin appeared to enjoy.

By October, there were a number of swimmers who regularly spent long periods in the water with the dolphin and, at this stage, we have the first reports of the type of possessive behaviour towards one person which we described previously for another dolphin (Lockyer & Morris, 1986). On these occasions the dolphin would swim hard at the 'intruder', only swerving away at the last moment. The impression given was that he wanted his 'playmate' to himself. On another occasion, Simo apparently tried to stop one of his regular campanions swimming back to the beach.

Mrs A. Marks has provided an account of the dolphin's behaviour when a dog was taken into the water by some swimmers. Simo showed great interest in the swimming dog, ignoring the people and staying with the dog for a long period, his beak immediately underneath the dog.

During the winter months December-February, few people made any close contacts with Simo, although he was regularly seen, save for a period in January during very bad weather when he may have gone offshore into deeper water. When the first swimmers made contact again during February 1985, they reported an initial wariness on the part of the dolphin but this was only for a short period.

From March 1985, the penis was displayed on a number of occasions with swimmers in the water with the dolphin but, generally, these displays were only for short periods and only 1–2 inches were visible. Reports of the dolphin rubbing himself on boats and rearing up alongside boats and swimmers were common. In general, Simo appeared to be rather more confident and dominant when in the company of swimmers than during the previous year.

Defaecation by the dolphin started to become a regular feature of play periods during the Spring of 1985 and, on occasion, he would be seen to defaecate repeatedly over a short time. An example is the sequence of events when the investigators anchored their boat for a typical study period with the dolphin. The first defaecation would occur either as the boat was anchoring or just as the first swimmer entered the water. It came to be regarded as almost a greeting. Then, over a session of $1\frac{1}{2}$–2 hours, eight to ten further defaecations would occur, often if the animal became particularly interested in something. Sometimes Simo appeared to deliberately defaecate directly into the divers' faces. Normally, the faeces were yellow-brown to brown in colour and consisted of loosely-packed lumps which quickly broke up and sank as a cloud. The volume expelled at any one time varied a lot but, generally, each defaecation was sufficiently large to affect the local visibility for a short period of time.

During May 1985, the behaviour of Simo appeared to change. He sought much more physical contact and, for the first time, the erect penis became a commonly-reported feature of 'play' periods with swimmers. Butting behaviour was reported when a number of swimmers were in the water with the dolphin and there was one incident when Simo grasped a swimmer's arm quite forcibly (D. Carnby-Lewis, pers. comm.). The dolphin then began trying to make belly-to-belly contact with swimmers with the penis erect. For some of the time, the penis appeared to be used for tactile contact but often the purpose was explicitly sexual, the erections being accompanied by thrusting movements directed at swimmers.

By June 1985 Simo had an erect penis virtually the whole time swimmers were in the water with him, the penis being indiscriminately used to ram or rub

against legs, thighs, arms, boats, or anchor chains or ropes. He would regularly give swimmers rides, preferably in the belly-to-belly position with the swimmer hanging on to the pectoral fins, but also with the swimmer hanging on around the body or dorsal fin. At the end of such sessions with individuals, Simo would regularly attempt to prevent the swimmer leaving the water. Often, another swimmer had to enter the water to distract the dolphin so that the first swimmer could get out. Simo's typical approach to a swimmer was from underneath with his ventral side against the swimmer's body.

During his quieter moods, Simo appeared to like being rubbed, particularly on the underjaw and throat and around the blowwhole. At such times, he would often lie completely still in the water for quite long periods.

By the end of June his most explicit sexual displays occurred only with female swimmers. Simo would make very obvious attempts at copulation either when lying horizontally or vertically in the water and often when lying at right angles to the swimmer. The pelvic thrusting movements would often be accompanied by the opening of the jaws. With couples in the water, there were several reports of Simo violently butting the male swimmer until he left the water, leaving the dolphin alone with the female.

As Simo matured, his curiosity increased. Simple underwater tasks carried out by the investigators, such as the unbuckling and buckling-on of weight belts, the removal and cleaning of diving knives, pulling a float to the bottom and releasing it so that it returned to the surface, operating underwater cameras and videos, all were closely followed in detail with the dolphin re-positioning himself continually so that nothing was missed.

From the middle of July until the end of August, Simo became the focus of a great deal of public attention. Solva was packed with holidaymakers, newspaper reporters, film crews, boating and diving enthusiasts, all actively seeking contact with the animal who by now had become quite famous. Those who had regularly swum with him during the year, reported a gradual change in his behaviour. He became much more aggressive and snapped with his jaws at outstretched hands and feet, often drawing blood from the inexperienced person who attempted to jerk his or her hand away. The frequency of butting increased and often he would swim up behind an individual and roughly shove them in the back, sometimes forcing them underwater. Loud underwater sounds ('screams') were also reported of a type not heard before.

Much bad feeling was caused among the local population by the behaviour of some of the visitors towards the dolphin. One particular incident involved three inflatables from a London sub-aqua club which repeatedly circled Simo at speed until he appeared very confused. During this incident one of the inflatables appears to have hit the animal, for the next sharp day parallel marks were observed on his body, running downwards and backwards from the blowhole. Such behaviour was unfortunately a hallmark of many of the incidents that summer. Indeed, in perspective, the happenings in Solva during the summer months of 1985 are remarkably similar to those described by Pliny the Younger when a dolphin took up residence off Hippo, a Roman town on the African coast (Letters of the Younger Pliny, reprinted 1983). On this occasion the local problems, divisions and arguments caused by the dolphin's presence resulted in the village elders eventually destroying the animal in order to save the stability of their own community. It seems the human race have not learnt much during the intervening years.

During this very hectic summer period, Simo appears to have adopted a most unusual pattern of behaviour. Most afternoons he would move to a quiet part of the outer harbour and then swim in circles very slowly in an anti-clockwise mode for periods of up to an hour. During this time he would not allow any close contact. Such behaviour has been repeatedly seen in captive dolphins and has been interpreted as a sleep/resting period. Such behaviour was only observed during the peak summer period and it could be that the animal actually needed to rest himself, away from his many admirers.

(b) Interactions with other animals

Direct observations As we have already mentioned, Simo was seen taking and playing with bass and mackerel at the surface on a number of occasions. In addition, we have a considerable number of direct observations of contact between Simo and grey seals. A group of grey seals, comprising a large bull (estimated length 7–8 ft), several smaller females (4–5 ft) and some young pups were known to be residents of the area between Dinas Fach and Pen Dinas in Simo's mean fishing area. From an early stage of Simo's residence in the area we have reports of his being seen in the presence of some of the smaller seals, sometimes apparently playing with the seals, turning, rolling and twisting among the rocks and seaweed (Mrs A. Marks, pers. comm.). On one occasion in the summer of 1984, when a boat approached the dolphin and some of the smaller seals, Simo left the seals and apparently attempted to lead the boat away from the young seals. Once the boat was some distance away from the seals he then rejoined them. The boat then approached the group again and the dolphin swam towards the boat and proceeded to broach alongside the vessel, crashing back down to make a splash. He repeated this behaviour several times until the boat withdrew and only then did the dolphin re-join the seals.

During the Spring and Summer of 1985 we observed and recorded a number of encounters between Simo and the seals from a vantage point on the cliffs above his main fishing site. When only the smaller seals were present, quite close contact between the seals and the dolphin was observed while they were apparently all actively fishing. On those occasions when the large bull seal was present, however, the dolphin and the seals kept 40–50 yards apart. Clearly, the site was a prime fishing area for both the dolphin and the seals and the bull seal and Simo kept their distance from each other. A number of confrontations between Simo and the bull seal were observed. On two occasions the dolphin appears to have chased the seal away from swimmers in the water, while on another he left a group of swimmers to join the bull seal for several minutes. Evidence that these confrontations were not always peaceful will be presented later.

On two separate occasions, R. Morris was in the water with both Simo and some of the smaller seals. One of the seals was observed touching the dolphin snout-to-snout underwater and then diving with Simo. On one occasion the seals came within 2 m of the investigator but Simo always tried to position himself between the swimmer and the seal.

Indirect observations The use of close visual inspection, assisted by photography, of body marks and scars in providing information on dolphin behaviour has already been described (Lockyer & Morris, 1985*b*). For Simo, a detailed record of the marks and scars was made from August 1984-October 1985.

Many of the body scars were considered to be the result of wounds and scratches obtained from various underwater obstacles obtained during the animal's normal feeding, swimming and play-behaviour (i.e., barnacles, rocks, mooring lines, boats, etc.). Other marks, however, occurred routinely as regular patterns on different parts of the body. After a careful measurement of the marks (depth, width, length, formation) we concluded that at least four sets were a product of the dolphin's contact with other creatures.

The first type of mark was seen on several occasions and consisted of long parallel lines up to nine or ten in number with a regular spacing of between 1.0–1.5 cm (Fig. 8). As discussed earlier (Lockyer & Morris, 1985) we believe these to be tooth rake marks from other *Tursiops*, thus indicating that this animal has had regular, intimate contact with others of his kind.

The second type of mark was seen on two or three occasions during the study period and consisted of long parallel lines, up to four to five in number, with a regular spacing of between 2.5–3.5 cm (Figs. 9a and b). The marks were seen on the flukes, the lower jaw and the flanks. As discussed previously (Lockyer & Morris, 1985*b*), we conclude that thses are tooth rake-marks resulting from social interaction with a larger species of whale. They are too widely spaced to be *Tursiops* tooth rake-marks. Pilot whales and killer whales are regularly seen off this coast and would have a tooth-spacing of approximately this size.

Figure 8. *Tursiops* rake marks.

a

b

Figure 9a and b. Pilot whale or killer whale rake marks.

The third type of mark was similar to the first and second types but the lines were much closer together, being spaced approximately 0.5 cm apart (Fig. 10). Such a tooth spacing is too close for all but the

Figure 10. Rake marks from young *Tursiops* or porpoise.

Figure 11. Claw marks from a grey seal.

smallest *Tursiops*. Such an animal would be still suckling and constantly in the company of the mother and normally several other adult females. An alternative is that these are the tooth rake marks from a porpoise but we have no information on whether such marks are a feature of porpoise social interaction. The marks were seen around the blowhole in May 1985 and schools of porpoise are often seen in the area at this time of the year. We received a report from Mrs A. Marks of a possible contact between Simo and a porpoise in August 1984 when Simo apparently drove the porpoise off. About a week later, a dead four-foot porpoise was washed up at the northern end of Newgale beach, on the edge of Simo's territory.

The fourth type of mark was seen in September 1985, just behind the dorsal fin. It consisted of five-digit, deep, short scratches (Fig. 11) which we believe were made by a claw. The wound was quite serious and had penetrated the blubber well into the flesh. The spacing of the scratches was approximately 2.0–2.5 cm. From known inter-digital spacing in grey seals, as calculated by us from measurements taken by the Sea Mammal Research Unit, we believe the marks were made by a large adult male Grey Seal (*Halichoerus grypus*). We suspect the resident bull seal was the animal involved in what was obviously an aggressive encounter as wounds that deep would not be expected to occur during play.

As discussed previously for the animal 'Percy' (Lockyer & Morris, 1985*b*), we believe these scars are evidence of social and sometimes aggressive contacts with other animals.

6. Wound Healing and Skin Re-pigmentation

The first documented wound was a deep cut on the right side of the dorsal fin which was seen during the early summer of 1984. This later healed to give the prominent white patch across the fin which was the animal's main identifying mark (see Figure 1). This mark did not noticeably fade during the study period (i.e. over 18 months). Other deep wounds on the body gave rise initially to pale scars, but many of these scars faded perceptibly over a period of 4–5 months. Similarly, many of the marks resulting from more superficial wounds on the body also faded over a period of months. In general, wounds on the flukes, dorsal or pectoral fins, whether they were deep or superficial, appeared to give rise to a scar which remained unpigmented for a considerably longer period than equivalent wounds on the body.

It has been shown that the basal germinative cells of the *Tursiops* dermis proliferate far more rapidly that that of terrestrial mammals (Harrison & Thurley, 1974; Brown, Geraci, Hicks & St Aubin, 1983) giving rise to a thick epidermis. Thus, for even a deep wound, the healing rate would be very fast. Re-pigmentation of such wounds would normally be slow and uneven as wound contraction occurs. For more superficial wounds where the melanocytes are not damaged, Bruce-Allen and Geraci (1985) found that the healed skin was less pigmented than normal, although those workers considered that most minor scars would recover their pigmentation with time. We suggest that, while this does appear to be the case on the body where there is a thick layer of blubber, this is not the case on the extremities of the body, i.e. flukes and fins. In these areas, a wound, particularly a deep wound, seems to leave a very pale scar which is present for well over a year.

One possible explanation is that, in such low blubber areas of the body, the number of melanocytes is much reduced. Certainly the skin is a very complex organ and we believe the process of wound re-pigmentation requires a lot more study. Whatever the explanation, the long duration of scars on the flukes and fins does, we suggest, provide a very useful means of identifying individuals. Once a dolphin has received a wound in these areas it gives rise to a scar

which lasts a long time and, once this scar is documented, it can be used as a recognition mark.

Conclusion

In this paper we have extended our previous work on resident, wild dolphins (Lockyer, 1978; Lockyer *et al.*, 1978; Lockyer & Morris, 1985*a,b*, 1986; Morris *et al.*, 1985). We believe our results have further confirmed the value of careful, observational work on such animals.

In particular, we have been able to:

1. Obtain growth rates for a wild, juvenile male *Tursiops* and suggest a girth parameter which is a useful measure of condition.
2. Make some estimate of weight change with growth.
3. By comparing our measured growth data with published data, to make an estimate of the animal's age and hence the age at which he was fully weaned and independent.
4. Measure changes in the animal's home range with increasing maturity.
5. Document changes in the animal's sexual maturation and behaviour towards humans for an estimated age range of 2–4 years old.
6. Build up a picture of the animal's feed behaviour and diet during the year and, from biochemical analyses of the faeces, obtain some metabolic information.
7. Collect a considerable amount of data on the dolphin's diving and swimming behaviour, in particular the relationship between dive duration and blowing time and the relationship between duration and speed of swimming.
8. Demonstrate, by a range of simple experiments, that the dolphin does possess a sensitive chemosensory faculty.
9. Collect a wide range of novel recordings of the dolphin's underwater acoustic emissions. Detailed analysis of some of these have clearly supported the hypothesis that the dolphin's acoustic sensory faculty is extremely sophisticated.
10. Gain valuable information on the animal's contact with other animals from a regular documentation of body scars.
11. Gain information on the rate of healing and repigmentation of wounds on various parts of the dolphin's body.

Our own part in this study has been to keep regular watches and collate the information available but we would emphasise that our ability to have built up what we regard as a fairly complete record of Simo's daily, seasonal and yearly habits over a period of nearly two years has been due mainly to the careful record-keeping and enthusiasm of a group of local, reliable observers.

Acknowledgements

Funding for this research project was provided by the Nuffield Foundation (research grants to R. Morris) whose support is gratefully acknowledged. Susan Brown, Margaret Klinowska, Sally Oxer, Mary Armitage, David Goodson and Bryan Woodward are thanked for their enthusiasm and assistance on field trips. We would especially like to thank Mr Jan Sendall, Mr Paul Raggett and Mr David Canby-Lewis of Solva and Mr Bob James of Newgale for their support and help throughout our studies, and Ann Marks for her generous hospitality.

References

Brown, W. R., Geraci, J. R., Hicks, B. D., St Aubin, D. J. & Schroeder, J. P. (1983). Epidermal proliferation in the bottlenose dolphin (*Tursiops truncatus*). *Can. J. Zool.* **61**(7), 1587–90.

Bruce-Allen, L. J. & Geraci, J. R. (1985). Wound healing in the bottlenose dolphin (*Tursiops truncatus*). *Can. J. Fish. Aquat. Sci.* **42**, 216–28.

Caldwell, D. K. (1955). Evidence of home range of an Atlantic bottlenose dolphin. *J. Mammal.* **36**(2), 304–5.

Connor, R. C. & Smolker, R. S. (1985). Habituated dolphins (*Tursiops* sp.) in western Australia. *J. Mammal.* **66**(2), 398–400.

Dobbs, H. E. (1977). *Follow a wild dolphin*. Souvenir Press, London, 237 pp.

Dobbs, H. E. (1981). *Save the dolphins*. Souvenir Press, London, 128 pp.

Dobbs, H. E. (1984). *The magic of dolphins*. Lutterworth Press, Guildford, Surrey, 77 pp.

Dobbs, H. E. (1987). *Tale of two dolphins*. Jonathan Cape, London, 187 pp.

Goodson, A. D., Klinowska, M. & Morris, R. J. (1988). Aspects of sonar behaviour of a wild bottlenose dolphin (*Tursiops truncatus*) resident in a sea area off West Wales. *Aquatic Mammals* 1988, **14.1**, 7–12.

Gruber, J. A. (1981). Ecology of the Atlantic bottlenose dolphin (*Tursiops truncatus*) in the Pass Cavallo area of Montagorda Bay, Texas. M.Sc. Thesis presented to Texas A & M. University, College Station, TX 77843.

Harrison, R. J. & Thurley, K. W. (1974). Structure of the epidermis in *Tursiops, Orcinus* and *Phocoena*. In *Functional anatomy of marine mammals* (Ed. R. J. Harrison), Vol. 2, 45–71, Academic Press, New York, 366 pp.

Hussenot, E. (1980). Le grand dauphin *Tursiops truncatus* en Bretagne: types de frequentation. *Penn ar Bed* **12**(103), 355–80.

Irvine, A. B., Scott, M. D., Wells, R. S., Kaufmann, J. H. & Evans, W. E. (1979). A study of the activities and movements of the Atlantic bottlenosed dolphin, *Tursiops truncatus*, including an evaluation of tagging techniques, *NTIS* PB-298 042, 54 pp.

Klinowska, M., Lockyer, C. & Morris, R. J. (1987). Chemoreception in wild and captive dolphins. Paper presented at European Cetacean Society meeting at Hirtschels, Denmark, 26–28 January 1987.

Kuznetsov, V. B. (1978). Ability to communicate chemically and to transform information about chemical stimuli in the Black Sea *Tursiops*. *VII-aya Vses. Konf.*

Morsk. Mlekopitayuschim. Simpherspol, 178–80. (In Russian).

Leatherwood, S., Reeves, R. R., Perrin, W. F. & Evans, W. E. (1982). *Whales, dolphins and porpoises of the eastern North Pacific and adjacent Arctic waters. A guide to their identification.* NOAA Technical Report NMFS circular 444, 245 pp.

Lockyer, C. (1978). The history and behaviour of a solitary wild, but sociable, bottlenose dolphin (*Tursiops truncatus*) on the west coast of England and Wales. *J. Nat. Hist.* **12,** 513–28.

Lockyer, C., Flewellen, C., Madgwick, A. & Morris, R. (1978). Some field observations and experiments on a bottlenosed dolphin. *Prog. Underwater Sci.* Report Underwater Association **3,** 177–90.

Lockyer, C. & Morris, R. J. (1985*a*). A wild but sociable dolphin off Portreath, North Cornwall. *J. Zool. Lond.* **(A)207,** 605–7.

Lockyer, C. & Morris, R. J. (1985*b*). Body scars of a resident, wild bottlenosed dolphin (*Tursiops truncatus*): information on certain aspects of his behaviour. *Aquatic Mammals* **11**(2), 42–5.

Lockyer, C. & Morris, R. J. (1986). The history and behaviour of a wild, sociable bottlenose dolphin (*Tursiops truncatus*) off the north coast of Cornwall. *Aquatic Mammals* **12**(1), 3–16.

Lockyer, C. & Morris, R. (1987*a*). Observed growth rate in a wild juvenile *Tursiops truncatus*. *Aquatic Mammals* **13**(2), 27–30.

Lockyer, C. & Morris, R. J. (1987*b*). Observations on diving behaviour and swimming speeds in a wild juvenile *Tursiops truncatus*. *Aquatic Mammals* **13**(2), 31–35.

McBride, A. F. & Kritzler, H. (1951). Observations on pregnancy, parturition, and post-natal behaviour in the bottlenose dolphin. *J. Mammal.* **32,** 251–266.

Morris, R. J. (1984). The endemic fauna of Lake Baikal: their general biochemistry and detailed lipid composition. *Proc. Royal Soc.*, **222B,** 51–78.

Morris, R. J. (1986). The acoustic faculty of dolphins. In, *Research on dolphins* (Eds M. M. Bryden & R. J. Harrison), Oxford University Press, pp. 369–399.

Morris, R. J., McCartney, M. G., Lockyer, C. & Holborn, R. (1985). The particulate load of the Red River, St Ives Bay: its geochemical composition and the effect of its discharge plume on the behaviour of a resident wild dolphin. *Mar. Poll. Bull.* **16**(3), 106–8.

Pelletier, F. X. (1985). Jean-Louis, le gentil dauphin breton. *30 millions d'amis, la vie des betes* **83,** 22–7.

Letters of the Younger Pliny. Penguin Classics (reprinted 1983) pp. 254–255.

Saayman, G. S. & Tayler, C. K. (1979). The socioecology of humpback dolphins. In: *Behaviour of marine animals—current perspectives in research Vol. 3: Cetaceans* (Eds H. E. Winn & B. L. Olla), pp. 165–226, Plenum Press, New York, 438 pp.

Saayman, G. S., Tayler, C. K. & Bower, D. (1973). Diurnal activity cycles in captive and free ranging Indian Ocean bottlenosed dolphins (*Tursiops aduncas*, Ehrenberg). *Behaviour* **44,** 212–33.

Shane, S. H. (1977). The population biology of the Atlantic bottlenose dolphin, *Tursiops truncatus*, in the Aransas Pass area of Texas. M.Sc. Thesis presented to Texas A and M University, College Station, TX 77843.

Shane, S. H. & Schmidly, D. J. (1978). The population biology of the Atlantic bottlenose dolphin, *Tursiops truncatus*, in the Aransas Pass area of Texas. Technical Information Services, DB-283 393, US Department.

Suchowskaja, L. I. (1972). Morphology of the taste organ in dolphins. *Invest. on Cetacea* Vol. **IV,** 201–4.

Tavolga, M. C. (1966). Behaviour of the bottlenose dolphin (*Tursiops truncatus*): social interactions in a captive colony. In: *Whales, Dolphins and Porpoises* (Ed. K. S. Norris), pp. 718–730, University of California Press, Berkeley.

Tavolga, M. C. & Essapian, F. S. (1957). The behaviour of the bottlenose dolphin. *Zoologica,* **42,** 11–31.

Webb, N. G. (1978*a*). Boat towing by a bottlenose dolphin. *Carnivore* **1**(1), 122–9.

Webb, N. G. (1978*b*). Women and children abducted by a wild, but sociable adult male bottlenosed dolphin. *Carnivore* **1**(2), 89–94.