

## **Behavioural observations of rough-toothed dolphins (*Steno bredanensis*) off La Gomera, Canary Islands (1995-2000) with special reference to their interactions with humans**

Fabian Ritter

*M.E.E.R. e.V., Berlin, Germany, [info@m-e-e-r.de](mailto:info@m-e-e-r.de)*

### **Abstract**

Rough-toothed dolphins (*Steno bredanensis*) were sighted 145 times from 1 September 1995 through 22 March 2000 off La Gomera, Canary Islands. Sightings were made during regular whale watching trips and occurred year-round. Group size ranged from 1 to 50 individuals (mean 16.8, SD=12.0, n=137). Mean depth was 506 m (range 20-2500, SD=473 m, n=140) and mean distance from shore was 4.44 km (range 0.05-14.8, SD=2.33 km, n=137). Behavioural data, collected for 26 sightings showed that the reaction of the animals to the observation vessel varied from no response to interaction. Boat-related behaviours were quantified and were rare up to frequent per sighting, with *approaches* (46%), *bowriding* (21%), and *scouting* (20%) being the predominant types of behaviours. Interactions between the dolphins and swimmers also differed in their duration and intensity. The year-round abundance off La Gomera indicated that this species might endure temperatures well below 25°C. Moreover, for the first time, behavioural categories were defined for the rough-toothed dolphin.

Key words: rough-toothed dolphin, La Gomera, behavioural sampling, boat-related behaviours, interactions with humans

### **Introduction**

This paper describes sightings of rough-toothed dolphins (*Steno bredanensis*) off the island of La Gomera (Canary Islands). The rough-toothed dolphin is a the poorly known delphinid. They are found in tropical and subtropical waters with temperatures above 25°C (Leatherwood & Reeves, 1983; Corkeron, 1988; Miyazaki & Perrin, 1994). This species has a wide distribution, but does not appear to be particularly numerous and in the Atlantic Ocean occurs mainly in equatorial waters (Carwardine, 1995). Their true distribution; however, is not well known. Rough-toothed dolphins are regarded as an offshore species (Corkeron,

1988; Norris 1991) which prefers deep waters (Leatherwood & Reeves, 1983). Little is known about their life history and behavioural observations. In the Canary Islands, only a few observations have been made (Urquiola *et al.*, 1997; Martin *et al.*, 1998). This species, at first glance, can be confused with other cetaceans, but the lack of a crease between the beak and the forehead is a reliable identification characteristic. Likewise, the fins and eyes are larger than in other delphinids.

La Gomera (17°15'W-17°21'W and 28°1'N-28°14'N) lies about 400 km off the West African mainland in the Atlantic Ocean and belongs to the Western Canary Islands. The islands are steep volcanoes surrounded by deep waters close to the coast. Some authors describe the oceanographic circumstances as the absence of a shelf (Martin *et al.*, 1992). In the Western part of the archipelago, the sea-bottom drops steeply to about 4,000 m into the Canaries basin (Rothe, 1986).

The climate is mainly determined by the island's position in the northeastern trade-winds. Water temperatures are approximately 22-24°C in summer and about 17-19°C in winter. This temperature is lower than might be expected for a subtropical region, mainly due to the cold upwelling off West Africa and the cooler Canaries Current (Fernandopullé, 1976).

### **Material and methods**

Off La Gomera, small whale watching vessels operate from the Valle Gran Rey, situated in the southwest of the island. These boats, three 6-11 m long former Canarian fishing boats and one 14-m steel ketch, have been used as the platform for the systematic collection of data on cetacean sightings since 1995.

From 1 September 1995 to 22 March 2000, sighting data were collected during regular whale watching trips, usually run once or twice a day throughout the year. Depending on weather and sea state, trips can reach a distance of up to 15 km (with the ketch only) off the coast.

**Table 1.** Definitions of boat-related behaviours shown by cetaceans off La Gomera (see Ritter, 1996).

Behaviour	Definition
Approach	Reduction of the distance between animals and boat, the latter maintaining a constant direction or being motionless.
Scouting	Brief approach toward the boat up to a few metres and then moving away.
Bowriding	Swimming in the pressure wave in front of the boat.
Wake Riding	Swimming in the wake produced by (and behind) the boat.
Spyhop	Lifting the eyes above water while in an upright position.
Orientation towards the boat	Animal(s) floating or swimming very slowly at the surface turning the head towards the boat.
Accommodation of speed	Change in the speed of animal(s) in accordance to changes in boat speed.
Accommodation of direction	Change of direction of animals(s) in accordance to changes in boat

However, most of the trips are conducted within a distance of 5 nm (9.3 km) to the coast.

The sea was visually scanned for cetaceans by one or two experienced observers. In case of a sighting, data collection began with identifying the animals to the lowest possible taxa. It also included an estimated distance to the coast (determined by GPS in 1996-2000 and by 3-point-bearings using a handbearing compass in 1995), sea depth (using a Spanish sea chart: SP 517, Instituto Hidrográfico, Cadiz), date, time, group size, and sighting duration. The presence of juveniles and calves was noted for each sighting. Animals of about 2/3 of the length of adults were considered juveniles, whereas animals of lesser size were said to be calves (similar to Caldwell *et al.*, 1990, p. 208).

Additional behavioural data were collected from 1 September to 31 December 1995, 1 April to 31 May 1998, and 1 to 22 March 2000. Behaviours were sampled in 3-min behavioural samples (Altmann, 1974) during group follows (Mann, 2000), i.e. focal group behavioural sampling. To define behavioural states for the rough-toothed dolphin, which to my knowledge never has been done before, ethograms for the bottlenose dolphin (*Tursiops truncatus*, Weaver, 1987; Shane, 1990; Bearzi, 1994) and the spotted dolphin (*Stenella frontalis*, Herzing, 1995) were used in a comparative way. For individual behavioural events, which were recorded continuously, definitions were based on Weaver (1987), Ostman (1987), Connor (1990), and Herzing (1995). Emphasis was given to the observation of boat-related behaviours and the spatial relationship between the boat and dolphins. Boat-related behaviours (see Table 1) were recorded continuously, and their occurrence was analysed on a one-zero sampling basis (Altmann, 1974; Martin &

Bateson, 1993). The sightings were categorised according to the responsive behaviour of the dolphins, as defined by the frequency of boat-related behaviours, the minimum distance between a boat and dolphins, the duration of the encounter and the occurrence of in-water-encounters (only in 1995 swimming with cetaceans was allowed), i.e. the affinity of the animals towards the boats. Sighting categories were avoidance, no response, proximity, and interaction (see Table 2). The definitions of sighting categories were derived from those given in Würsig *et al.* (1998).

Other data collected during behavioural observations included group structure (defined as tight or 1 bodylength between individuals, loose or 2-5 bodylengths, dispersed or >5 bodylengths or widely dispersed or more than 50 m between individuals), group composition, and dive durations. Recorded details on the in-water-encounters included duration, number of swimmers, and the minimum distance between swimmers and dolphins. Qualitative descriptions of the in-water-encounters by tourists and direct observations helped to identify the animals' curiosity towards swimmers (categorised as little, intermediate and obvious), which was judged from the general reaction of the dolphins to swimmers entering the water, the minimum distance between swimmers and dolphins, and the duration of the in-water-encounters.

The duration of 126 whale watching trips was determined to calculate the total sighting effort by multiplying the mean value with the total number of trips. Photographs were taken using Canon T90 (equipped with a 70 to 210-mm zoom lens and a 200-mm tele lens) and Pentax MZ10 (equipped with a 300-mm lens) single lens cameras.

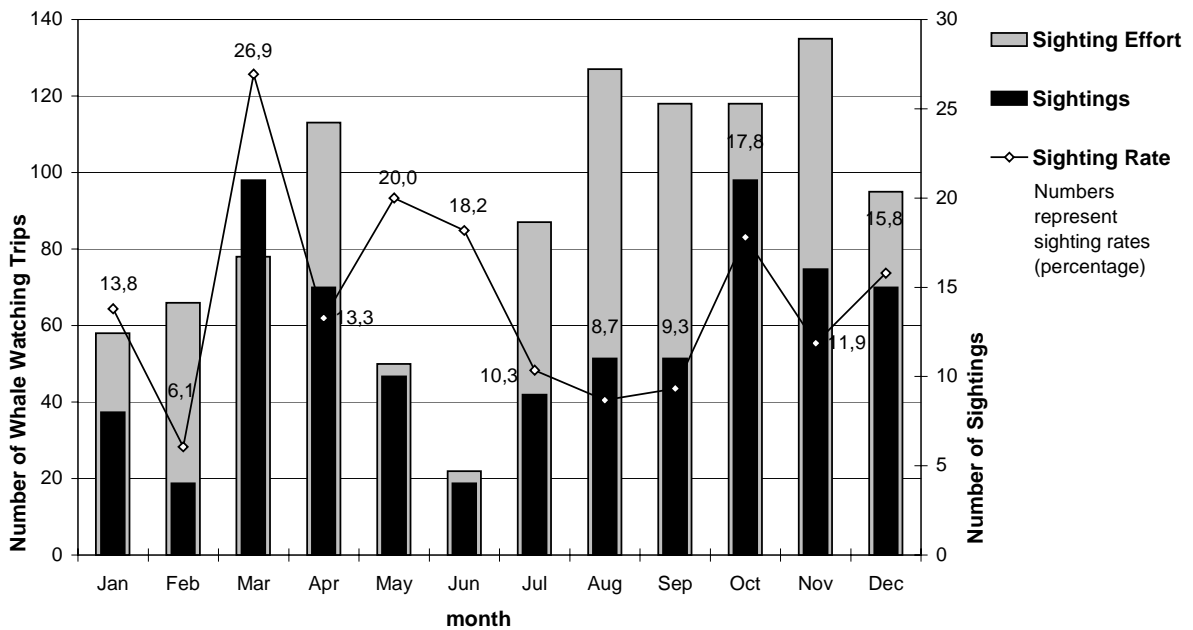
Category	Definition
<i>Avoidance</i>	Movement away from the boat or simply disappear by diving.
<i>No Response</i>	No apparent response to the approach by the boat. Animal(s) keep(s) a certain distance without disappearing. Boat-related behaviours rare or missing.
<i>Proximity</i>	Movement of animal(s) towards the boat for at least part of the sighting. Short distances (< 10 m) between animals and boat possible. Boat-related behaviours possible, but not frequent.
<i>Interaction</i>	Movement of animal(s) towards the boat for a larger part of the sighting. Boat-related behaviours frequent, i.e. during $\geq 50\%$ of the samples. Long sightings of 1 h or longer possible. In-water encounters possible (only in 1995).

**Results**

A total of 1,134 whale watching trips were conducted. The average duration of a trip was 3 h 54 min (range 37 min to 12 h 45 min, n=126). This corresponds to 4,423 hours of sighting effort. There were 1177 cetacean sightings in total, of which 145 (12.3%) were of rough-toothed dolphins. The mean duration of the sightings was 51.1 min (range 3 to 182 min, SD=36.7, n=71). Total time of observation of rough-toothed dolphins was 50 h and 44 min, and 418 3-min samples were collected. Sighting conditions were generally good, because whale watching trips on La Gomera only start when windspeed does not exceed Beaufort 3-4. Most sightings were made during conditions of  $\leq 2$ -3

Beaufort, only rarely were conditions worse. The number of trips per month ranged from 22 to 135 (mean=88.9, SD=35.3, n=12). Sightings were made throughout the year with two peaks, in March and October (see Figure 1). The number of sightings per month varied from 4 to 21 (mean=12.1, SD=5.7, n=12). The mean sighting rate thus was 14.3% (range 6.1 to 26.9, SD=5.5, n=12, see Fig.1). The number of whale watching boats that were together with one group of dolphins never exceeded three, and usually there were one or two boats. Mean group size was 16.8 (range 1 to 50, SD=12.0, n=137). The mean distance from the coast was 4.44 km (range 0.05 to 14.8, SD=2.33, n=122). The mean sea depth was 506 m (range 20 to 2500, SD=473, n=140). Descriptive statistics of the

**Figure 1** Seasonal distribution of rough-toothed dolphins off La Gomera, 1 September 1995 to 31 May 1998 (n = 71).



sightings are given in Table 3.

towards the fin and approximately parallel to the

**Table 3.** Descriptive statistics of rough-toothed dolphin sightings off La Gomera (1995-2000).

a) Sighting data

	mean	SD	minimum	maximum	n
<b>Total number of trips</b>	-	-	-	-	1134
<b>Number of sightings</b>	-	-	-	-	145
<b>Trip duration</b>	3h54min	-	37min	12h45min	126
<b>Duration of sightings (min)</b>	51.1	36.7	3	182	71
<b>Sighting rate (%)</b>	14.3	5.5	6.1 (FEB)	26.9 (MAR)	12
<b>Group Size</b>	16.8	12.0	1	50	137
<b>Distance to coast (km)</b>	2.4	1.3	0.01	8	140
<b>Depth (m)</b>	506	473	20	2500	122

b) Sighting categories

Sighting category	No. of sightings	Percentage
Avoidance	-	-
No response	18	65%
Proximity	6	21%
Interaction	4	14%

In general, this species was met at a distance of more than 2 km offshore, where the depth is approximately 100- 1000 m. Nevertheless, on rare occasions (n<5) the rough-toothed dolphin also was encountered inshore (within <100 m), where the water is only 20 to 50 m deep.

About one half of 83 groups, for which group composition was recorded, were composed of only adult or almost adult animals (44 sightings, 53%). During 39 sightings (47%), juveniles could be identified and during 13 sightings (16%), calves were present. Juveniles and calves together in the same group were observed in eight sightings (10%). Juveniles were observed during all months except January and September, and calves from January through April, June through August and in October. Juveniles and calves tended to be present in small numbers (approx. 1 to 3) even in the bigger groups of 20 or more animals.

The rough-toothed dolphin appears grey in colour without outstanding pigmentation patterns apart from a more or less clear ventral cape and areas mottled with spots on the latero-ventral region. The flanks are lighter grey than the back (see Figure 4). In the dolphin's frontal portion, these two regions are separated by a light band that extends from above the eye

top line of the back (see Figures 4-5). During several sightings, groups with this "line" (the ventral margin of the dark cape) were more distinct, in some dolphins it even appeared white (see Figure 5). These individuals in general were brighter and more scarred than others in the same group.

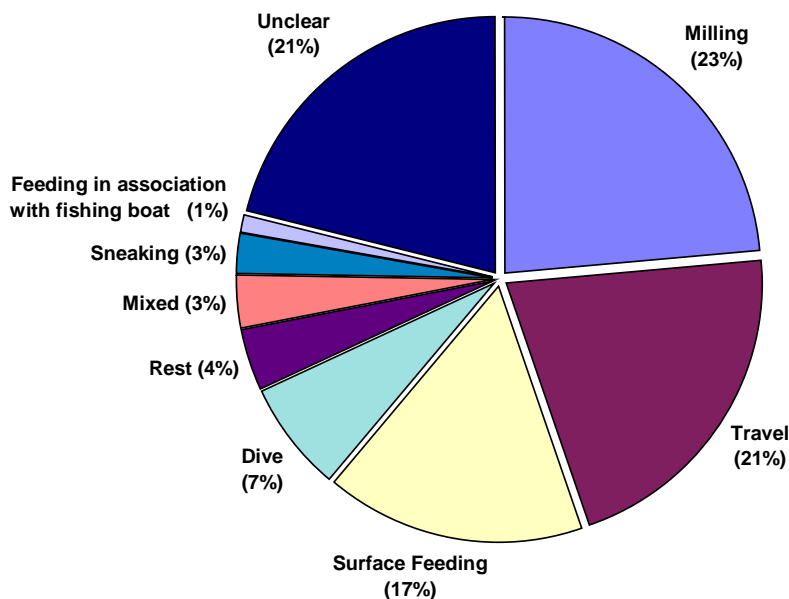
Additional behavioural observation during 26 sightings of rough-toothed dolphins totalled 20 h and 54 min or 418 3-min samples.

#### *Surface activity*

Activity on the surface can be very high in this species at times. During several sightings, dolphins were seen up to several hundred metres away because of splashes, breaches, and leaps.

During a sighting, the surface activity of individuals or groups also could rise dramatically for short periods, with leaps, breaches, and slaps performed in bouts. In other situations, the behaviour of certain individuals (juveniles and adults) was more active than that of others in the group. In general, the behavioural events shown by this species appeared similar to those described for other delphinid species. However, there were some unusual behaviours that should be mentioned.

**Figure 2** Percentage of behavioural states of rough-toothed dolphins off La Gomera (percentage of 3-min samples, n=418, 20.9 h of observation).



Breaches were the type of aerial behaviour observed most. In more than half the instances when breaches were observed, the first breach was followed by one or more consecutive breaches. This could be two or three breaches in a row, but also up to 15 breaches performed by one dolphin. In two cases, two dolphins together performed 10 and 24 breaches, respectively. The last leaps tended to be less intense, i.e. lower than the first ones. High breaches, with only the fluke remaining in the water, were performed in series up to seven times.

Leaps mostly were shown individually and solely, but could be repeated up to five times. Once, four consecutive *twisted leaps* were observed, with the dolphin reentering the water crosswise in the direction of full leaps. Also *tail slaps*, generally performed solely, could be repeated up to 15 times. Tail slaps and breaches at times were performed in an intense way, i.e. more powerful.

#### Group structure

An outstanding behavioural peculiarity of this species was the formation of tight subgroups, which behave extremely synchronously. Animals then swim in a synchronised manner, surfacing and submerging at the same time, side-by-side (see Figure 5). These subgroups swam so close to each other that there had to be a continuous or frequent direct body contact. Thus, an observed group could consist of several subgroups (e.g., of three and five

dolphins) or of subgroups and one or more single animals. Subgroups consisted of 2-7 dolphins. The formation of these tight subgroups was fluid, i.e. subgroups could break up only to re-form in the same or a different manner later. Subgroups of this kind were observed during 15 (52%) of the 29 sightings. Typically, the distance between individuals and subgroups or between subgroups was more than five bodylengths, which was termed "dispersed in tight subgroups".

The general group structure was quite uniform. Rough-toothed dolphins mostly were *dispersed* or *widely dispersed* and this changed rarely within a sighting. When widely dispersed, the mean distance could be  $\geq 100$  m among individuals. Groups hardly ever stayed *tight* as a whole, but only in subgroups, the group formation termed *loose* was observed only twice for short periods.

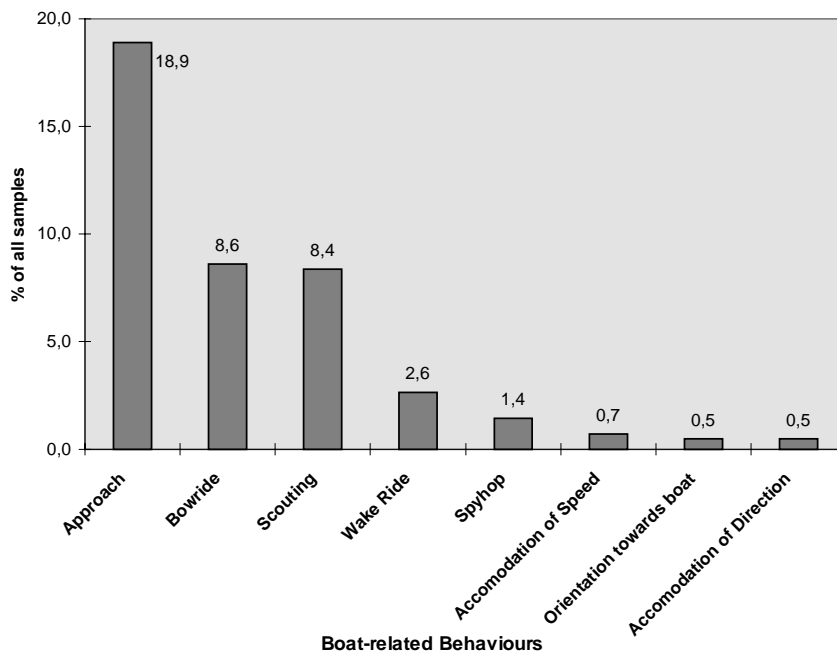
#### Behavioural states

To determine different behavioural states for the rough-toothed dolphin was relatively easy, as long as the group behaviour resembled those defined for other species, e.g. *travel* or *milling* or if an obvious, feeding-related behaviour was observed. In other cases, the group activity was ambiguous and did not allow a definite categorisation. Hence, I defined the following group behaviours, which were consistently displayed during several sightings:

Travel (10 sightings)-- Movement in a relatively constant direction without repeated dives at speed of 2-3 knots. Group formation was typically *dispersed*, but *loose* also was possible.

Other behavioural states were observed during only one or two sightings, but were distinct enough to allow the following descriptions:

**Figure 3** Percentage of boat-related behaviours of Rough-toothed dolphins off La Gomera 1995-2000 (percentage of 3-min samples, n=418, 20.9 h of observation).



Surface activity was from low to high. Formation of tight subgroups was possible. Groups could travel faster than 3 knots with the dolphins *porpoising* and leaping occasionally (*fast travel*) or slower than 2 knots in a loose formation (*slow travel*).

Surface Feeding (10 sightings)-- Group was dispersed or widely dispersed and more or less stationary. Apparent hunting activity was close to the surface often together with sea birds. Fish were sometimes visible. Typical behavioural events were fast surfacings, skimming, breaches, leaps, etc. Formation of subgroups was possible.

Milling (6 sightings)-- Dolphins changed directions within a certain area without long dives. General activity of the group was high and boat-related behaviours were more frequent. During two sightings, this state had a prominent social component, with animals repeatedly socializing. Group formation typically was *dispersed* or *widely dispersed*. Formation of tight subgroups was possible.

Mixed (3 sightings)-- Dolphins within the same group have different activities, e.g. some feed while others dive or do something else.

Dive (2 sightings)-- Group was stationary over a greater area. Repeated dives of 0.5 to 3.5 min were made by the whole group. Surface activity was low. Subgroups and group composition changed, but generally was *dispersed*.

Rest (1 sighting)-- Group divided into tight subgroups and were more or less stationary without a uniform direction. Surface activity was slight. Individuals or subgroups floated at times. Subgroups could dive for  $\geq 1$  min, but no group dives occurred.

*Milling* (24%) and *travel* (21%) were the predominant behaviours, while the dolphins were surface feeding during 17% of the observations. *Travel* was once performed close (<100 m) and parallel to the shoreline by a group of 7 animals. Figure 2 shows the frequency of the behavioural states of rough-toothed dolphins off La Gomera, along with the percentage of 3-min samples observed. During those months, where 72% of the behavioural observations were made, the percentage of behavioural states differed markedly: while in March *travel* (35%), *surface feeding* (29%) and *milling* (28%) were observed most frequently (*sneaking*: 5%, *dive*: 3%), in October, *milling*

(39%) was predominant while *travel* (17%), *surface feeding* (14%), *rest* (12%) and *mixed* (11%) accounted for smaller proportions of the behaviour. Note that an important percentage of samples (21%) could not be defined accurately.

Another characteristic of the behaviour of this species was that these dolphins could behave in a very inconspicuous manner. Occasionally, we only discovered the animals when we were already close to them. In these situations, the dolphins also were difficult to re-sight. Dolphins moved smoothly and non-energetically, surfaced without splashing, and stayed submerged, but close to the surface (only the tip of dorsal fin emerged), while swimming, and changing direction frequently. I called this "sneaking". *Sneaking* sometimes was displayed only by individual dolphins, but the behaviour of the whole group also could be characterised by this feature. *Sneaking* occurred during different behavioural activities (e.g. "sneak travel"). Or, if a behaviour could not be defined because of the animals behaving so faintly, the behavioural state was termed *sneaking* (see Figure 2) - merely to describe the character of the dolphins' movements than their actual activity. Sneaking tended to occur more often in smaller groups of 3 to 10 animals. This behaviour was also noted when we encountered a solitary rough-toothed dolphin for a short time.

#### *Interactions with other species*

The rough-toothed dolphin was sighted five times with other cetaceans; three times with bottlenose dolphins (*Tursiops truncatus*), and two times with Atlantic spotted dolphins (*Stenella frontalis*). The first of these sightings was a mixed group of about 40 to 50 rough-toothed dolphins and bottlenose dolphins, encountered on 16 September 1995. The dolphins were completely mixed and behaved as a group of only one species. Nevertheless, there was no uniform behaviour. Also, the animals were dispersed over a greater area. Both species interacted frequently with two whale watching boats and swimmers in the water (see also below). The sighting lasted 1.5 hr.

A sighting with Atlantic spotted dolphins occurred on 29 April 1998. This was one of the situations when the rough-toothed dolphins "sneaked". Surface activity was low and the animals seemed to travel, but this remained somewhat unclear, because both species were widely dispersed and were lost out-of-sight twice. The species did not seem to interact. Nevertheless, one animal of each species was seen to swim for a short time with only 2-3 m

distance between them. Cory's shearwaters (*Calonectris diomedea borealis*) and two sharks (unidentified species) were seen during this sighting in the direct vicinity of dolphins. Rough-toothed dolphins were seen only sporadically and after 1 h and 15 min were not re-sighted, while the observation of spotted dolphins continued.

Interactions with other species included surface feeding of rough-toothed dolphins together with herring gulls (*Larus argentatus atlantis*) and Cory's Shearwaters. The seabirds repeatedly were helpful to indicate the presence of dolphins due to their greater detectability from a distance. Apparent hunting behaviour by these birds, together with the occasional visibility of fish, prompted the categorisation of the dolphins behavioural state as *surface feeding*. During all sightings when the dolphin's were surface feeding, Cory's shearwaters, gulls or both were present. During another sighting, it was observed that a rough-toothed dolphin scared away a shearwater sitting on the water surface by approaching - and possibly touching it - from below. Other bird species observed in the vicinity of rough-toothed dolphins were a great skua (*Stercorarius sp.*) and a common tern (*Sterna hirundo*).

Apart from the sharks mentioned above, other species of fish were observed; once, tuna of unknown species jumped nearby the dolphins and once a marlin (family *Istiophoridae*) was observed in the same area, but no interaction between these species was noted.

On 4 December 1995, several rough-toothed dolphins "mistreated" a tortoise (*Caretta caretta*) as a toy, repeatedly nudging and pushing it on the water surface - a procedure likely to be quite uncomfortable for the tortoise. The tortoise looked exhausted and obviously was not able to get away even when it was recovered by us for a short period.

There was one instance when a dolphin swam close to (within 1 m) a Portuguese man-o-war (*Physalia physalis*). Two rough-toothed dolphins were observed to manipulate plastic bags by balancing them with the fin and pushing them with the beak above water, respectively.

#### *Interactions with boats*

Rough-toothed dolphins showed all eight of the behaviours towards the whale watching boats (see Table 1). Boat-related behaviours occurred during 19 (73.1%) of 26 sightings. At times, this species was inquisitive, came close and stayed with the boat(s). Boat-related behaviours occurred during 125 (29.9%) 3-min samples.

The mean proportion of samples with boat-related behaviours per sighting was 21.2% (range 0 to 55.9, SD=18.9). However, during 7 (26.9%) of 26 sightings, no boat-related behaviours were observed.

The most frequently observed interactions were *approaches* towards the boats, its propeller and a hydrophone that occasionally was pulled behind the boat. Approaches were performed during 79 (18.9%) of the samples. The hydrophone projected the sounds of the dolphins to the whale watchers aboard the boat and was approached and investigated acoustically by individuals or groups. Once, a juvenile approached the observation platform slowly while it was floating, repeatedly playfully rolling on its side.

*Bowriding* also occurred frequently and was observed during 36 (8.6%) of the samples. It was performed individually or in groups and could be short (a few seconds) or maintained for minutes. Once, a dolphin corkscrewed in the pressure wave of the boat, this was never observed in other species.

*Riding the wake* of the boat was observed during 11 (6%) samples. *Scoutings* (brief approaches) were more frequent (35/8.4%) and often were performed by juveniles and sometimes calves. Once, a dolphin scouted towards the propeller of the boat.

During six samples (1.4%), *spyhops* were observed, while *orientation towards the boat* was observed in only 2 samples (0.5%). Dolphins rarely *accommodated* their *swimming speed* or their *direction* to the boat's speed or direction. Figure 3a summarises these numbers.

Eighteen (65%) sightings were categorised as *no response*, eight (21%) as *proximity*, and four (14%) as *interaction*. Avoidance as a sighting category was never observed in this species. Thus, during two-thirds of the sightings the dolphins did not show an obvious reaction to the boats (see Table 3b). Interestingly, all 12 sightings made during March 2000, were categorised as *no response*.

On one occasion, I noticed an interaction between the dolphins and a fishing boat. It was a bigger typical Canarian fishing boat (14 m) that usually catches tuna with traditional lines. However, these fishermen occasionally catch bait and other fish. When this interaction started, the sighting of 9 rough-toothed dolphins lasted about 1 hr. The dolphins' behaviour had been tentatively categorised as *dive*. The group was *dispersed* or *widely dispersed* and repeatedly divided into subgroups, regularly showing *arched dives* and dive times of several minutes.

One of these subgroups (7 dolphins) showed a regular rhythm of 2-min periods at the surface and 2-min dives. These dolphins were breathing quite often while at the surface. Then the dolphins - still widely (and more or less evenly) dispersed - approached the fishing boat, where gulls and Cory's shearwaters were present. Fishermen were discarding single, small fish of unknown species and the dolphins apparently caught it. The seabirds also repeatedly plunged into the sea to get fish thrown overboard. This interaction, with the dolphins acting individually and staying close to the fishing boat, continued for at least 20 min, when the observation stopped.

#### *In-Water Encounters*

In 1995, swimming with cetaceans was not yet prohibited in the Canary Islands, which now is the case, after the whale watching regulations (Boletín Oficial de Canarias, Año XIII, Número 148. Lunes, 20 de Noviembre de 1995. pp. 11247-11252) came into effect in 1996. Swimming with cetaceans during whale watching trips in 1995 only was permitted when the general situation appeared suitable, i.e. the dolphins did not behave in a wary manner and showed at least some interactive behaviours. When this was the case, one or two swimmers entered the water at a time.

During 6 (86%) of 7 sightings in 1995, there were 21 swimming attempts. Seven swimming attempts were characterised by *little* curiosity of the dolphins towards the swimmers, i.e. no dolphins were seen or the dolphins stayed at a distance, or swam away. During four swimming attempts, the animals' curiosity was *intermediate*, with some scoutings or approaches. *Obvious* interest towards swimmers was observed in five cases. Sustained interactions (as defined by Constantine 1997) with swimmers occurred during the longest swimming attempts which lasted 9, 11 and 12 min respectively. There were repeated approaches and scoutings towards the swimmer, at times the dolphins stayed close for minutes. The minimum distance was about 2 m.

## Discussion

#### *Abundance and distribution*

This species is regarded as an offshore species (Corkeron, 1988; Norris, 1991) which prefers deep waters (Leatherwood & Reeves, 1983). The sightings at a short distance to the coast of La Gomera, in shallow waters thus seem rather



uncommon. This species was the only cetacean, except the bottlenose dolphin, found less than 100 m from the shoreline. Yet, there are reports of rough-toothed dolphin sightings in even shallower waters (Lodi, 1992; Lodi & Hetzel, 1999; Ott & Danilewicz, 1996). Moreover, the stomach contents of stranded rough-toothed dolphins on the Oregon and Washington coasts (USA) suggested that the dolphins were feeding in coastal waters (Ferrero & Hodder, 1994). Therefore, this species may regularly frequent coastal waters and areas with shallow depths, which is especially true for Brazilian waters, as pointed-out by Ott & Danilewicz (1996).

The sea surface temperature in the Canarian Archipelago is approximately 22°C to 24°C in summer and 17°C to 19°C during winter (Fernandopullé, 1976). Taking this into consideration, the year-round presence of rough-toothed dolphins off La Gomera may be unusual. While rough-toothed dolphins prefer waters of higher surface temperatures (Leatherwood & Reeves, 1983; Corkeron, 1988; Miyazaki & Perrin, 1994), the findings presented here indicated that this species also can be abundant in waters of lower temperatures than 25°C over long periods. Strandings on the coast of Brazil also indicated that rough-toothed dolphins can endure lower water temperatures (Ott & Danilewicz, 1996).

The rough-toothed dolphin was the fourth most frequent cetacean species in our sightings since 1995 (Ritter, 2001). More than 12% of all cetacean sightings are represented by this species. Taking into account the status of this species as described above, this proportion seems high. The rough-toothed dolphin is present year-round off the south coast of La Gomera (see Figure 1). Along with other species; the bottlenose dolphin, short-finned pilot whale (*Globicephala macrorhynchus*), and Atlantic spotted dolphin (*Stenella frontalis*), and 16 more cetacean species (Ritter, 2001). For the pilot whale, residency in the Canarian waters is confirmed (Heimlich-Boran, 1993), and likely for the bottlenose dolphin (Ritter, unpubl. data; see also Escorza *et al.*, 1992). Obviously, the study area attracts species that consequently can be seen here more often than elsewhere, such as the rough-toothed dolphins and the dense beaked whale, *Mesoplodon densirostris* (Ritter & Brederlau, 1999). As was the case during a sighting survey in French Polynesia, the second-most frequent cetacean species was the rough-

toothed dolphin (Gannier & Gannier, 1998), indicating that in some areas this species might prefer habitats of a certain type or certain oceanographic circumstances.

It seems reasonable to conclude that oceanographic conditions off La Gomera favour high productivity and hence a substantial prey availability for cetaceans. Although it is known that Canary waters usually are oligotrophic and have a large mesoscale variability in chlorophyll distribution throughout the archipelago (Aristegui *et al.*, 1997), a number of reasons could explain favourable conditions developing regionally off Gomera (Ritter, 2001). An island mass effect (Hernandez Leon, 1986) or eddies, generated "downstream" the island masses can concentrate nutrient rich waters on its lee side (Aristegui *et al.*, 1997). The input of trace elements from the land masses into the sea, as observed in the Galapagos Islands (Martin *et al.*, 1991), and/or filaments of upwelling water masses off west Africa (Aristegui *et al.*, 1997) are also plausible.

The group size of rough-toothed dolphins typically 10 to 20 and exceptionally with up to 50 or even 100 individuals (Ross, 1990; Miyazaki & Perrin, 1994). An aggregation of approximately 160 dolphins was observed in the Mediterranean Sea (Watkins *et al.*, 1987) and Steiner (1995) observed a group of 50 to 60 dolphins off the Azores. Lodi & Hetzel (1999) observed groups of 6 to 20, and Ott & Danilewicz (1996) counted 3 to 10 dolphins. The group sizes observed off La Gomera fit this range. The encounter of one single rough-toothed dolphin appears unusual for a group-living species, although Gannier & Gannier (1998) also reported group sizes of 1 to 15. However, this could be a consequence of the group structure, when the animals are widely dispersed, as actually rough-toothed dolphins seem to have a typical group structure that is not observed in other delphinids. None of the other dolphin species off La Gomera were so dispersed and close (in subgroups) as the rough-toothed dolphins. In general, the predominant group formations were *dispersed* and *widely dispersed*. Hence the rough-toothed dolphin appears to have a group organisation, where group cohesion and social bonds seem to be expressed mainly by tight subgroups that swim close and synchronously together.

Rough-toothed dolphins often are sighted together with other cetacean species (Miyazaki & Perrin, 1994; Ross, 1990). In the Pacific Ocean, they frequently have been sighted in tuna feeding grounds together with bigger promulgated here, has not been reported previously. From time to time, rough-toothed dolphins also mix with bottlenose dolphins (Perrin & Walker, 1975; Leatherwood &

associations of spinner dolphins (*Stenella longirostris*) and spotted dolphins (*Stenella attenuata*, Miyazaki & Perrin, 1994). An aggregation with *Stenella frontalis*, like

Detailed descriptions of individual behaviour are rare. Lodi & Hetzel (1999) described that tailslaps and leaps were performed very regularly during feeding behaviour (see also



Figure 4

Reeves, 1983; Scott & Chivers, 1990; Lodi & Hetzel 1999), as we observed in three cases. In captivity, these two species also are reported to have mated successfully once (Pryor, 1975).

#### Pigmentation

The pigmentation pattern observed in some dolphins with the light white band above the eyes was described by Watkins *et al.* (1987). In Miyazaki & Perrin (1994, p.5), Martin (1991, p.134) and Steiner (1995, p.126) photographs clearly showed this feature, too. This pattern has not been rendered prominent before. It was especially pronounced in dolphins that generally appeared more scarred, lighter grey, and/or larger than other dolphins (see Figure 5). These are thought to be old animals (Miyazaki & Perrin, 1994) and also were observed off Brazil (Lodi & Hetzel, 1999).

#### Behaviour

Remarks about the behaviour of rough-toothed dolphins are rare and mostly anecdotal. Until now it obviously has not been possible to study these animals over a longer period of time.

below). Leatherwood & Reeves (1983) outlined a behaviour that they called "skimming": dolphins swim "rapidly with the snout continuously close to the surface and the dorsal fin continuously exposed". While it remains unclear if there is much water splashing during this behaviour - which is the case in my definition for *skimming* (see Weaver, 1987) - this behaviour compares to what I have called *sharking*. Lodi & Hetzel (1999) observed this behaviour, too, so that swimming with only the fin above the surface could be a typical behaviour for this species. Several authors claimed that these dolphins are either difficult to track (Pryor, 1975) or to follow, because they stay under water a lot and may dive up to 15 min (Miyazaki & Perrin, 1994). Likewise, Watkins *et al.* (1987) described the surface activity as mostly slow movements. These observations parallel what I called *sneaking*. These dolphins obviously dive close to the surface over longer distances - with or without the dorsal fin exposed.

However, it was also often the case, that rough-toothed dolphins behaved actively on the surface (see Figure 6). I repeatedly experienced these dolphins being highly active and curious, and in other situations behaving in a tranquil and/or inconspicuous state.

During many situations, the group behaviour of the dolphins was not easy to determine. Sometimes *surface feeding* was shortly interrupted by *travel* and then resumed. In other situations, the behaviour seemed to change from one 3-min sample to the next.

We observed *surface feeding* in association with gulls, Cory's shearwaters, and fish. The same has been reported by Steiner (1995), where shearwaters and rough-toothed dolphins were observed under water feeding on a small "bait ball of fish". Feeding aggregations with seabirds also were reported by Lodi & Hetzel (1999), who made some remarks about feeding behaviour in shallow waters in the area of Ilha Grande Bay (Brazil). Leaps and tailslaps were frequent and the dolphins often were seen shaking their heads with fish in their mouth - I



A significant characteristic was the formation of tight subgroups that acted completely synchronous. These subgroups often dissolved partially only to reappear a short time later. Subgroups have been reported by several authors (Watkins *et al.*, 1987; Lodi, 1992; Steiner, 1995; Lodi & Hetzel, 1999; Reeves & Leatherwood, 1987). Lodi & Hetzel (1999) described a "probable" resting behaviour, where two subgroups showed a regular rhythm of dives of 1.5 min and surface periods of 3 min with the dolphins swimming very calmly and in "chorus-line". However, these subgroups appeared during several behavioural states off La Gomera. Thus, they seem to be more an aspect of the structural organisation of a group than of a certain behaviour, possibly reflecting social relations within a group. Social bonds might be strong in this species, as indicated by observed epimeletic behaviour (Lodi, 1992).

observed an analogous behaviour and termed it as *fish jerk* (compare Ostman, 1987). Lodi & Hetzel (1999) also observed co-ordinated movements by the dolphins and interpreted this behaviour as a co-operative feeding strategy. Smeenk *et al.* (1995) watched hunting rough-toothed dolphins which were herding fish. Reeves & Leatherwood (1987) reported a rough-toothed dolphin holding a big dolphin fish (*Coryphaena hippurus*) in its jaws, of which other dolphins partook. This also could be a hint to cooperative feeding.

During most observations off La Gomera, the dolphins predominantly seemed to hunt individually. Once, a group of 5 to 10 dolphins was observed apparently surface feeding in association with shearwaters, but the group showed regular dives of up five minutes, which is not typical for surface feeding as defined above. This also could have been another, as yet unknown hunting strategy.

#### *Interactions with humans*

Leatherwood & Reeves (1983) claimed this species is "not especially wary, but shows less propensity to bow-ride than most species of wild dolphins". Lodi & Hetzel (1999) observed that, when followed by four boats, the "dolphins did not seem to be bothered by the boat's presence". On the contrary, they seemed to use them as barriers "to trap fish against". Watkins *et al.* (1987) also stated that the initial contact with a large group of rough-toothed dolphins was when "the dolphins approached our vessel".

Although this species is less-known and described as rather inconspicuous, the proportion of sightings off La Gomera categorised as *proximity* and *interaction* (35%) was quite high. The fact that the most frequent boat-related behaviour were approaches also highlights their curiosity. Bowriding was one of the most frequent interactions observed. Bowriding has been described also by Watkins *et al.* (1987) and Steiner (1995). Moreover, of eight sightings in the Gulf of Mexico made by Würsig *et al.* (1998), six were categorised as "bowriding" and two as "approach" (i.e. *proximity* in this study).

However, seven sightings were without any boat-related behaviours and the overall predominant sighting category was *no response*. Therefore, I believe that if a boat catches their

interest, rough-toothed dolphins will be showy companions, otherwise, they are not likely to

interact. Also, the lack of observation of *avoidance* could lead to an underestimation of its occurrence, because the dolphins might avoid boats before they are detected.

In-water encounters lasted up to 12 min and might thus be called "sustained interactions" (Constantine, 1997). Again, there are few comparable cases. Pryor (1973, cited in Miyazaki & Perrin, 1994) characterised this species (referring to captive animals) as "potentially dangerous swimming companions as they are hot-tempered", Lodi (1992) reported that "dolphins apparently ignored the presence of divers swimming nearby". We experienced different reactions to swimmers entering the water, from avoidance to sustained interaction. Also, a great variety of reactions of rough-toothed dolphin groups to the presence of boats during various behavioural activities of these groups was observed. This is also true for other species off Gomera (Ritter, 1996).

#### *Interaction with fisheries*

In the eastern tropical Pacific this species belongs to those that are occasionally killed in tuna purse seines and in other net fisheries (Perrin & Walker, 1975; Leatherwood & Reeves, 1983; Miyazaki & Perrin, 1994), but obviously the catches of dolphins were intended during this fishing practice. The observation of



Figure 6

rough-toothed dolphins that apparently fed on discarded fish from a fishing boat suggested that

rough-toothed dolphins that apparently fed on discarded fish from a fishing boat suggested that

this species feeds opportunistically at times and thus, could be threatened by entanglement in fishing gear. Rough-toothed dolphins also were observed close to gillnets, possibly feeding on disabled fish from nets, and dead dolphins showed signs of possible interactions with fisheries (Lodi & Hetzel, 1999; Monteiro-Neto *et al.*, 2000). Sometimes also rough-toothed dolphins come to the coast of Japan and become victims of Japanese dolphin hunters (Whitehead *et al.*, 2000).

Taking this background into consideration, together with the obvious curiosity often displayed by these dolphins, this study sheds a new light is on this species. Rough-toothed dolphins in the wild can be playful, which is underlined by their dealing with other, cetacean, non-cetacean species, and objects, making them an attractive potential target for whale watching activities. But at the same time, this species is vulnerable to detrimental effects of human activities.

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