

Three-day survey of dolphins in Shaab Samadai (14th – 16th October 2003)

STUDY REPORT



The spinner dolphin (*Stenella longirostris*)

Patrick Louisy, November 2003

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INTRODUCTION

Almost every day, a group of spinner dolphins (*Stenella longirostris*) settles inside the lagoon of the crescent-shaped reef of Shaab Samadai, also named Dolphin House. There, they seem to rest and engage in various social activities. Every day too, a growing number of snorkelers enter the lagoon to meet the dolphins. The incidence of this human presence on the dolphin population, although not precisely assessed, is a matter of concern.

Some monitoring of the tourist inflow obviously is needed, but the poor biological knowledge of these dolphins makes it quite a difficult task. The purpose of the present study is to supply some precise biological data, which could be useful in terms of management of the area.

Our survey involved a group of amateur French divers, who participated during their holiday time. This trip was one of the “Voyages Bio Sous-Marine” (also called “Blue Expeditions”) I periodically organise with the scientific association “Peau-Bleue” for amateur divers; it originally was designed to offer them to “play science” while diving. When first preparing this trip, after a few days snorkeling with Shaab Samadai dolphins in April 2003, I discussed the possible program with Mr Hossam Helmy. It came out of our meeting that I could try to devise a scientific protocol likely to answer some useful questions regarding a sustainable management of human presence in Shaab Samadai: How do dolphins occupy the lagoon area? How do their activity change during the day ? How do snorkelers influence the dolphins’ behaviour?

Thus, originally starting from a holiday “science-playing” trip, this “blue Expedition” became a true scientific survey with precise goals, definite and rigorous study protocol.

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1 • METHODS

1.1 Purpose of the study

The designed protocol of the study originally aimed at three objectives:

- To describe location and movements of the dolphins within the lagoon for a whole day length.
- To describe group structure and activity changes during the day.
- To assess the possible incidence of snorkelers on the dolphins' behaviour.

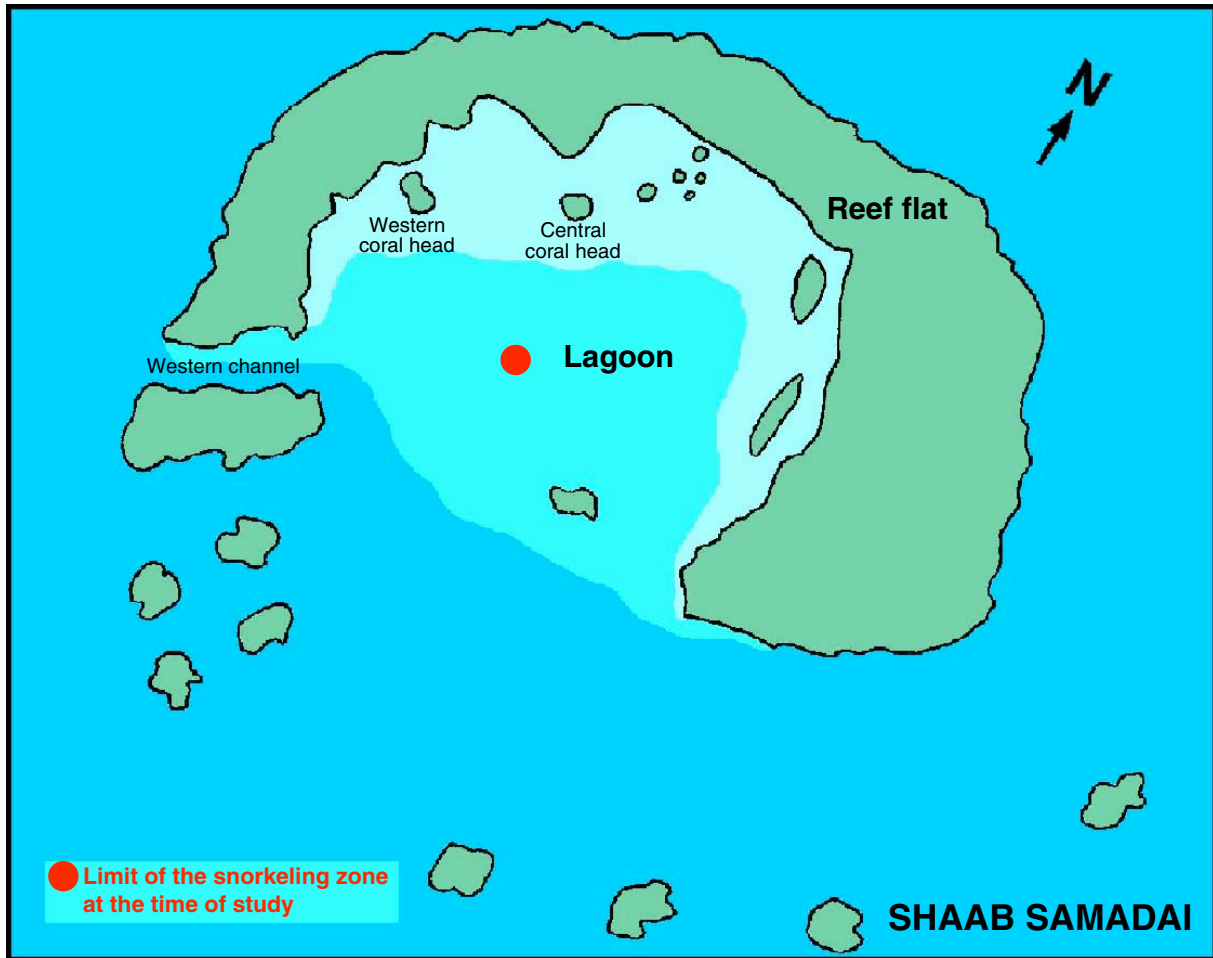
However, a governorate decree, taking effect from October 13th, forbade snorkeling and any human presence inside Shaab Samadai lagoon. Although our survey team was allowed to operate as originally scheduled, it was obviously impossible to observe the effect of heavy human presence on dolphins' behaviour. Conversely, we gained a unique opportunity to study the dolphins as little disturbed as possible; we may then consider that the picture given by our result reflects quite closely their natural behaviour.

This short time study was not expected to bring out great discoveries, rather to supply a precise, objective and quantifiable description of diurnal activities of the dolphins inside the lagoon. And would the observations tell no more than the mere confirmation of what most people frequenting the dolphins already know, the meaning of these results would even be reinforced.

1.2 Study area

The reef of Shaab Samadai, also named Dolphin House, is located some 10 km south of Marsa Alam, and less than half an hour boat from Marsa Nakari, the closest sheltered bay on the main coast. It is one of two reefs known to shelter spinner dolphins in the southern Egyptian Red Sea (the other is Shaab Sataya, or Dolphin Reef, located in the Fury Shoals area).

The roughly north-south oriented horseshoe-shaped reef encloses a sheltered semicircular lagoon opening southwards (see Fig. 1). The actual size of the reef couldn't be measured; the width of the lagoon roughly can be evaluated at about 500 metres, with no certainty. The north-western part of the lagoon is shallowest (about 3-4 meters), the depth reaching 8 to 12 meters in its centre. The bottom of the lagoon is made of white coral sand, with only a few tiny coral formations (except the large coral heads approaching the surface close to the reef flat). The inner edges of the reef and large coral heads walls are steep, almost vertical in general. The reef flat usually is submerged, and only partly emerges at low tide. Prevailing winds ordinarily blow from the northern sector, and most commonly get stronger during the day.



*Fig. 1 : Approximated map of Shaab Samadai.
Reef flat and large coral heads in green, sandy lagoon in light blue hues.*

1.3 Survey design and procedure

The present study was designed to provide, through a short-term survey, precise quantitative data on how dolphins behave and utilise Shaab Samadai lagoon during the day.

Thus, the study addressed two main aspects of the dolphins’ life inside the lagoon:

- **location** (movements, changes during the day)
- **activity and behaviour** (different types of activity, changes during the day).

Activity and behaviour were studied through a set of descriptive parameters assessable in a semi-quantitative way (Fig. 2).

The general principle of the survey was to combine aerial (surface) observation with underwater (snorkeling) observation: at any time of the day, two teams of observers (aerial / underwater) were at work simultaneously. Every 5 minutes (and at the same time for aerial and underwater observers), each team would write down the observed data on a special sheet or underwater slate.

AERIAL (surface) OBSERVATION

Date	time	speed	total number	aerial activity (nb/1 mn)					jumps & leaps (nb/1 mn)					number of snorkelers		Observers
				breathing	nose out	tail slap	head slap	back slap	arcuate	salmon	tail-over-head	spin	other	in the lagoon	close to dolphins	
	hhmm	(-,+,++)	nb	nb	nb	nb	nb	nb	nb	nb	nb	nb	nb			
	hh:mm	(0)1,2,3		nb	nb	nb	nb	nb	nb	nb	nb	nb	nb			

N.B. Location of the dolphin group(s) is noted at the same time on the map

UNDERWATER (snorkeling) OBSERVATION

Date	time	speed of group	dispersal of group	synchrony	distribution in depth	total number	nb of young	nb of babies	sub-groups	breathing	surface activity	interaction with observer	observers	Other observations : caressing and displays, copulation or copulation-like behaviour, comments
	hhmm	(-,+,++)	(-,+,++)	(-,+,++)	(-,+,++)	nb	nb	nb		nb	(0-,+,++)	(-,+,++)		
	hh:mm	(0)1,2,3	1,2,3	1,2,3	1,2,3	nb						1,2,3		

Coding of parameters used in the field
Coding of parameters used for data analysis
In white : not evaluated or not used

Fig. 2 : Tables of parameters actually assessed during the field survey (partial fac simile of the field sheets).

The planning was organised to get continuous observations from the moment dolphins would first enter the lagoon early morning until last dolphins leave in the afternoon. Surface observation teams (usually 2 observers together) were taking turn on an inflatable boat anchored in the middle of the lagoon (south to the central coral head). Each team had to carry out one and a half hour period of observation per day. Underwater teams, usually composed of two snorkelers, also were taking 1 h 1/2 turns. They had to follow more or less the general movement of the dolphins (without rushing behind them), but couldn't always remain in sight of the group. Thus, there are inevitable lacks in the underwater data.

AERIAL (surface) OBSERVATION TEAM

Every 5 mn, observers would evaluate and write down:

- The location of the group (or various groups) of dolphins on the map of the lagoon (see Fig. 1).
- The swimming speed of the dolphins.
- The number of each type of aerial activity (breathing, nose out, different slaps, different leaps) during 1 mn observation.

N.B. Observers were equipped with binoculars.

UNDERWATER OBSERVATION TEAM

Every 5 mn, observers would evaluate and note:

- The swimming speed of the group.
- Descriptors of group structure (dispersal, synchrony, depth distribution).
- The number of dolphins in the group.
- The interest dolphins show towards observers.

N.B. Observers were equipped with underwater PVC slates on which the data collection table was already prepared.

1.4 The team

The survey team mainly was composed of French amateur divers, trained and managed by Patrick Louisy. The diving trip was organised in partnership with the French diving magazine OCTOPUS – BIO SOUS-MARINE and the tour operator NOUVELLES FRONTIÈRES PLONGÉE. Logistic support at sea (transportation and accommodation of the whole team, including one night on the spot) was offered by the RED SEA DIVING SAFARI, under direction of Mr Hossam Helmy, with the operational help of Mr Hesham M. Kamel.

During the three days of the survey, Rangers of the National Parks of Egypt were on board with us, especially Mr Mohamed A. Ghani, who fully participated in the field study.

Team leader

& scientific director

Patrick Louisy, Doctor in Biological Oceanography

Team participants

16 French amateur divers:

Claude Boudot, Véronique Brun, Gilles Carmine, Michèle Dugarreau, Laurence Faou, Véronique Garreaud, Chantal Gaubert, Aline Hamaoui, Jean-Claude Kiepferlé, Nathalie and Philippe Lesur, Florence Marsaglia, Sophie Montels, François Petitjean, Gérard Roignant and Rudy Serairi.

Other participants

Mohamed Abdel Ghani (environmental researcher, National Parks of Egypt)

Angélique Berkane (film-maker) and Frédéric Bassemayousse (photographer).

1.5 Carrying out of the survey

The present survey was carried out on 3 days, from 14th to 16th of October 2003.

A 2 days period of “theoretical” training preceded the actual field study. Of the 3 days in Shaab Samadai, the first was planned to accustom the participants to the place and the spinner dolphins themselves. This “field training day” provided the opportunity for practical training in the use of scientific methods and the assessment of the various study parameters. It also allowed refining of the reef map and final setting up of the study protocol (taking into account the difficulties and remarks of the participants after their field training phase). The next 2 days were entirely dedicated to scientific data collection.

Oct. 14th, field training day

Our boat arrived in Shaab Samadai at about 10:30 am. Participants started field training and underwater observation around 11:00.

Oct. 15th, data collection, first day

The boat arrived on site at 6:15 am. Some dolphins already were inside the lagoon, and aerial observation started right away from the main boat until the zodiac could be anchored in the lagoon. Underwater observation and surface observation from the zodiac started at 6:50. Observation ended at 15:25, when the last dolphins definitively left the lagoon. The boat stayed overnight on the spot with part of the team.

Oct. 16th, data collection, second day

The watch started from 5:00 am (on the main boat). Dolphins were first seen at 5:35 (out of the lagoon). Underwater observation and surface observation from the zodiac started at 6:35, and ended at 16:25 when dolphins left.

Altogether, the total sampling/observation effort can be estimated at 77:40 hours (summing up of all observers work periods) for the 2 days of actual data collection. Should also be added some 60 to 80 hours of field training, video- and photo-recording (which helped interpreting data more precisely), field measurements, additional underwater observations...

1.6 Reliability of results

Visual assessment of behavioural parameters in ranked classes is indeed not absolutely precise. It is however one of the best ways to collect objective data in a relatively short time, and paradoxically to get a precise figure of the studied phenomena:

- first, this approach allows for some quantification of data.
- second, the “random” sampling procedure (observation at set times) limits the possible bias due to human interpretation.
- third, the high number of observations somehow compensates for the lack of precision of each individual data.

One possible concern about this study was the reliability of field observations, since most participants were not scientists, nor specialists in cetology. This problem was specifically addressed from the very beginning of the protocol setting up. The first step was to select the items to be assessed so that they could easily be affordable by anyone (this is anyway a good rule for any scientific study). The second was to prepare clear, easy to use and fast to fill in tables for data collection, together with field reference sheets reminding definition and ranking of each parameter to be assessed.

In addition to these field tools, the participants obviously needed to be trained for this study (but this also would have been true for any observer since the designed protocol was quite unusual, even for experienced cetologists). Preliminary “theoretical” training included existing knowledge about spinner dolphin biology and behaviour, hints about Shaab Samadai and the local dolphins, explanations and reflection about the scientific approach and sampling methods, detailed discussion of planning organisation...

The “field training day” in Shaab Samadai, first gave the participants the opportunity to approach the dolphins and “feel” how they behave in their natural environment. Then, the observers could test the scheduled protocol and try to evaluate the various parameters (counting of dolphins, group structure description, size evaluation of babies, etc...).

After this training / trying phase, the encountered difficulties were discussed, and some items were removed from the list to be assessed (i.e. orientation of swimming, surface counting of dolphins). Later on, other items were not included in the analysis, either because precision and consistency of the evaluation was not guaranteed, or because not all the observation teams actually assessed the parameter (i.e. number of breathings for aerial observations, number of breathings and surface activity for underwater observations).

2 • RESULTS

2.1 General observations

Here is exposed the general behavioural frame of dolphin days in Shaab Samadai lagoon, as observed during the 3 days of the survey (including the first “field training day”).

October 14th

(Sunny weather, northern wind becoming moderate in the course of the day)

Observers were in the water at about 11:00 am. From then up to 12:00 / 12:30, the dolphins were very active. Leaps and tail slaps were visible from the main boat, and many social interactions, including mating, were observed underwater. At times, some dolphins would readily play – and sometimes seek contact – with the observers.

Location and movement of the dolphins were not specifically recorded, but the group(s) mostly remained in the area surrounding the western coral head, up to the central coral head (see Fig. 1), i.e. in the western part of the lagoon.

Dolphin activity then settled down until mid afternoon when they progressively started to be active again, swimming faster and in a wider area of the lagoon. The dolphins left the lagoon between 16:00 and 16:30, in successive groups.

October 15th

(Cloudy weather, becoming very dark during the afternoon; low to moderate northern wind)

When observation started at 6:20 am, the dolphins already were present. They were quite active and mobile in the whole lagoon. From about 8:10, they settled into rest, remaining in the north-western part of the lagoon.

Around 11:30, the level of activity abruptly rised again (quite comparable to the day before) for about one hour and a half. While activity lowered somehow (but remained irregular) in the afternoon, the range of movement widened progressively to the whole lagoon until dolphins eventually left the area quite early (between 15:00 and 15:25), probably due to the darkness of the day.

October 16th

(Sunny weather, northern wind becoming quite strong in early afternoon)

A few dolphins first entered the lagoon at 5:45 am, then left and came back at 6:20. Unlike the day before, the dolphins quickly settled in a reduced area close to the reef (although they were not resting, and swam quite actively), mostly between western coral head and central coral head, and around the later.

At about 8:00, a group of 20 to 30 tourist snorkelers entered the lagoon; it was impossible to persuade them to leave until 8:25, and only 8:45 for the most refractory. In the meantime, dolphins became quite active (or nervous?).

The following rest period was not very clear nor very long. A new rise in activity was observed from about 10:00 to 12:00 or so. Only later did a typical resting phase start. From 14:00 – 14:15 on, activity level rised again and remained quite high until dolphins left the lagoon in various groups, between 16:15 and 16:30.

2.2 Number of dolphins

The first day (Oct. 14th), a maximum of 50 to 52 dolphins were counted (around 11:30 am). Among them were 6 babies of relatively small size (no more than 1 m total length), each going with an adult. The second day, a maximum of 55 was observed around 8:00 am, but subsequent counts gave about 40 individuals (including 2 small babies): some fifteen dolphins probably went back to the open sea. The third day, no more than 40 dolphins were observed (early morning), and the group stabilised at 30-33 individuals (with no small baby).

During our survey (and as far as could be assessed by surface observation), dolphins entered the lagoon (early morning) or got out (in the afternoon) in successive groups, not all together. Thus, the group occupying the lagoon was composed of various units who joined there for the day.

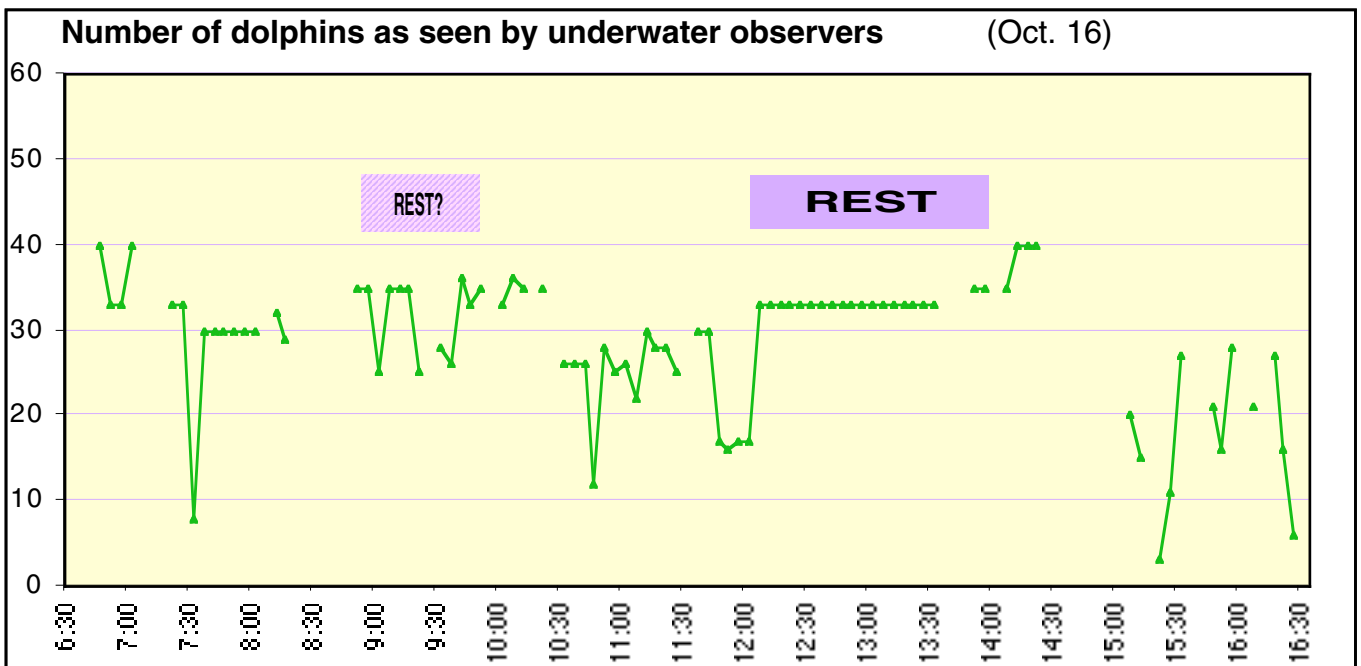
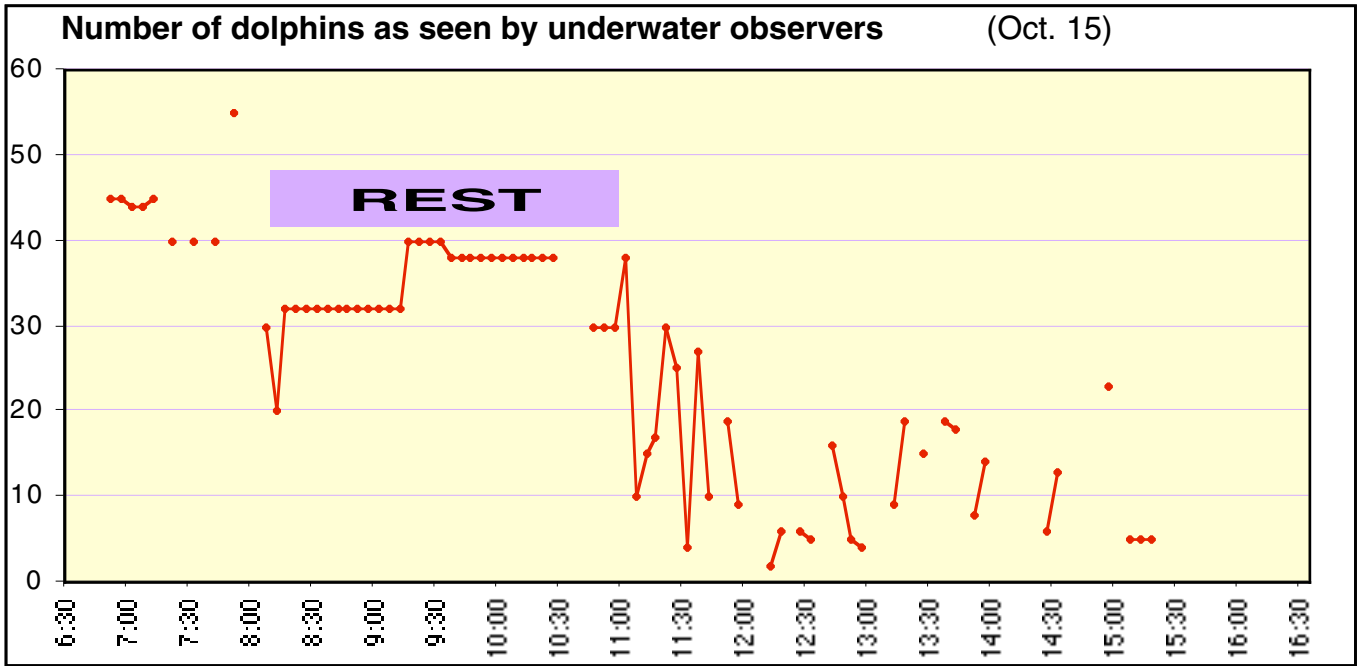


Fig. 3 : Number of dolphins counted every 5 minutes by underwater observers. This is the number observed in the group(s) actually seen by observers. Oct. 15th in red, Oct. 16th in green. Some data lack because underwater observers couldn't always be close to the dolphins.

Fig. 3 shows that the number of observed dolphins is not constant during the day. Some subgroups may separate at times, especially during phases of high activity. Surface observers could thus sometimes detect up to 3 different subgroups swimming in different areas of the lagoon. It also is very probable that groups of dolphins leave the lagoon as already stated (for example, on Oct. 15th, the maximum number of dolphins was 55 at 7:50, then lowered at 38-40 up to 11:00, and remained at 27-30 until the end of the day). And the possibility that some dolphins join from outside in the course of the day cannot be ruled out either. There are however periods when group size remains quite constant, especially during typical resting phases, and this will be discussed later.

2.3 Location and movements

Field observations concerning location of the dolphins during the day were noted every 5 minutes on a sheet of translucent tracing paper superposed on a map of Shaab Samadai lagoon. To analyse the location data, a grid was superimposed on these maps. It was then possible to sum up the number of observations in each square for given periods of time. The results are summarised in Fig. 4.

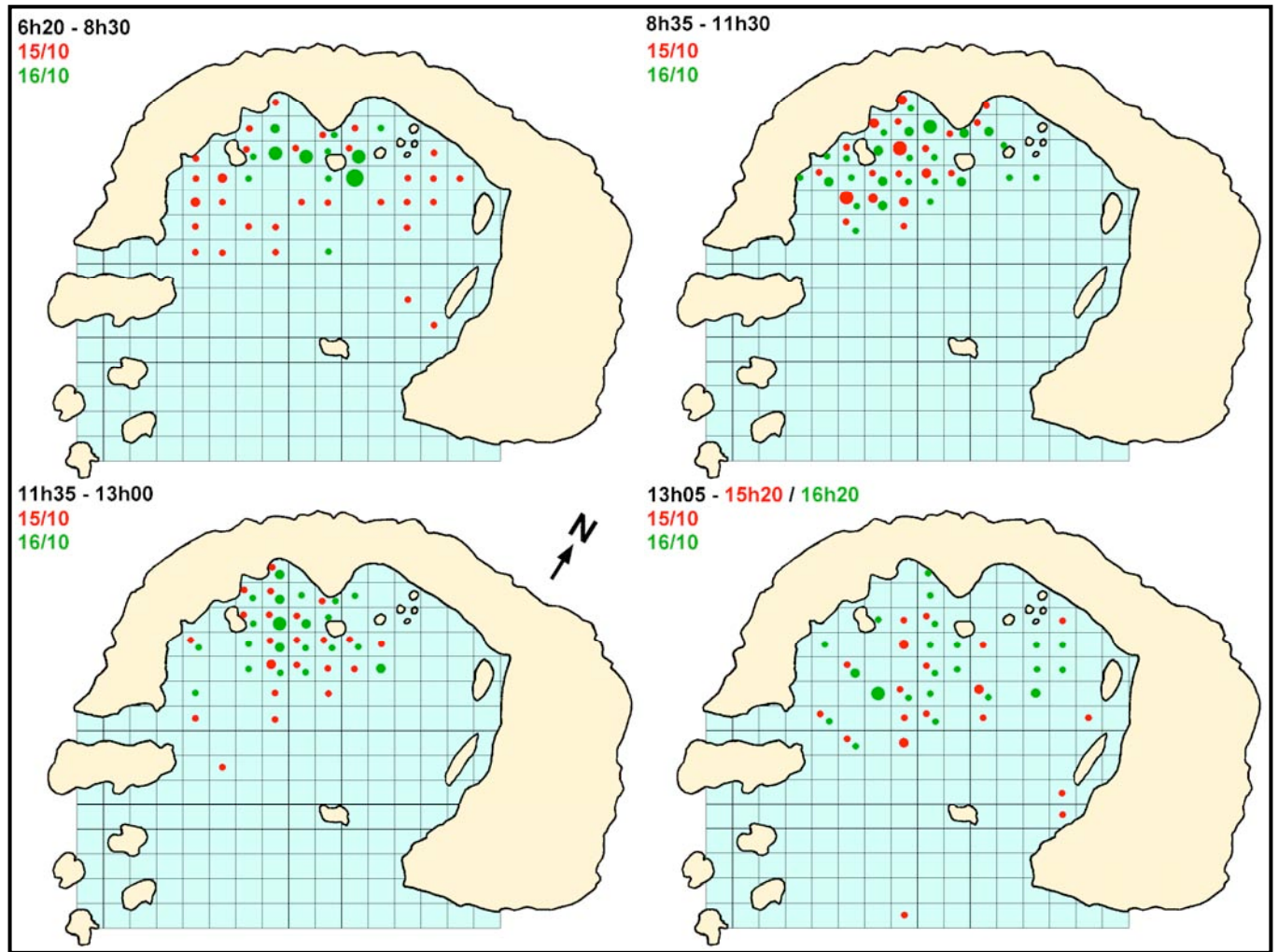


Fig. 4 : Locations where dolphins were observed during successive periods of the day. Data of first observation day (Oct. 15th) in red, second day (16th) in green. In yellowish: reef flat and main coral heads. Size of the dots is proportional to the number of observations at each point:

- Small dots: ≤ 5% of observations (usually only 1 obs.).
- Medium dots: 5.1-10% of observations.
- Large dots: 10.1-20% of observations.
- Larger dot: > 20% of observations.

When comparing the two days of observation, evolution of location and movements of dolphin groups look quite similar for most of the day. Only the early morning phase differs clearly, dolphins being very mobile on Oct. 15th, and quite sedentary on Oct. 16th.

The most striking feature is that dolphins spend a large part of the morning (period 8:35 - 11:30 at least) in a restricted zone of the lagoon. This is the area where they settle when they get into rest (see further), hence the proposed name of “resting area”, as illustrated in Fig. 5.

In general, dolphins seem to favour northern and western parts of the lagoon. Only rarely do they swim in the south-eastern sector, and mainly during arrival or departure phases. Thus, their main “activity area” (see Fig. 5), which encompasses the resting area, doesn’t extend to the whole lagoon.

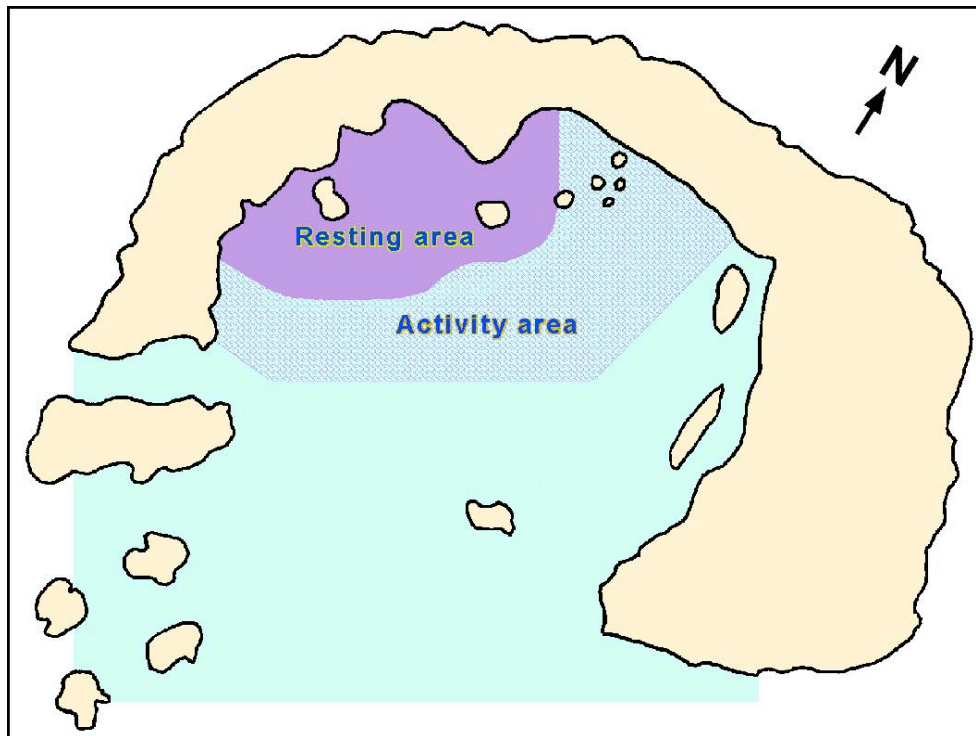


Fig. 5 : Main activity area and resting area (included in the wider activity area) deduced from the two days survey.

2.4 Activity and behaviour: overall evolution

Dolphin activity and behaviour were studied from two viewpoints: underwater (snorkeling) observation, and aerial (surface) observation. Underwater observations mainly addressed the description of dolphin group structure and activity, and the relation with human observers. Surface observations, together with assessment of location and movements of the dolphins, recorded aerial signs of activity (slaps, leaps...).

Since observation times were the same under and above the surface, this schedule was expected to show possible relations between underwater activity and group structure on one hand, and aerial activity and behaviour on the other hand.

The overall evolution of the various underwater and aerial parameters describing activity and behaviour of the dolphins is shown in Fig. 6 (Oct. 15th) and Fig. 7 (Oct. 16th), on the following pages. These graphs feature “mean” values observed every half hour from the early morning beginning of observations to the moment dolphins leave the lagoon in the afternoon. They help visualise the simultaneous evolution of all recorded parameters.

HOW WERE THE GRAPHS CONSTRUCTED ?

Most underwater field data were qualitative ranked variables: speed, dispersal, synchrony and depth distribution of group, and interaction with observer. For aerial data, only speed was a ranked variable; other aerial activity variables were counts.

The ranked variables were coded “-, +, ++” for field data collection. These codes were changed in “1, 2, 3” for calculation and plotting. Code 1 is thus the lowest (minimum) value for these parameters, code 3 being the maximum.

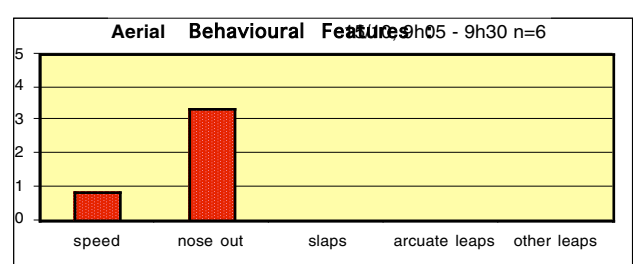
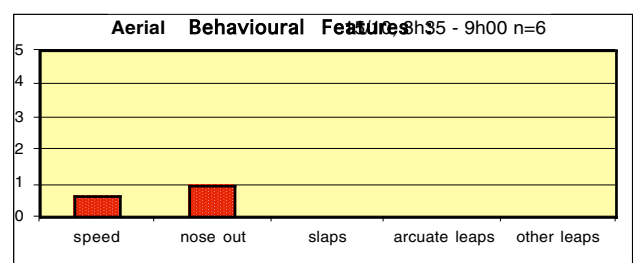
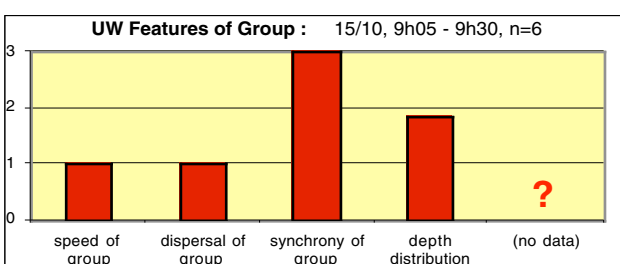
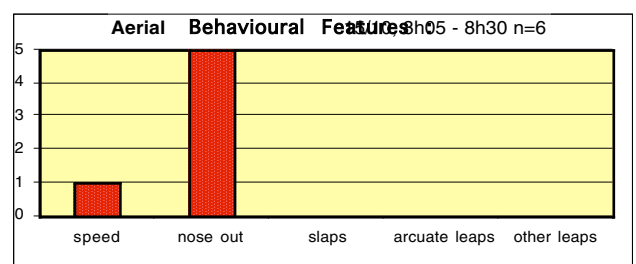
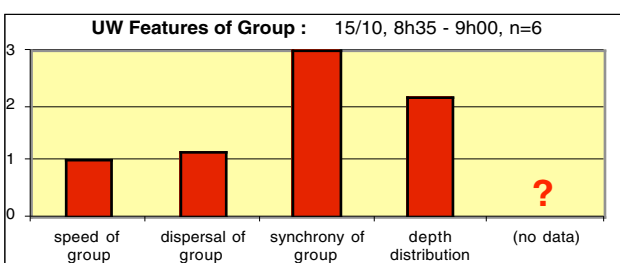
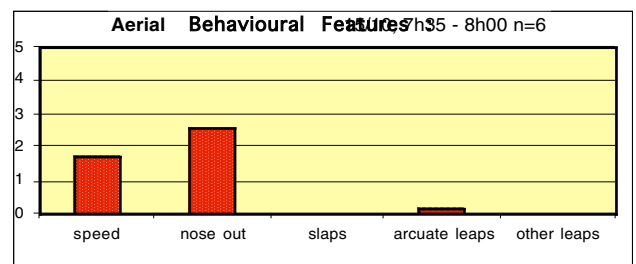
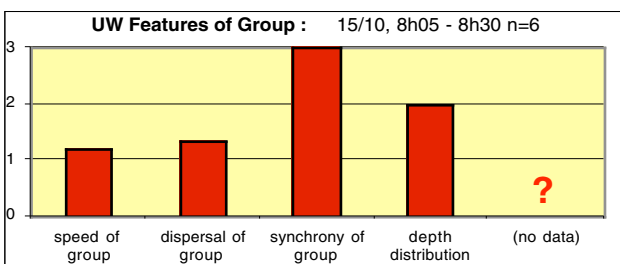
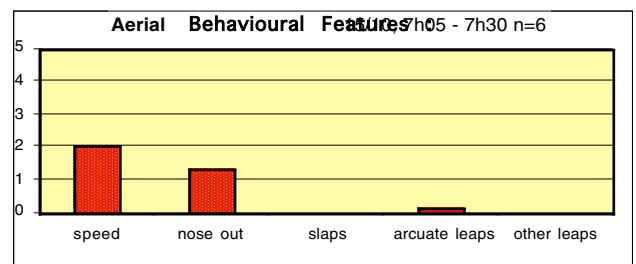
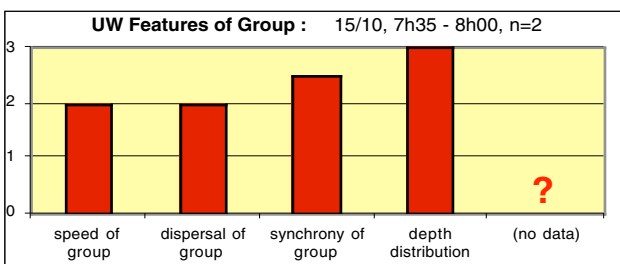
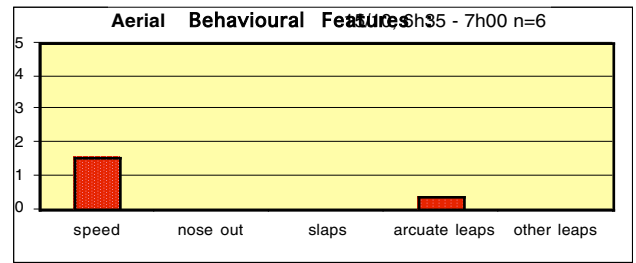
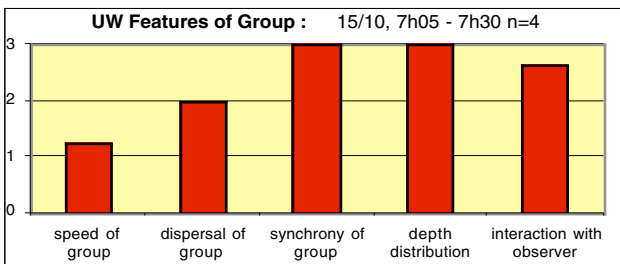
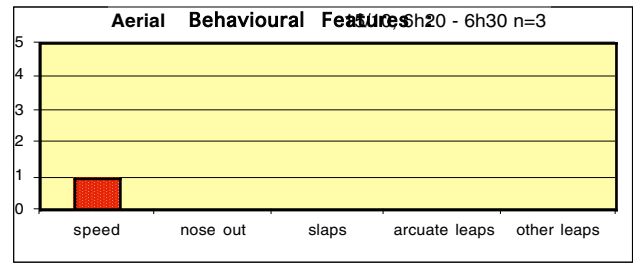
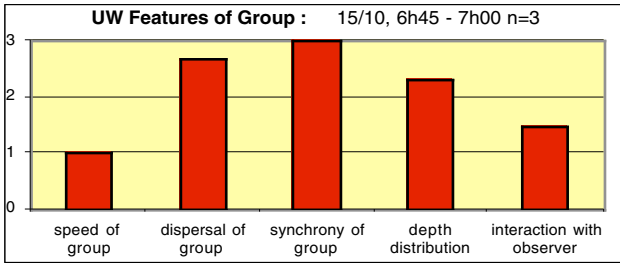
For the variable “swimming speed”, a code 0 was added since dolphins sometimes were observed completely still; in that case, 1 is not the minimum possible value.

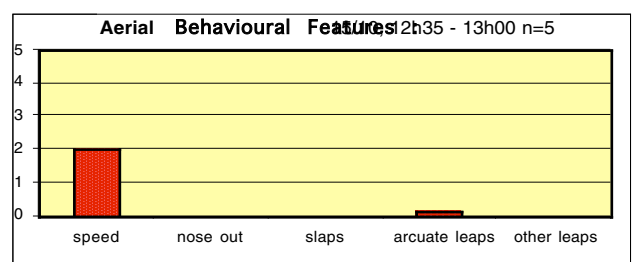
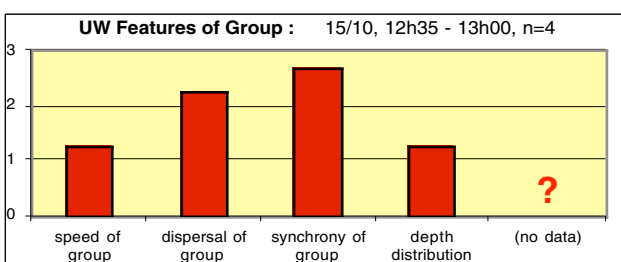
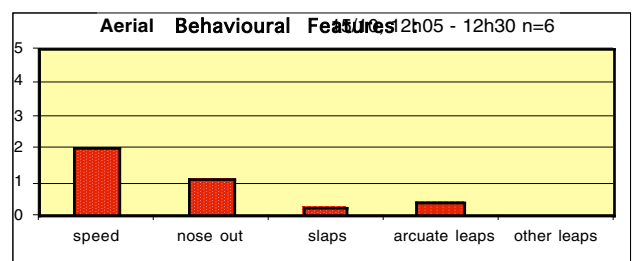
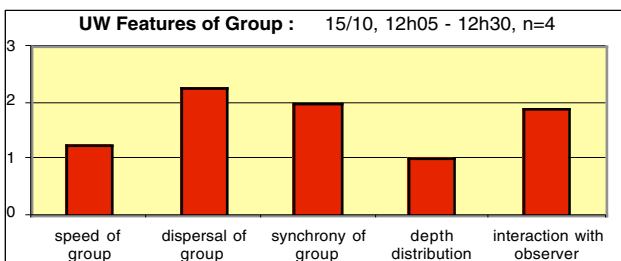
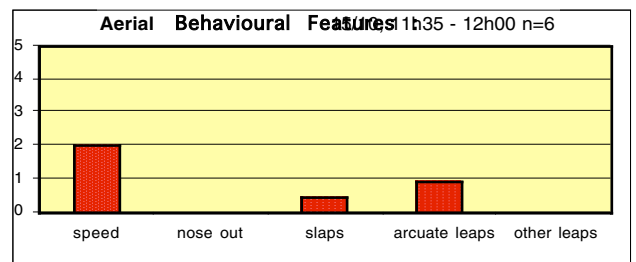
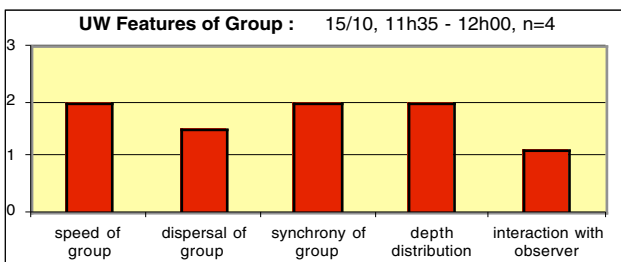
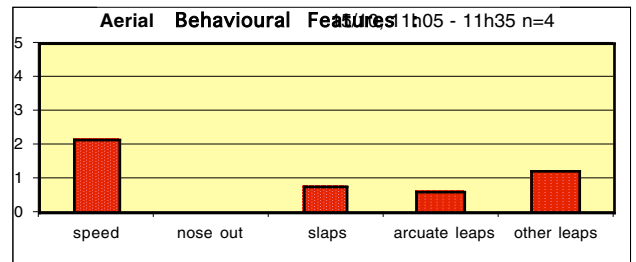
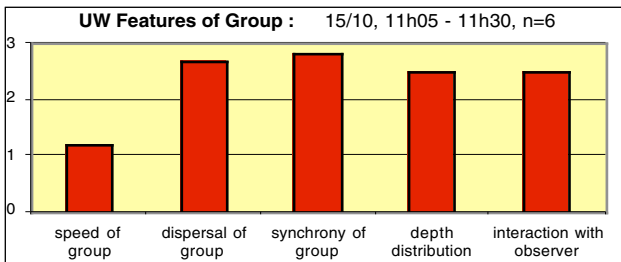
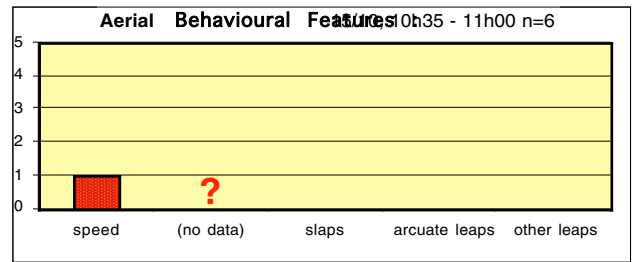
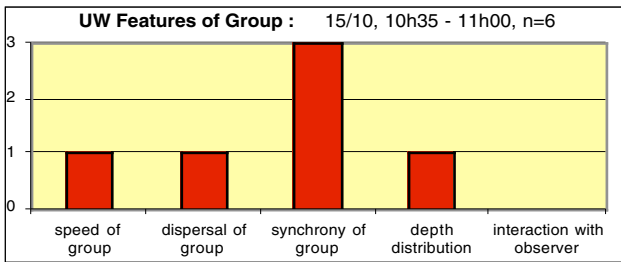
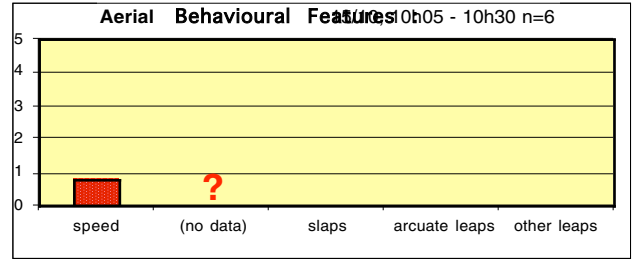
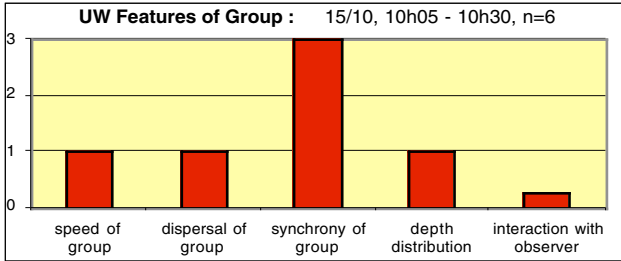
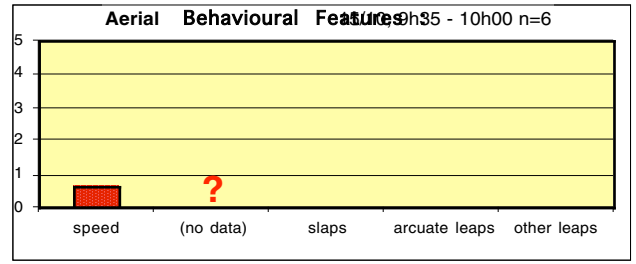
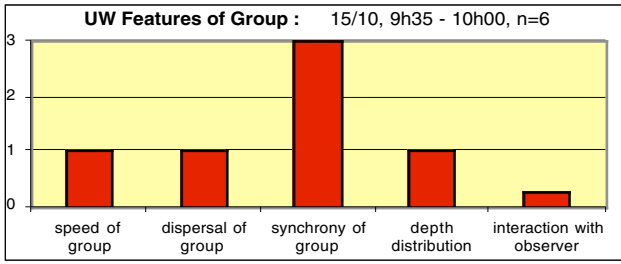
For most observation teams, the variable “interaction with observer” only was noted when dolphins showed special interest towards observers (i.e. ranks + and ++). This is why this variable was differently coded for the final analysis: - (or no value) -> 0, + -> 1,5, ++ -> 3. So, the minimum value is 0, and means that dolphins show no noticeable interest towards observers

The graphs in Fig. 6 and 7 show the evolution of the various parameters every half hour. Each graph features mean values calculated on the available observation data for the considered period. The maximum number of observations per graph is $n = 6$, but some data may lack, especially for underwater observations (observers couldn't always follow the dolphins).

NOTE: For the ranked variables, the “means” plotted on the graphs have no statistical value as such, since they are calculated on discrete – and certainly not gaussian – values. However, the ranks of the variables being hierarchically ordered, these “mean” values can be considered as useful indexes helping visualise variations in the graphs.

Fig 6 : October 15th. Evolution of “mean” values of the parameters describing underwater and aerial activities during the day (each graph corresponds to half an hour of observation).





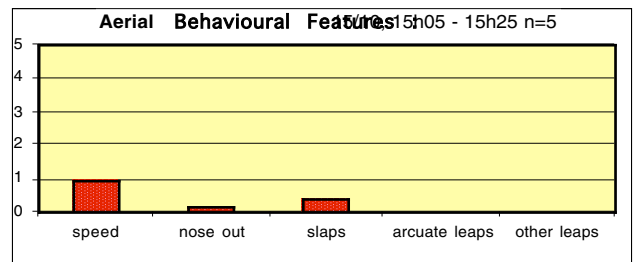
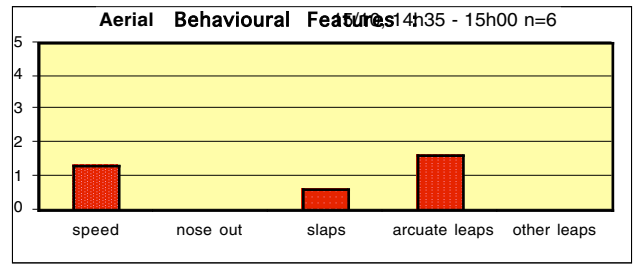
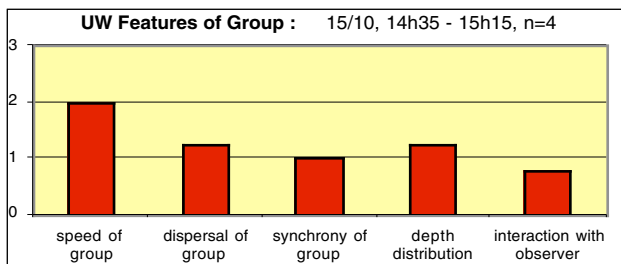
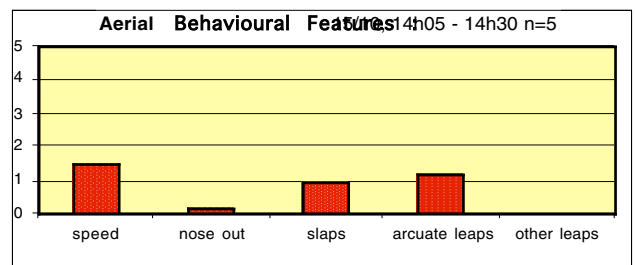
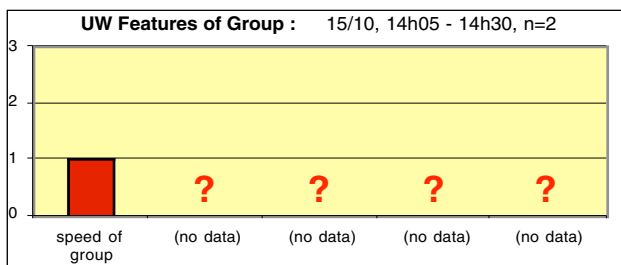
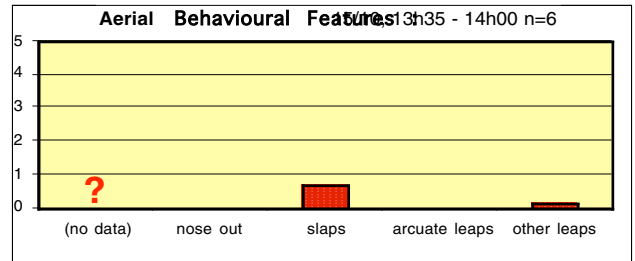
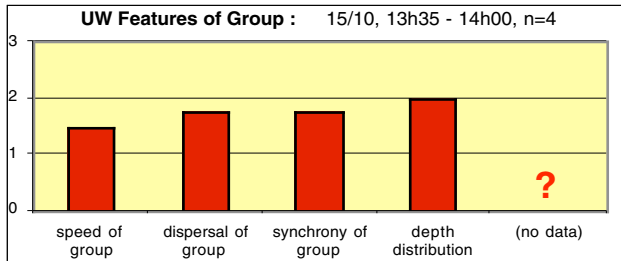
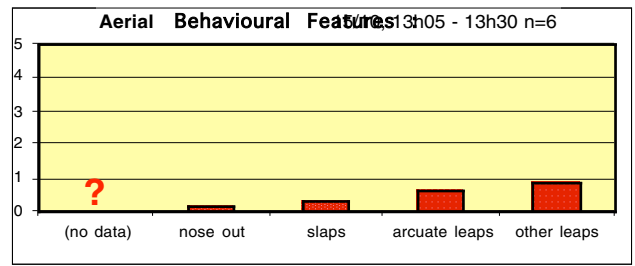
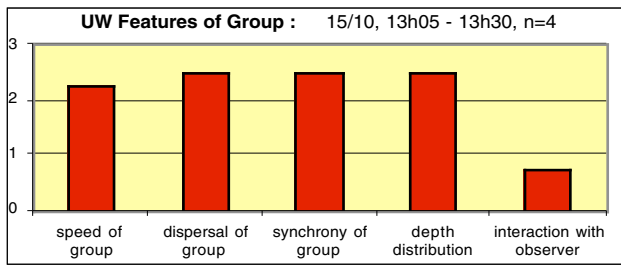
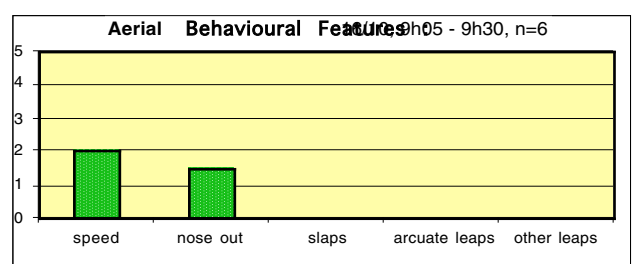
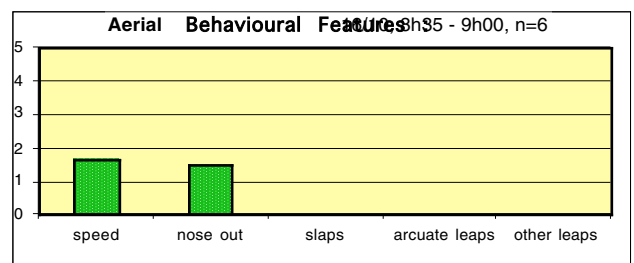
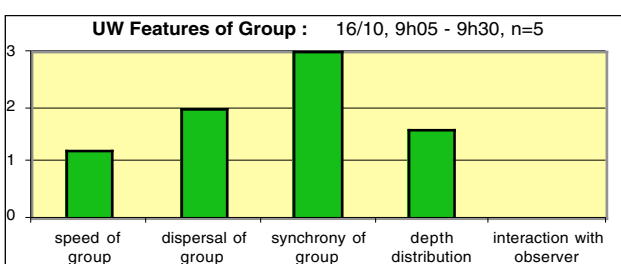
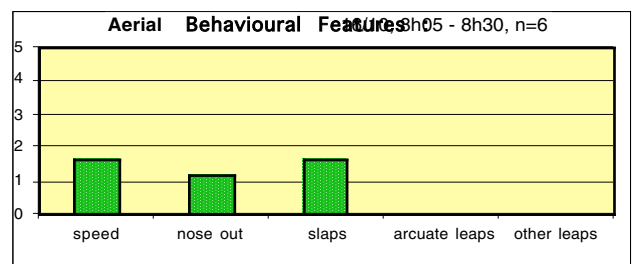
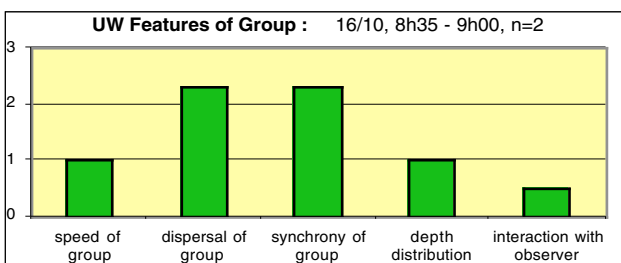
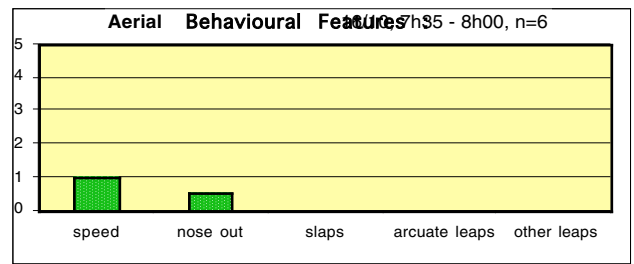
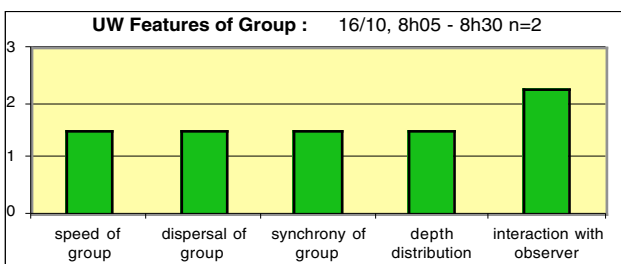
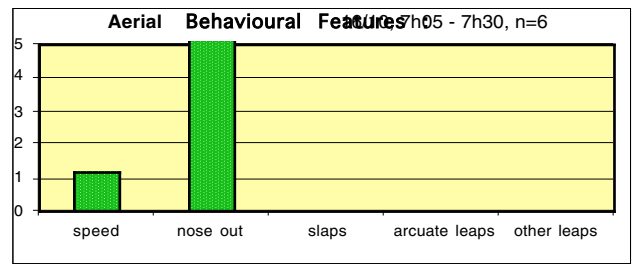
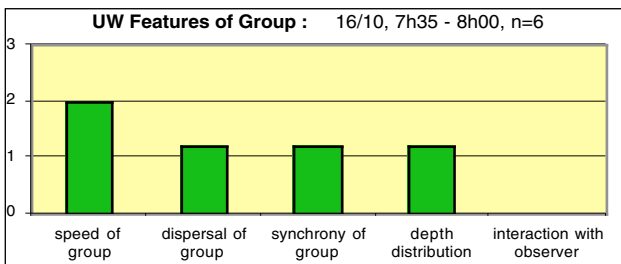
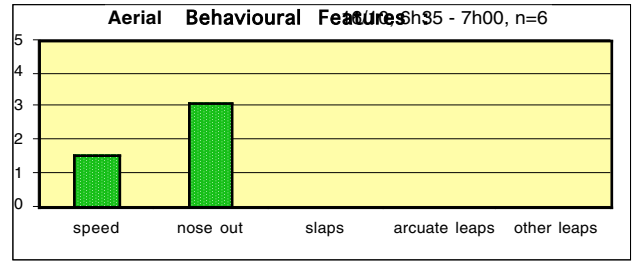
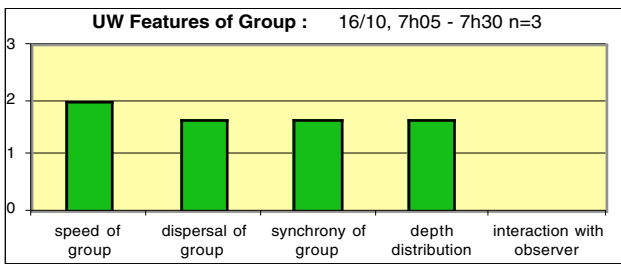
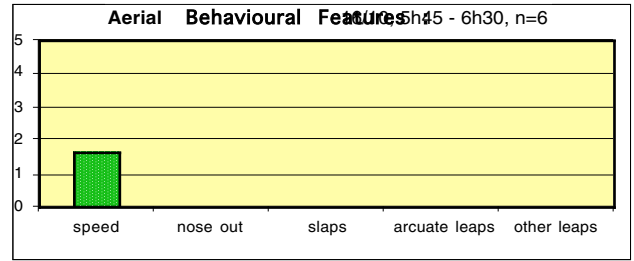
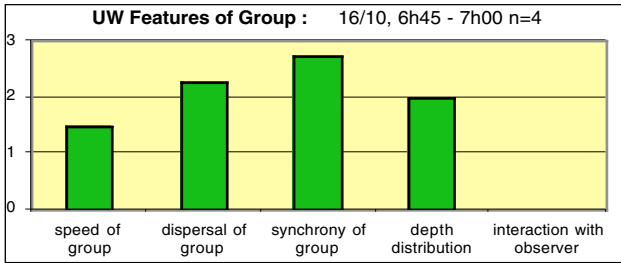
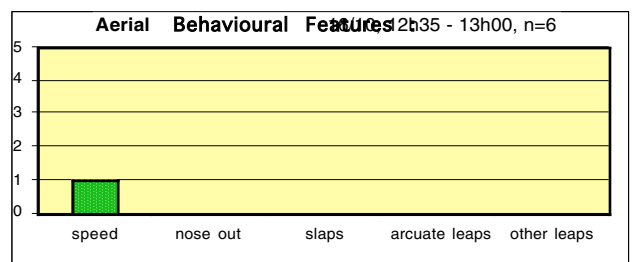
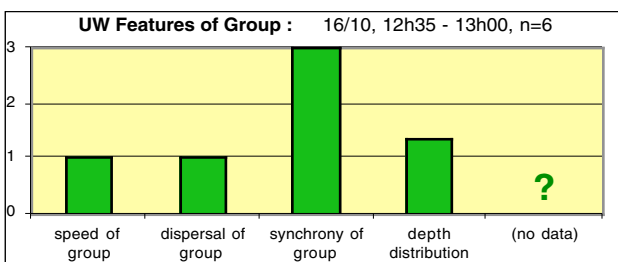
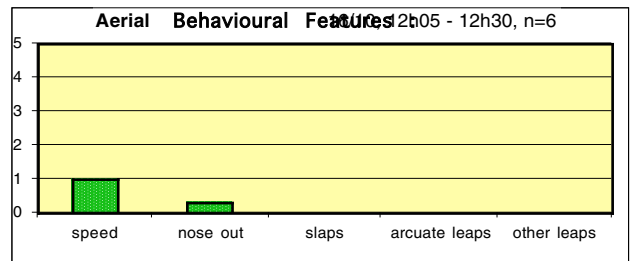
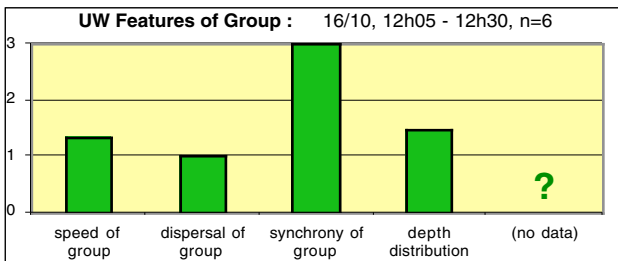
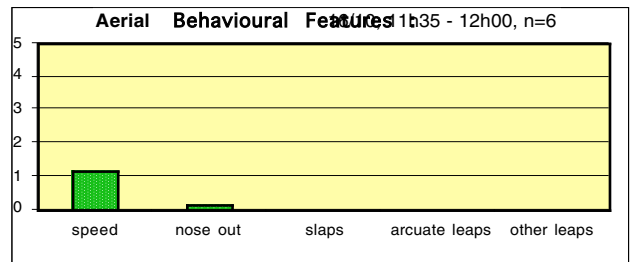
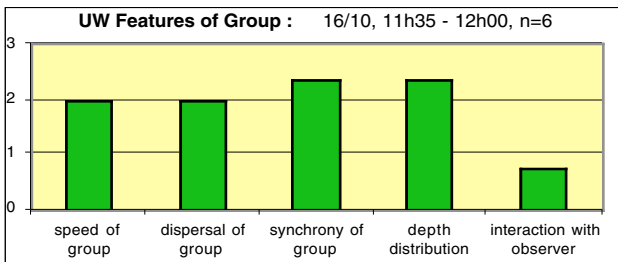
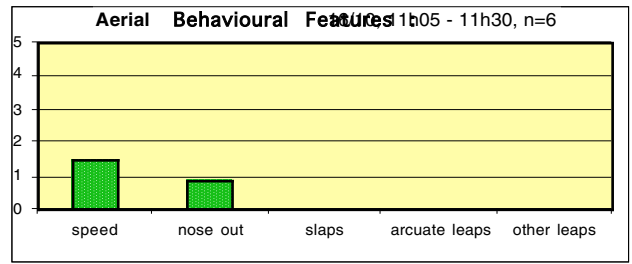
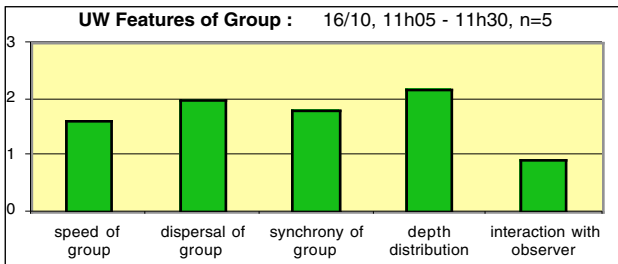
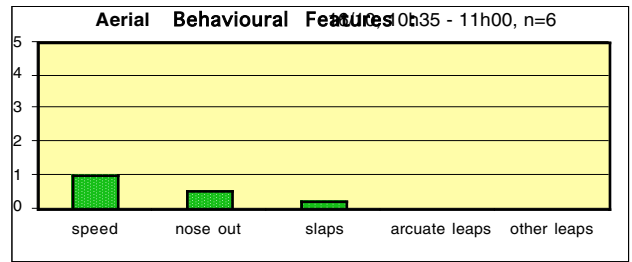
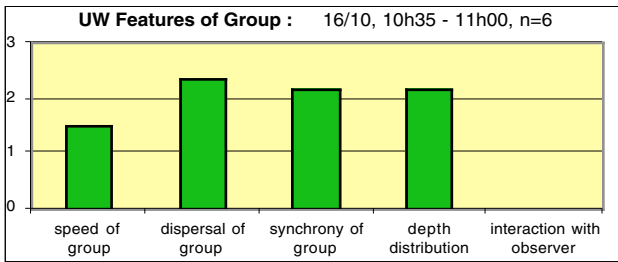
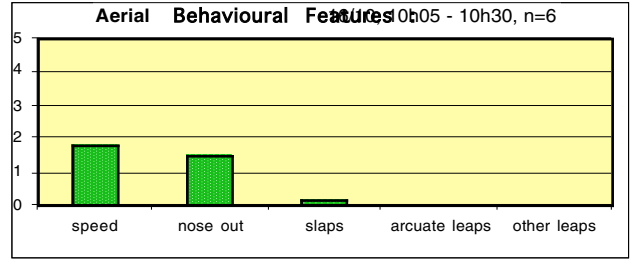
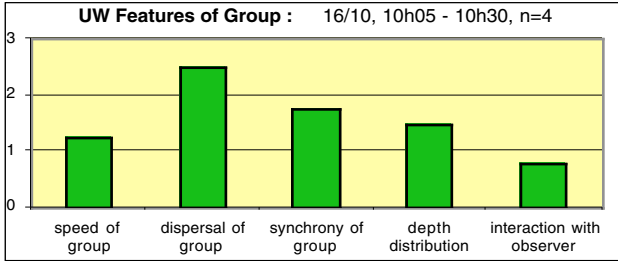
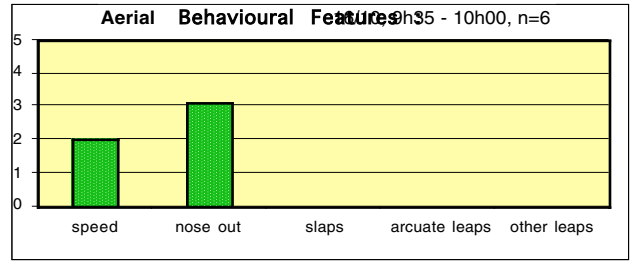
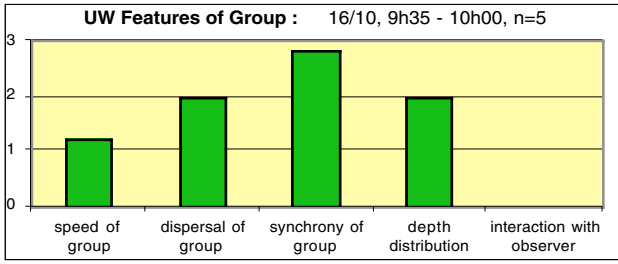
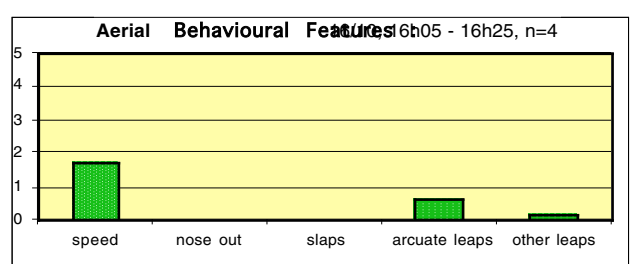
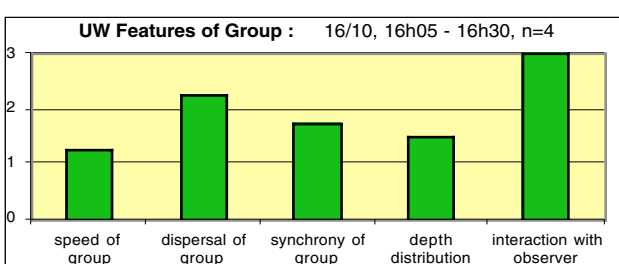
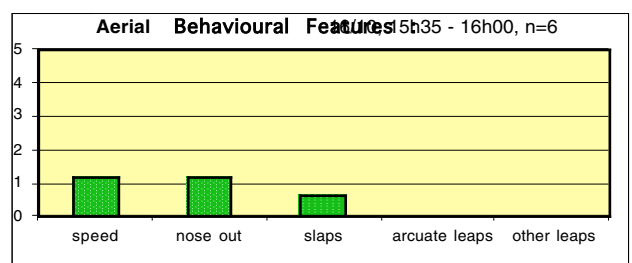
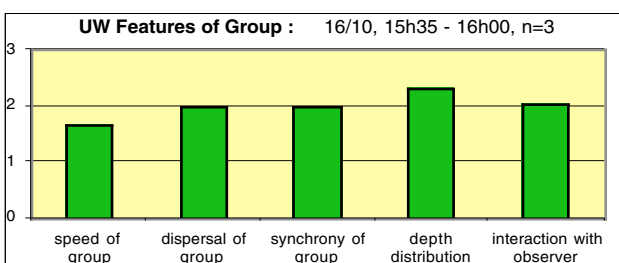
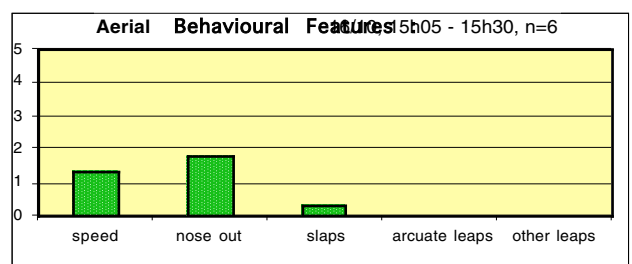
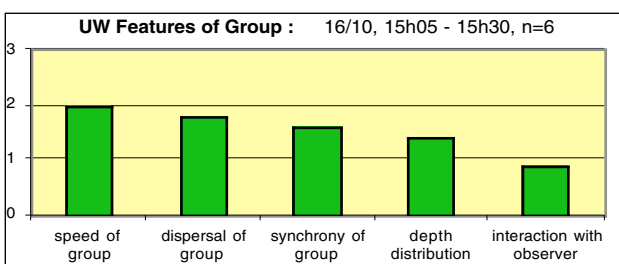
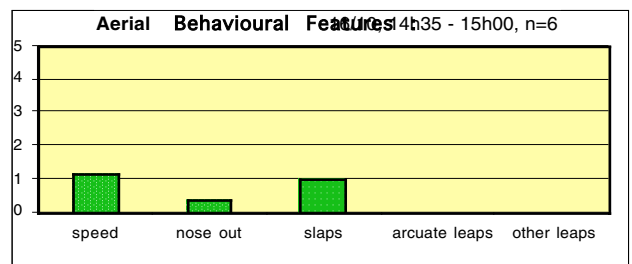
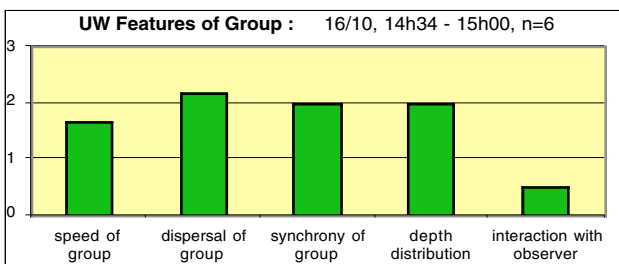
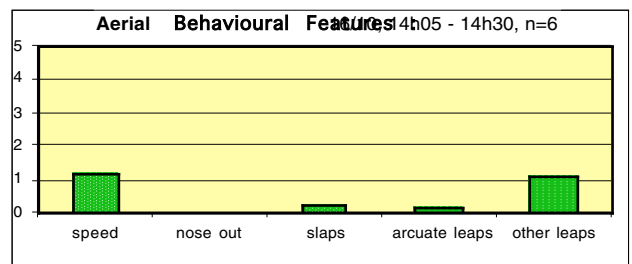
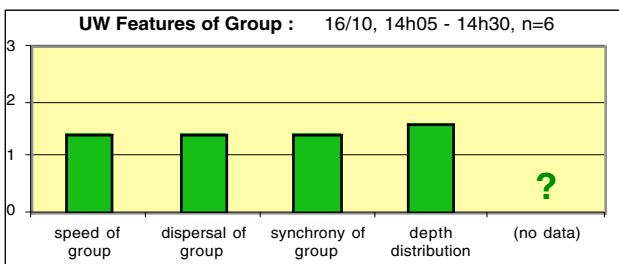
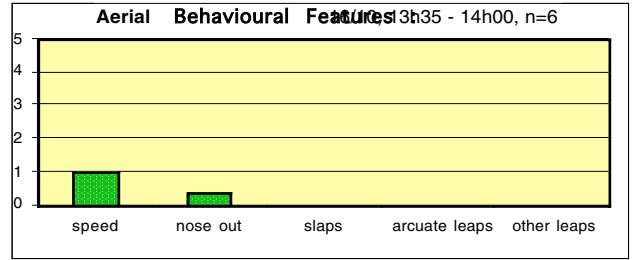
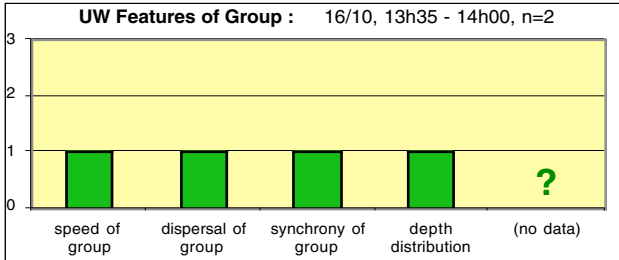
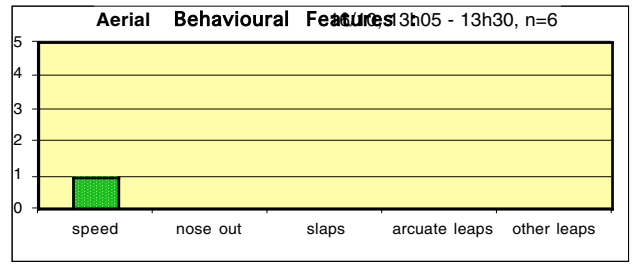
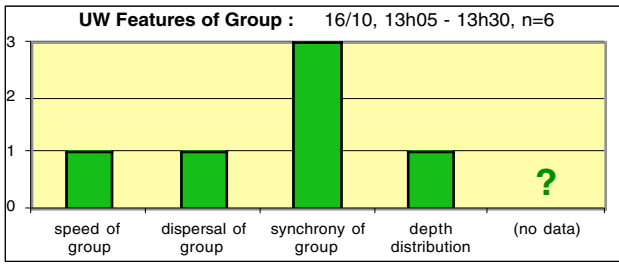


Fig 7 : October 16th. Evolution of “mean” values of the parameters describing underwater and aerial activities during the day (each graph corresponds to half an hour of observation).







During both observation days, Shaab Samadai dolphins showed alternating phases of activity and quietness. Typical resting periods are clearly identifiable in the graphs by the combination of:

- low swimming speed,
- low dispersal of the group,
- high synchrony of the group,
- and usually low depth distribution.

During resting phases, dolphins remain preferentially in a restricted area of the lagoon (“resting zone”), as already mentioned.

Active periods mainly are characterised by:

- rising swimming speed,
- higher dispersal and lower synchrony of the group,
- occurrence of aerial behaviours such as slaps and leaps.

Apart from the rise in activity preceding departure in the afternoon, dolphins also were more or less active at the end of the morning; this was especially true on the first observation day and the day before (“field training”). Much more mobile during these phases, the dolphins occupy a wider area of the lagoon (“activity zone”). It is interesting to notice that the rise in activity (especially when aerial behaviours occur) most of the time associates with a rising interest towards observers.

The various above parameters will be checked more in detail in the following sections.

2.5 Swimming speed results

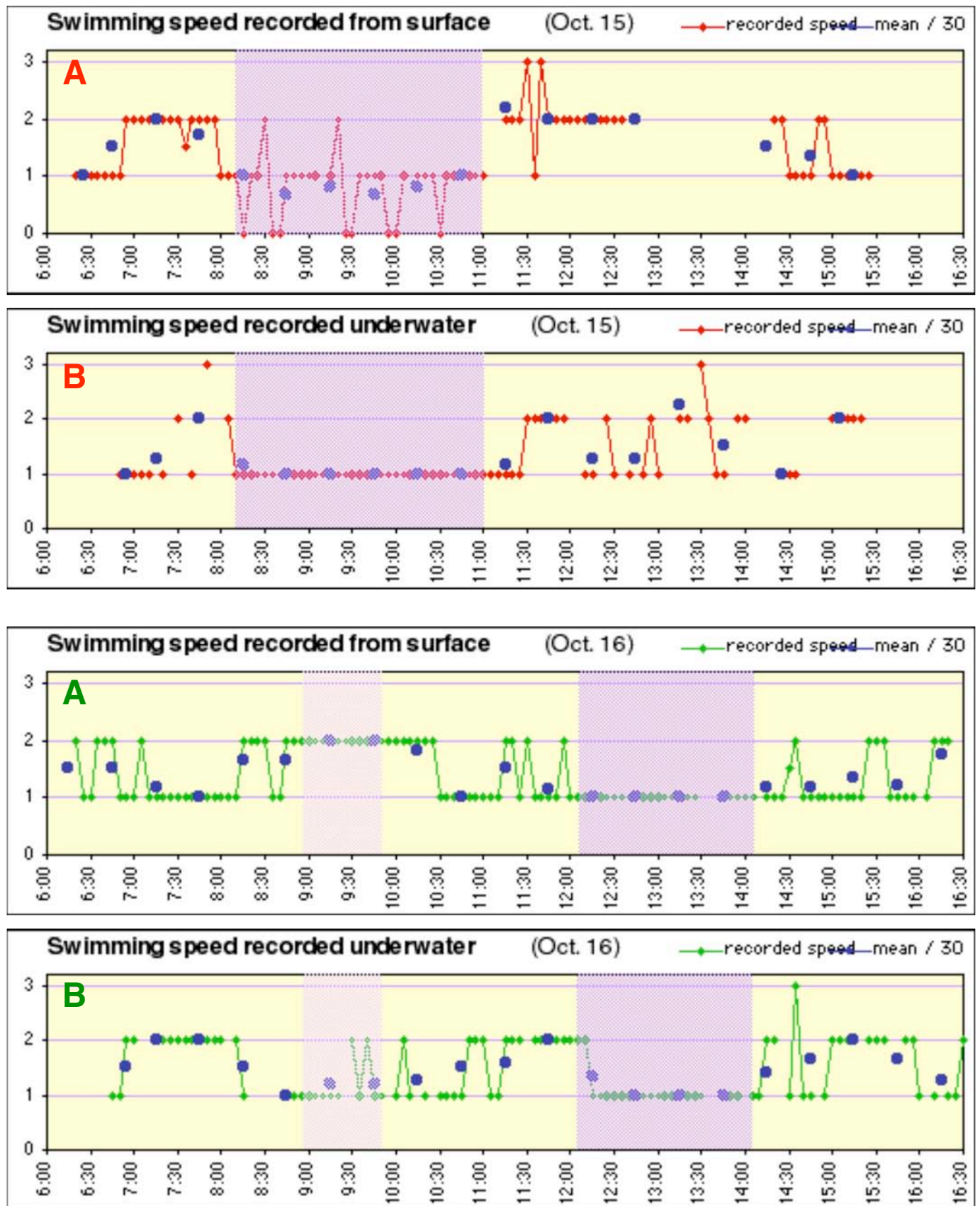
The swimming speed of the dolphins was the only parameter to be recorded by surface and underwater observers as well. It is then interesting to compare aerial and underwater evaluations of this parameter.

The detailed results obtained during the two observation days are plotted in Fig. 8.

There is obviously no clear correlation between aerial and underwater evaluations of swimming speed. This is probably due to the fact that surface and underwater observation teams didn't assess exactly the same parameter: while underwater observers recorded swimming speed of the dolphin group as a whole, surface observers would see only the individuals surfacing or breathing. At any moment, the swimming speed of surfacing animals is likely to be somewhat different from that of the rest of the group.

Also, when the dolphins are not together in one group, the subgroup which speed was assessed by surface observers is not necessarily the same as the one observed by snorkelers. This source of discrepancy is rather theoretical however: when various subgroups were assessed at the same time by surface observers, the evaluated speed was the same in most cases.

Fig. 8 : Swimming speed evaluation (as recorded A: from surface, and B: underwater) plotted against time of the day. Oct. 15th in red, Oct. 16th in green. Blue dots: “mean” values calculated every half hour. Purplish areas: resting phases.



For both aerial and underwater observations, recorded speed is more constant, and usually lower, during resting periods. This is quite clear for the long resting phases on both days. On the morning of Oct. 16th however, the short “resting phase” is not typical (see further), and the discrepancy between aerial and underwater speed evaluations confirms this point of view.

During Oct. 15th morning resting phase, speed evaluated by surface observers was quoted “0” eight times: dolphins were observed still, the dorsal fin or spiracle area visible at the surface. Yet, at the same time, speed was ranked “1” by underwater observers. This probably means that only some dolphins remained motionless at the surface while the others were swimming underwater.

2.6 Resting phases

Typical resting phases easily could be identified by field observers. Low movement and restriction to a certain area of the lagoon are the main signs of rest for surface observation. Yet, the most striking features of resting phases are related to underwater group structure.

What is a resting phase?

According to the different graphs (Fig. 6 & 7, Fig. 9 & 10), and to the detailed field data and comments noted by the observers, typical resting phases can be characterised by a long lasting combination of parameters, as follows:

- The swimming speed is low, whether it is recorded from the surface or underwater; some individuals even may stop swimming for a while, as noticed by surface observers.
- Dispersal of the group is very low, i.e. the group is very tight, individuals remaining close together (usually less than 0.5 m apart).
- Synchrony of the group usually is very high, the dolphins swimming and turning in a very coordinated way (it should be noted however that synchrony sometimes may remain high in an active group).
- The depth distribution of the group tends to be reduced (most typically all individuals within 1 to 2 m depth range), but this parameter may sometimes be irregular, possibly because part of the group may remain quite close to the bottom when subgroup(s) surface to breath.

Identified resting phases

During the two days of observation, the following resting phases could be identified (see Fig. 9 & 10):

- October 15th: one phase (8:10 to 11:00 am)

Actual beginning and end of this resting period were quite easy to define since the various descriptive parameters of the group structure changed sharply at about the same time.

- October 16th: first phase (8:55 to 9:50 am)

Although not as quiet as typical rest behaviour (less typical combination of parameters), this period probably can be interpreted as a resting phase.

- October 16th: second phase (12:05 to 14:05)

Typical resting period, but beginning and end difficult to define precisely since the various group structure parameters don't change simultaneously.

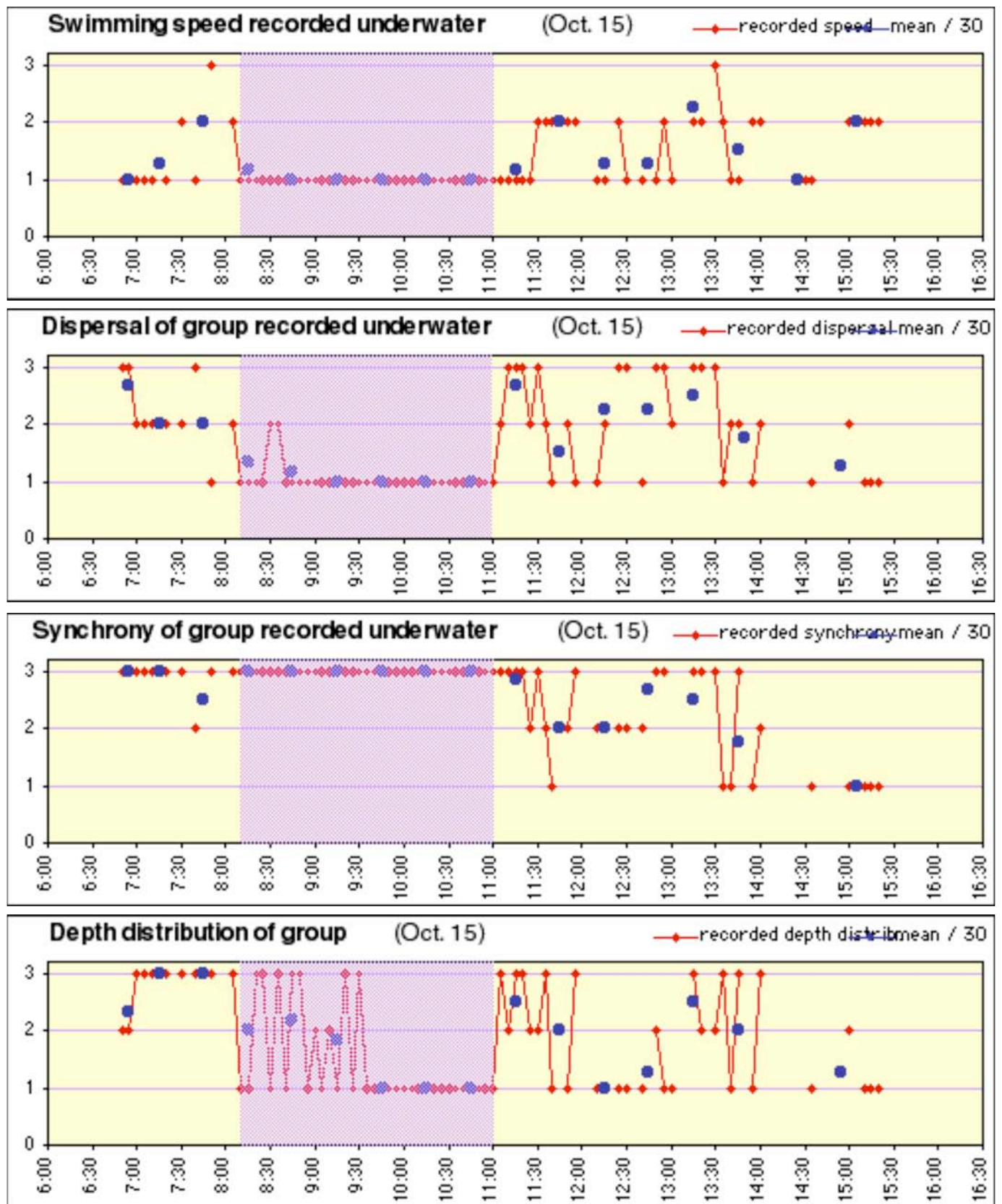


Fig. 9 : October 15th : Group structure parameters recorded underwater, plotted against time of the day. Blue dots: “mean” values calculated every half hour. Purplish areas: resting phases.

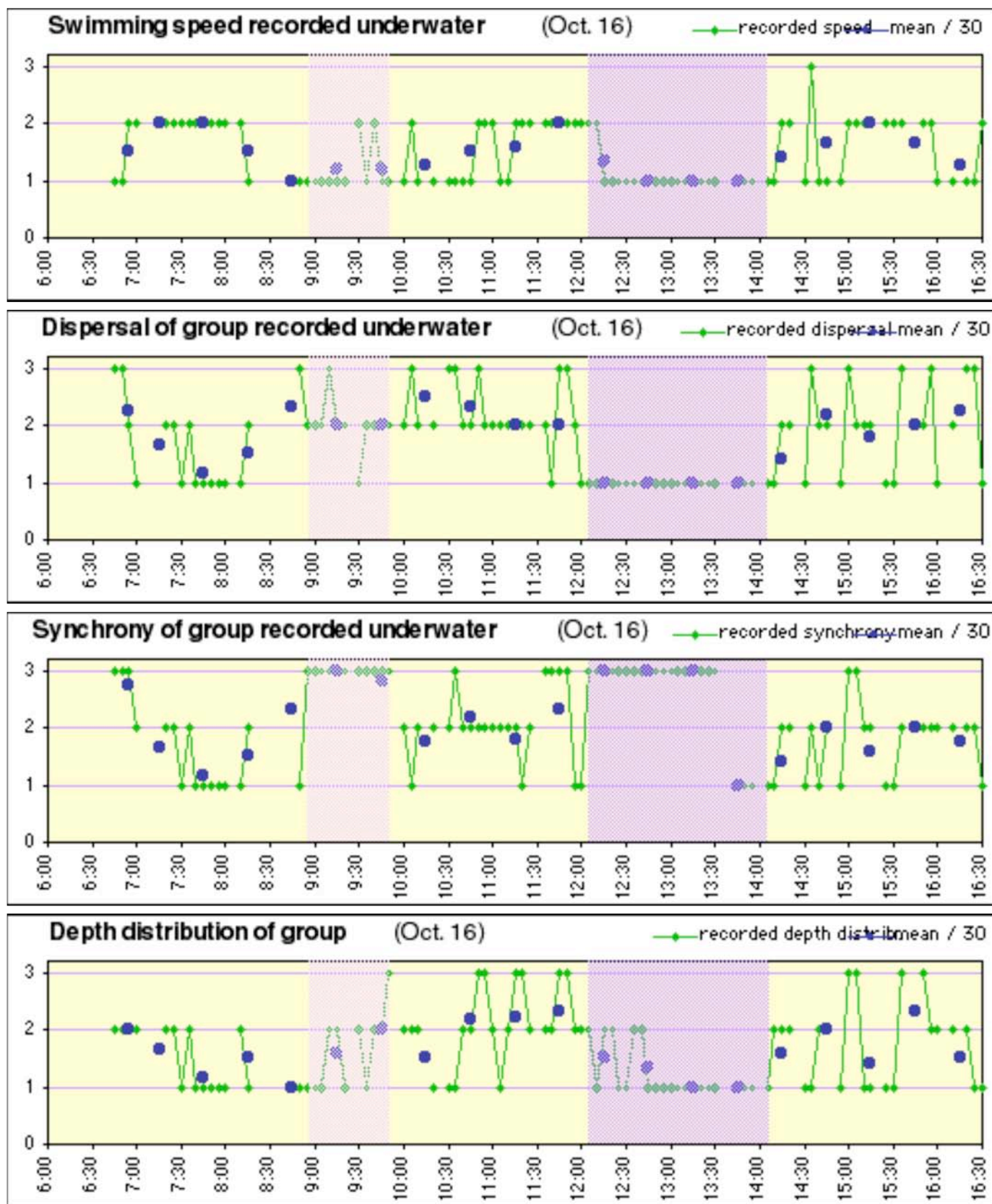


Fig. 10 : October 16th : Group structure parameters recorded underwater, plotted against time of the day. Blue dots: “mean” values calculated every half hour. Purplish areas: resting phases.

The time and duration of resting periods changed from one day to the other. Identified resting phases lasted 2 hours and 50 minutes on Oct. 15th, and 2 hours and 55 minutes on Oct. 16th (but in two different periods).

Observations of still rest

During Oct. 15th morning resting phase, dolphins were observed remaining still at the surface, their swimming speed being quoted “0” (see Fig. 8). When checking comments of the observers, it appears that a group of a few dolphins could stay motionless for up to 9 minutes consecutively, seemingly breathing in a rather jerky manner. Such motionless phases most of the time occurred far from underwater observers, and usually in quite shallow areas of the lagoon, mostly close to reef walls (see Fig. 11).

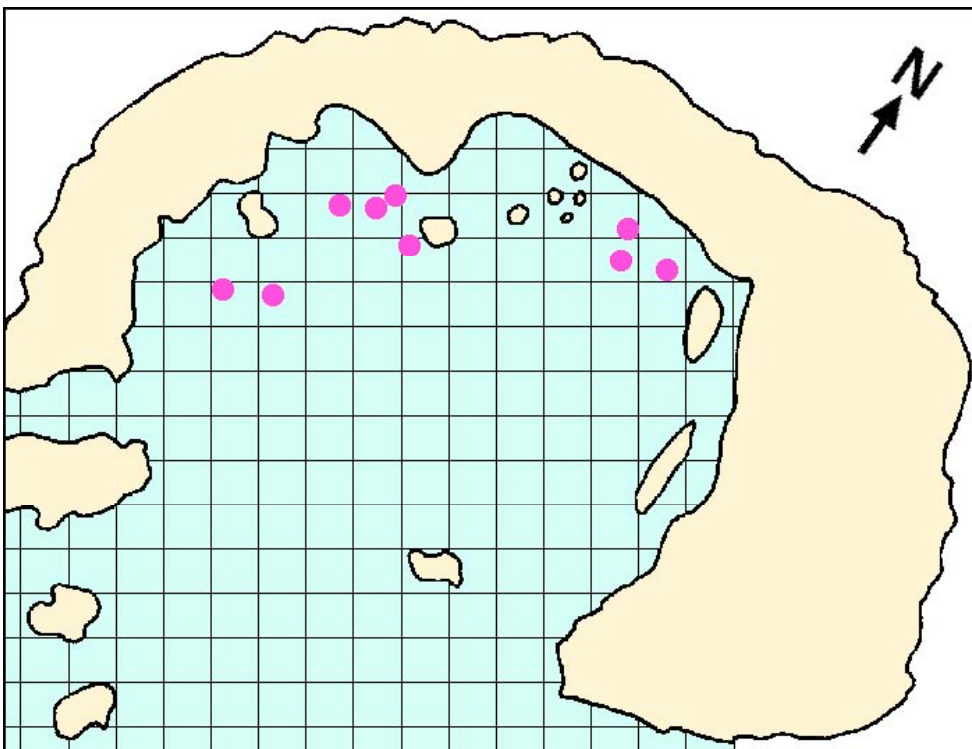


Fig. 11 : Points where dolphins were observed motionless at the surface during the morning resting phase on Oct. 15th.

Constancy of resting group

As noted on Fig. 3, the size of the group (number of observed dolphins) remains quite constant during a resting phase (when considering possible approximation in counting), but not necessarily for the whole period. Some subgroups may join or depart. This means that there may be various resting subgroups in the lagoon at the same time, or that a subgroup may not be resting while the main group is. The later probably was the case at the end of Oct. 15th morning resting phase, when a group of 8 dolphins disappeared for 20 minutes, and then joined back the main group, seemingly inducing a general rise in activity.

2.7 Active phases

Outside resting phases, the level – and nature – of activity are quite variable. Nevertheless, it can be stated that the most active periods combine a general rise in underwater activity (swimming speed, and also social interactions and play) with the occurrence of active aerial behaviours such as slaps and leaps. At any rate, two days of observation certainly are not enough to describe and understand clearly the different possible behavioural phases of the dolphin day in Shaab Samadai. However, the results detailed below bring to light some interesting aspects of dolphin daily activity cycle.

Underwater parameters

The most active phases (as defined above) globally combine quite a high swimming speed, a high dispersal of the group, a rather low synchrony, and quite an extended range in depth. This can be concluded from Fig. 6 & 7, and the “mean” values plotted on Fig. 9 & 10. However, the actual recorded data curves of Fig. 9 & 10 also show that, when dolphins are active, most parameters describing underwater group structure and behaviour can be highly variable. This variability certainly is a characteristic feature of active phases.

It should be emphasised that active phases do not necessarily involve all the individuals; it is in fact quite the reverse. During the study, the main group often was observed to behave rather quietly (although caresses and mating-like behaviours could be quite frequent within the group) while subgroups or individuals would swim fast and play on the periphery. Sometimes, a subgroup would depart from the main group to engage in very active social interactions in another area of the lagoon; in that case, the whole observed subgroup could be very active, while other dolphins present in the lagoon were not.

Aerial behaviour: slaps and leaps

Aerial behaviour categories retained in this study are those proposed by Norris *et al.* (1994) in Hawaii:

- *Nose out*: a dolphin “thrusts its rostrum from the water as it moves slowly at the surface”.
- *Tail slap* is “a slap of the tail flukes, made in either the normal or inverted position relative to the water surface”.
- *Head slap*: a dolphin “may emerge from the water as far as about mid-body and then slap its anterior belly against the water”.
- *Back slap*: a dolphin “may emerge from the water as far as about mid-body and then slap its back against the water”.
- *Arcuate leap* is “the clean, arcing leap made by rapidly moving dolphins”.
- *Salmon leap* is performed “slightly arched and stiff-bodied, usually falling back on its side” (this leap is reminiscent of a salmon leaping up rapids or falls).
- *Tail-over-head leap*: a dolphin “bursts from the water in a high, arcuate leap and literally throws its tail over its head”.
- *Spin*: a dolphin, “by twisting its neck and body while in air, is able to perform as many as about four rotations during a 1.25-sec. leap that can take it about 2 m into the air”.

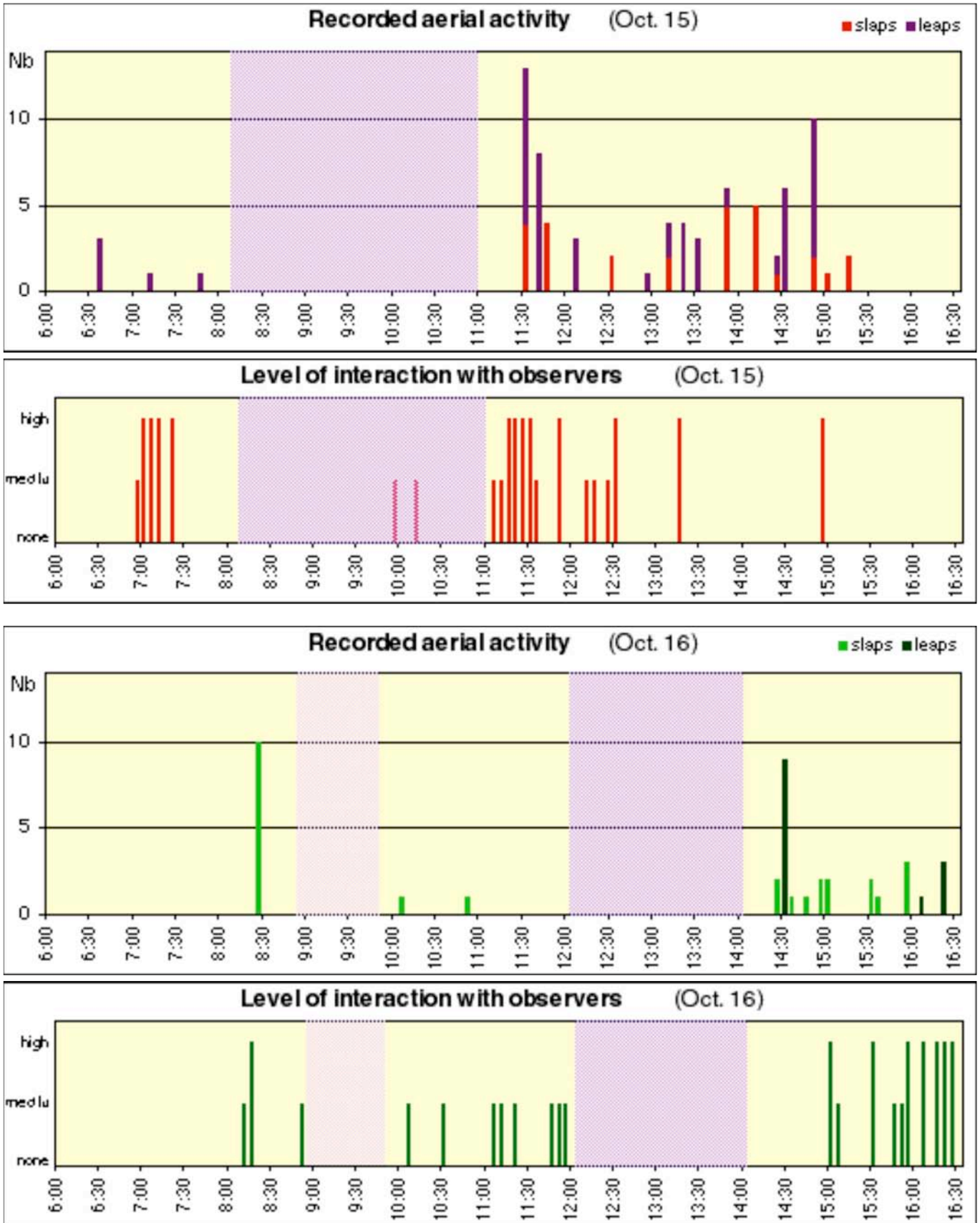


Fig. 12 : Number of aerial behaviours (slaps and leaps) per 1 min. observation period, and interaction with observers (i.e. interest of dolphins towards observers) plotted against time of the day. Oct. 15th in red, Oct. 16th in green. Purplish areas: resting phases.

Of the various aerial behaviours, nose out is the lower energy pattern. Then come the various slaps, and finally the more energetic leaps.

Recorded aerial behaviours were quite conform to what Norris *et al.* (1994) described for Hawaiian spinner dolphins, but not necessarily with the same frequency of occurrence. For instance, arcuate leaps were the most commonly observed leaps, contrary to what was observed in Hawaii.

Fig. 12 shows the recorded numbers of both slaps and leaps. It should be reminded that these parameters were not recorded continuously, but only for 1 minute out of every 5 minutes. Thus, results plotted on Fig. 12 only are short time samples of dolphins' aerial activity.

Only few active aerial behaviours were observed in the morning. They were much more common in the afternoon, recorded slaps and leaps starting at 11:30 am on Oct. 15th, and only at 14:25 on Oct. 16th (due to an afternoon period of rest that day). On both days, there was a peak in aerial activity about half an hour after the end of identified resting phases. On Oct. 15th, the frequency and number of aerial behaviours lowered after that peak, and rised again during the 2 hours before dolphins left the lagoon. On Oct. 16th, the peak in aerial activity seemed to mark the beginning of the activity phase preceding departure, 2 hours later.

Interest towards observers

Interaction with observer (i.e. how much dolphins are interested / attracted by human beings) is a very interesting parameter from the tourist management point of view.

Most of the time, dolphins showed no particular interest towards observers and wouldn't obviously change their way when passing by. In that case, the parameter "interaction with observer" was quoted "1", or – quite often – not recorded. Assessment of this parameter was more systematic however when dolphins changed their direction to pass closer to the observers (rank 2) or when they showed a strong attraction and even a tendency to interact with observers (rank 3). Thus, rank 1 or the absence of record could be attributed a similar meaning ("the dolphins showed no noticeable attraction towards snorkelers"), and were not taken into account for the data analysis. This is why only ranks 2 (= medium) and 3 (= high) were plotted in Fig. 12.

Fig. 6 & 7 and Fig. 12 show that high levels of "interaction with observers" mostly occur in periods when active aerial behaviours (slaps and/or leaps) are recorded. More generally, the tendency to approach – and even interact with – observers could be linked to higher social activity and propensity to play within the dolphin group. This repeatedly was confirmed (although not quantified in the study) during the 3 days of observation.

On the other hand, dolphins showed almost absolutely no interest towards divers during resting phases.

Aerial behaviour: nose out

Norris *et al.*(1994) state that nose out behaviour is “frequently seen among quietly socialising animals just before or after the rest period”, and consider that “their appearance at the end of a rest period is often the first sign that the group as a whole is waking”.

In the present study, such a correlation cannot be confirmed. Fig. 13 show no visible relationship between activity or rest phases and nose out occurrences, and Fig. 6 & 7 dot not help to relate it to other activities and behaviours.

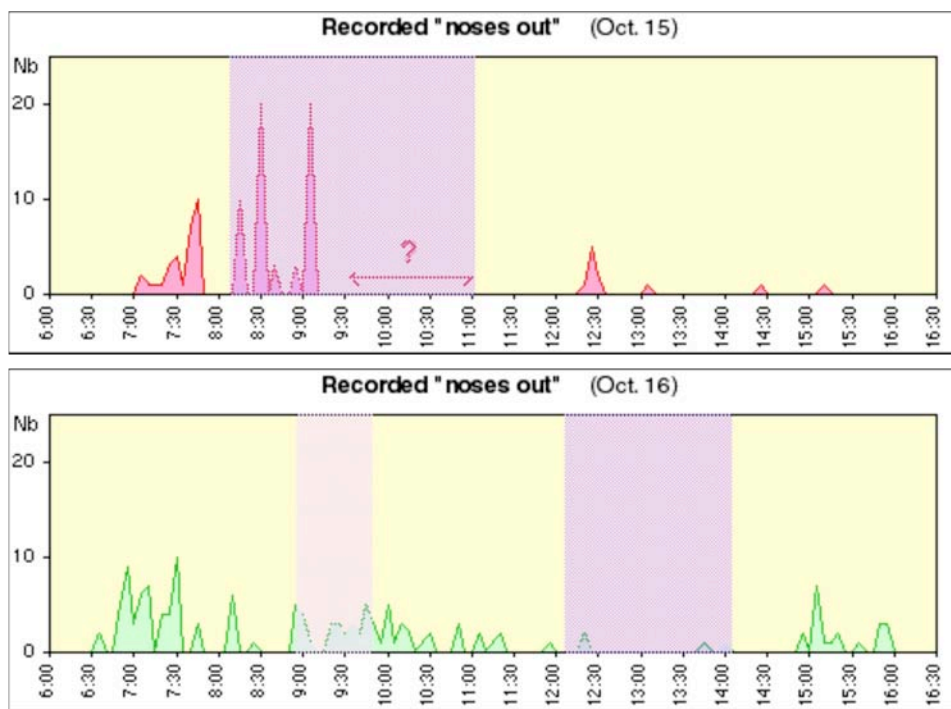


Fig. 13 : Number of “noses out” per 1 min. observation period plotted against time of the day. Oct. 15th in red, Oct. 16th in green. Purplish areas: resting phases.

One possible reason is that this behaviour was not easy to assess for inexperienced observers, who apparently encountered difficulties to make the difference between actual nose out behaviour and other emerging movements, especially on the first day (hence a possible over-evaluation).

However, the recorded data show an interesting trend: nose out behaviours are most numerous in the morning, and decrease in the afternoon. At present, no special meaning can be attributed to this observation.

Moreover, observers repeatedly noted typical noses out in reaction to surface disturbances: zodiacs going along the outer reef to drop scuba divers, our zodiac bringing new observers, underwater observers first approaching the dolphin group. During these nose out events, dolphins behaved as if they would visually check above the surface what caused the disturbance.

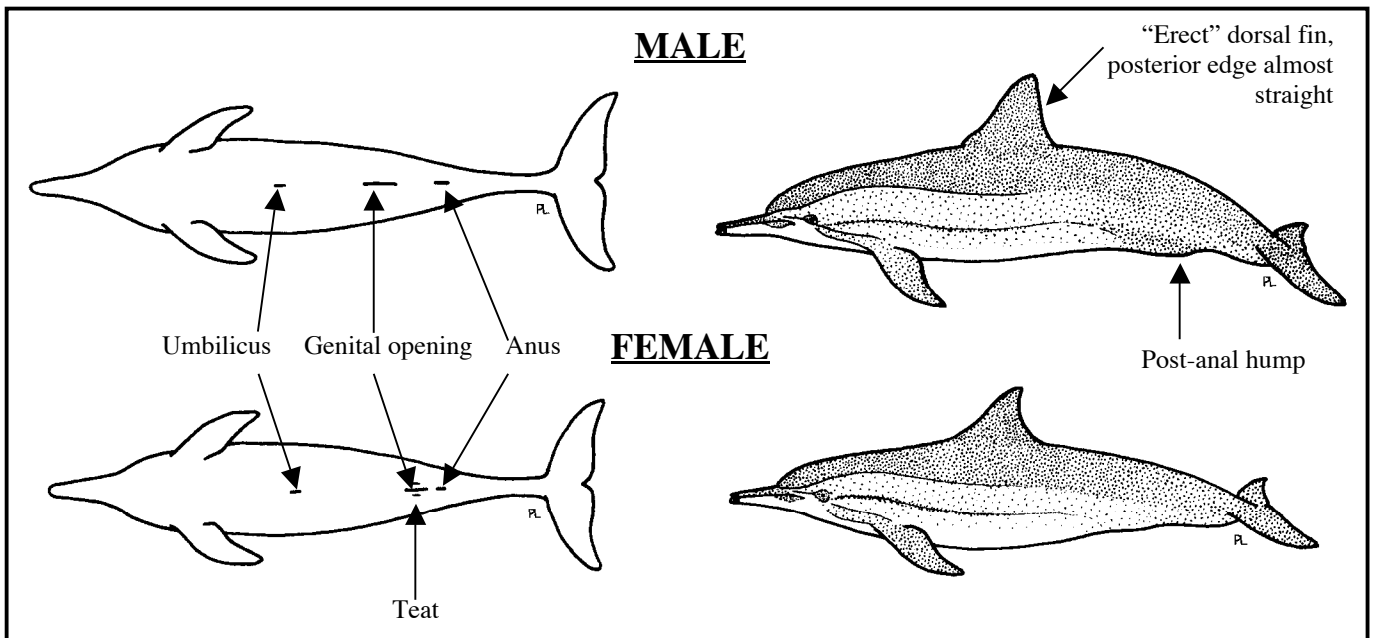
2.6 Additional observations

The mobilisation of energy and observation effort generated by the present survey also permitted to collect some interesting biological information beyond the scope of the original protocol.

Sexual dimorphism

Sexual dimorphism is usually faint in dolphins. The “official” way to distinguish males and females is the position of the genital opening, as illustrated for instance by Sylvestre (1990, p. 34). Yet, it is not very useful in the field since one need to be underneath dolphin’s belly to check that feature. Norris *et al.* (1994, Fig. 6) showed however that sexual dimorphism is quite pronounced in Hawaiian spinner dolphins, especially in older males.

Fig. 14 : Sexual dimorphism in Shaab Samadai spinner dolphins (after Louisy, 2003).



The sexual dimorphism observed in Shaab Samadai dolphins is quite similar to that described in Hawaiian spinner dolphins. Adult males usually are larger than females, have a more erect dorsal fin (with a steeper front edge and an almost straight rear edge), and their posterior body looks thicker due to the presence of a post-anal hump.

The position of genital openings (Fig. 14, left) is a bit different from that illustrated by Sylvestre (1990). In females, the genital opening looks almost continuous with the anal slit (teat slits are hardly visible). In males, the genital opening is clearly separate from anus, although less than half way to the umbilicus.

The drawings in Fig. 14 were realised after underwater photographs taken in Shaab Samadai, and thus show actual Red Sea specimens.

Nursing

Observers recorded small babies (i.e. less than 1 m total length) on Oct. 14th (5-6 babies) and Oct. 15th (2 babies), but not on Oct. 16th. Larger juveniles also were observed but their number couldn't be assessed with certainty. Young dolphins always were observed in pair with an adult, although observers generally couldn't tell for sure the sex of the adult. It is thus impossible to precise if juveniles were accompanied by their mother, another female or even a male (Norris *et al.* (1994) carefully avoid supposing that adults accompanying juveniles should necessarily be females).

In some cases however, actual suckling was observed:

- Oct. 15th, at 8:15 am, one nursing observed (no more detail).
- Oct. 15th, at about 10:10 am, a baby (less than 1 m long) was seen suckling twice for about 15 sec. with a 5-min. interval.
- Oct. 16th, at 13:10, two juveniles (about 2/3 adult size) were seen suckling at about the same time.

Thus, young dolphins (even up to 2/3 adult size) probably were not emancipated from their mother (or possibly another nursing female?).

Whistles and bubbles

Spinner dolphins are reputed very noisy. Yet, within the lagoon, sound production can be quite low in the course of the day, and almost non-existent during resting phases (as already remarked by Norris *et al.*, 1994). During active phases however, dolphins produce various audible sounds, mainly whistles and echolocation click trains.

Sound recording and analysis was not the purpose of the present survey, but an interesting fact appeared in a video filmed by Nathalie and Philippe Lesur. A dolphin clearly emitted a series of small bubbles at the very moment the underwater video-camera recorded a whistle. Further observations confirmed that this was not fortuitous. One of these, made on Oct. 16th around 15:30, seemed particularly meaningful. I was observing a group of ten very active dolphins, showing multiple social interaction including mating. At one moment, an individual situated on the edge of the group whistled and simultaneously released a series a small bubbles. It immediately started swimming resolutely away, the row of bubbles then deflected in a typical oblique line, similar to that already observed in the video-film. Within a second or so, another dolphin whistled and emitted bubbles in exactly the same way, and swam in the same direction. The other dolphins interrupted current social interactions, and the whole group went.

Due to the separation between respiratory and sound production systems, dolphins don't blow air when they emit sounds. Whistles are in fact often produced without any bubble. The release of bubbles thus probably bears a meaning. While the sound signal (whistle) is not very directional underwater, the bubble line can easily be detected by echolocation. So, dolphins of the group know who wants to leave (if this is really the message carried by the whistle), and where he is. Although Norris *et al* (1994) hypothesised the role of bubbles (related to leaps) in spinner dolphin communication, they didn't, in almost ten years of study, observe such a deliberate use of a bubble signal.

Aggressive posture

While making underwater photos, Frédéric Bassemayousse was confronted twice with a male displaying a typical aggressive posture, as described by Norris *et al.* (1994, Fig. 98). This “S-shaped posture in which the dolphin faces the object of threat, usually with mouth agape or snapping, head down with a sharply arched neck and anterior back, and with the flukes flexed upward from the general arch of the back” is reminiscent of that displayed by some territorial sharks.

More commonly, adult males would purposely swim between the observer and the main group (or the female they seem to be courting).

Dolphins close their eyes

Close observation of quietly swimming dolphins (especially during resting periods) revealed that many could have (at least) one eye closed. In that case, the eye on the side of the observer, i.e. towards the exterior of the group.

During this study, it was not possible however to check simultaneously both eyes of a given individual. But, since echolocation seems very low during resting phases, it is little probable that dolphins can swim in perfect synchrony without having recourse to vision.

Then, if spinner dolphins swim with one eye closed, does this mean that they are “half sleeping”, i.e. that one hemisphere of their brain is asleep, as could be demonstrated for various species like the bottlenose dolphin or the porpoise (see for example Ridgway, 2002)?

Dolphins eat cephalopods

In the morning, dolphins were seen to defecate and sometimes to regurgitate. Although the constraining study protocol didn't allow for a thorough inspection, some excrements were checked before they would completely disintegrate in the water. Almost nothing was identifiable at first sight, but closer inspection revealed the presence of small cephalopod horny beaks (up to about 40 complete beaks counted for one excrement). These beaks belonged to small cephalopods probably only a few centimetres long (certainly less than 10 cm).

In one instance, a dolphin regurgitated the backbone of a partly digested fish, apparently about 20 cm long (with no skull), but it was engulfed by a snapper before I could grab it. Nevertheless, it seems that this individual dolphin caught a fish definitely larger than the 20 cm or so supposed to be the maximum size of preys (Norris *et al.*, 1994).

So, Red Sea spinner dolphins can feed on fish (even on quite big ones) and on small cephalopods, which remains are common in the faeces.

3 • DISCUSSION

The spinner dolphin, *Stenella longirostris*, has been thoroughly studied in Hawaii (Norris *et al.*, 1994) for about ten years, and in Fernando de Noronha, an Atlantic island NW of Brazil (see Kiefner, 2002).

In Hawaii, spinner dolphins are known to spend the day in sheltered bays and coves. They arrive early morning, and then get into rest (i.e. they swim slowly in very tight groups above sandy bottoms) for part of the day. There are also phases of activity, when dolphins engage in strong social interactions, including mating or nursing of babies. During the afternoon, dolphins begin a new behavioural phase, consisting of sorties of greatly fluctuating speed, back and forth, a pattern called zig-zag swimming. When, at the end of the day, they eventually reach deep water out of the bay, the school fragment into subgroups that disperse for a while, and then reassemble again and start feeding once darkness has fallen.

In Fernando de Noronha, spinner dolphins enter a shallow protected bay between 5:00 and 7:00 every morning. There, they rest, play and mate. Between 14:00 and 16:00, they leave towards the open sea and their nocturnal hunt.

What was known of Shaab Samadai dolphins prior to the present survey fitted with the above general scheme. Dolphins would come in the lagoon almost every day, all the year long, and they would there rest, play, mate and take care of calves. The number of dolphins in the lagoon ranged from about 30 to 70-80 individuals, depending on the day (and the witness...); during 8 days snorkeling with dolphins in Shaab Samadai in April and October, I personally counted no more than 50-55 dolphins at a time. Departure time was known to be variable, from not much after midday to about 16:00-17:00.

3.1 What the results tell

The present survey provides a set of precise semi-quantitative data on how dolphins spend their days in Shaab Samadai Lagoon. Yet, it is a short-term study, and the results should be interpreted taking into account the knowledge of people who have a long experience of Shaab Samadai dolphins.

Dolphin days in Shaab Samadai

Here is a summary of the observations gathered during our 3 days survey. This is somewhat of an instantaneous figure, and it should be generalised only with care, especially to other seasons.

Dolphins arrive early morning in the lagoon (even 10 min. before official sunrise time on Oct. 16th), seemingly in small separate groups. Then, they gather in one large group (which size diminishes later), and normally descend into rest for some hours, although human disturbance (see further) or weather condition might alter this process.

In the course of the day, more or less active periods may alternate, in a variable pattern which remains to be more precisely described and understood. Subgroups may separate at times, not all the subgroups necessarily being simultaneously in the same behavioural stage. Active phases show increasing social behaviours: caresses and displays, play and possible quarrels, mating (but also social mating-like behaviours), nursing and play with babies; dolphins also may show evident interest towards snorkelers.

During the afternoon, movements increase in the whole lagoon area, until dolphins leave the place, apparently in successive groups. It seems that departing groups often go west after leaving the lagoon, and then north. The hypothesis that spinner dolphins hunt during the night is confirmed by the early morning high occurrence of defecation, similar to what was observed on Pacific Ocean populations (Norris *et al.*, 1994, p. 122).

Dolphins' preferences in Shaab Samadai

Apart from a short incident (see further), there was no human presence in Shaab Samadai Lagoon during the whole survey. The only human disturbance was the unavoidable – and limited – presence of observers. It can thus be postulated that the results show a good image of what dolphins' natural preferences are in undisturbed conditions.

Consistently with earlier observations, the survey confirmed that dolphins clearly favour a certain zone of the lagoon. During resting phases, they concentrate in quite shallow waters of the north-western part of the lagoon, in a “resting area” centred between central and western coral heads. During active phases, they swim in a somewhat wider area (“activity area”); this is not a displacing but rather an enlargement of the occupied lagoon area, still including the previous one. Dolphin movements extend to the whole lagoon only during the morning arrival phase or in the afternoon period prior to departure.

Variability in dolphin life in Shaab Samadai

Like any biological phenomenon, dolphin life in Shaab Samadai lagoon shows some kind of variability, part of which could be brought to light by the survey.

• Number of dolphins

The survey confirmed that the number of dolphins present in the lagoon varies from day to day, but also within the same day. Obviously some dolphins may leave the place during the day (even quite early in the morning). Subgroups may also separate for periods, especially during active phases. For instance, subgroups typically separate towards the end of the afternoon, this being apparently a prelude to departure in successive groups.

- Group variability from day to day

In Hawaii, Norris *et al.* (1994) demonstrated that only part of the spinner dolphins frequenting a bay would come back the next day, even though the group might look comparable in size and social composition. During our survey, at least two individuals (recognisable by marks on the dorsal fin or the tail stalk) were encountered on the 3 days. On the other hand, out of the 5-6 small babies recorded on Oct. 14th (and this probably can be extended to accompanying adults), only 2 were seen the next day, and none the day after. Thus, all what can be said up to now is that some dolphins come back from one day to the next, and some do not.

- Duration of stay

Dolphins were present in Shaab Samadai lagoon for at least 9 hours on Oct. 15th (morning arrival time not known), and for 10 hours and 50 minutes on Oct. 16th. However, the total resting time was similar on both days, about 2 hours and 50 minutes. This can be compared with the findings of Norris *et al.* (1994) in Hawaii, who estimated that daily resting time was between 4 and 5 hours whatever the length of time spent in the bay. Yet, their definition and perception of what is rest might differ from ours, since most data were recorded from surface (aerial) observations. In our survey also, surface observers did not perceive part of the activity phases observed underwater.

- Incidence of the weather

The difference in stay duration between Oct. 15th and 16th was obviously related (although possibly not totally) to the weather. Oct. 15th was a very cloudy day, and the sky was already very dark around 15:00. This probably urged the dolphins to leave earlier, anticipating an earlier settlement of the night. According to various testimonies, wind strength also has an incidence on dolphins. When the weather is very calm, they seem less prone to seek shelter in Shaab Samadai lagoon than during windy days.

Dolphins' reactions to humans

According to observations made during the survey, dolphins always seem perfectly aware of any human presence in the lagoon, would it be a very discrete observer. They also seem to be quite curious about distant surface activities (zodiac cruising by, diver passing the reef flat, approaching swimmer...) as illustrated by the frequent nose out behaviours in such circumstances.

In several instances, surface observers noted that the dolphins would slowly move away from a fast approaching swimmer, or even from a quiet swimming underwater observer. It also appeared that dolphins would slowly withdraw when they felt pursued by an observer swimming a bit too fast while trying to remain in contact with dolphins. This dolphin "shyness" seemed maximal during resting periods.

On the morning of Oct. 16th, some 20 to 30 snorkelers came inside the lagoon, mostly concentrating in the area between central and western coral heads. On this occasion, dolphins were seen to swim back and forth, as if they would desire to return to their preferred zone, but would hesitate in the face of the human crowd.

This important intrusion of snorkelers may have had another impact on dolphins. Just before these people entered the lagoon, the different activity parameters seemed to have become quite constant, as if resting was about to start. But from their arrival (8:00 am), activity rose anew. The disturbance and the argument between underwater observers and the intruders led to a break in underwater data collection. However, surface observers recorded an increased swimming speed and some tail slaps. A tendency to interact with snorkelers was also noted. I suspect that this strong human disturbance interrupted the normal process of descent into rest, thus inducing a somewhat abnormal activity rest cycle for the rest of the day. Yet, this suggestion remains hypothetical considering the very few available comparative data. In any case, it seems that descent into rest is a critical phase in the daily cycle of dolphins (as already observed by Norris *et al.*, 1994), and that particular care should be taken to avoid disturbance at this time.

But not all reactions to human are negative, and at times, dolphins are obviously interested or attracted by snorkelers. Indeed, they sometimes behave as if they were going to the zoo, mothers even bringing their babies to watch these strange swimming monkeys... More seriously, a rise in alertness and activity was typically accompanied by increased interest towards observers. Dolphins would closely circle around snorkelers, and even play with them. In several recorded instances, a dolphin would bring a plastic bag (usually with one of the flippers), let it float, and then take it back when the swimmer would try to grab it. Dolphins were also reported to really seek physical contact, including with quiet observers who would rather avoid interaction. Since the time it has been prohibited to enter Shaab Samadai lagoon, dolphins have sometimes been observed leaving the lagoon and seeking contact with snorkelers swimming around the large coral heads south to the main reef (Hossam Helmy, pers. com.).

3.2 Consequences for possible regulations

The main purpose of this survey was to provide detailed information on how dolphins live in Shaab Samadai lagoon, in order to help decision-makers to set up proper regulations. Here are gathered some elements of reflection on the biological aspect of the question. This is of course only a part of the problem since political, economical and social sides of the problem also are to be taken into account.

First of all, let us summarise the most pertinent information concerning the tourism management point of view:

- During resting phases, dolphins remain in a restricted zone of the lagoon (the “resting area”). They look rather “shy” and often prefer to avoid snorkelers.
- When active however, dolphins move around in a wider “activity area”. They usually tolerate human presence, and quite often readily approach snorkelers.

Zoning of the lagoon

As confirmed by the study results, zoning of the lagoon is the obvious answer to reduce human impact on dolphins. Total access prohibition doesn't seem to be a long-term solution considering tourism and economical development, but also for mere efficiency (frustrated tourists obviously tend to break the ban). The point is thus to devise a balanced regulation, likely to preserve dolphins' quietness, but limiting snorkelers' frustration by enabling them to enjoy somehow the proximity with wild cetaceans. The already envisaged plan, a "dolphin zone" (prohibited to snorkelers) in the bottom of the lagoon together with a "snorkeling zone" around it, is perfect in this respect. The delimitation of dolphins' "resting area" and "activity area", as preliminary defined in the present study, should be taken into account for the precise organisation of this zoning.

Number of snorkelers

During the last years, the number of snorkelers in Shaab Samadai increased dramatically. For instance, up to 50-100 snorkelers were at times observed to swim simultaneously in the lagoon in April 2003 (P. Louisy pers. obs.). In August 2003, 20-30 boats were present every day, which means sometimes more than 600 snorkelers per day in the lagoon (Hossam Helmy, Angelique Berkane, pers. com.).

According to the observed dolphin reaction to a group of 20-30 snorkelers, such crowds certainly exceed by far what dolphins can tolerate on the long term. Actual control of the number of snorkelers is unfortunately almost impossible to organise. The possible setting up of a fee to enter Shaab Samadai lagoon, apart from its virtues in terms of financial support to ecological management, may certainly help decreasing the number of coming tourists. Yet, if no snorkelers were allowed in the particularly sensitive "resting area", the overcrowding would only marginally affect the dolphins (and it is likely that only the most motivated snorkelers would stay in the water until dolphins would come close by, thus reducing the crowd).

3.3 What to do next

The present survey was not meant to be more than a first step towards the scientific knowledge of spinner dolphins in Shaab Samadai lagoon, a preliminary study likely to bring to light some major features and to set up the bases for further research.

Although the survey brought a bunch of interesting – and sometimes unexpected – data, new studies should be scheduled to confirm, precise and enlarge these preliminary conclusions.

A better knowledge for a better management

I believe that the present results will help set up and refine the regulation plan already envisaged. However, when dealing with nature, which is essentially variable and evolutionary, the suitability of the regulations must constantly be checked with respect to the evolving natural situation. Furthermore, various points of interest for the management of the place were not addressed in this first study. There are still some fields to explore in order to manage and organise human presence in Shaab Samadai with full knowledge of the facts.

- Deepening and refinement of the studies

The present survey was a very punctual approach of how dolphins live in Shaab Samadai lagoon, and its results should be corroborated by new data. One important question still unanswered is for instance the possible seasonal variability of dolphins' behaviour.

After its global validation through the present study, the same scientific protocol could be applied, in its broad lines, to a longer study addressing the seasonal dimension of the problem. A one year program of that kind, together with the focalised programs below, would provide all the needed information for a long term sustainable management of human activities in Shaab Samadai.

- Interaction between man and dolphin

One key question about tourism management in Shaab Samadai obviously is the relation between man and dolphin. What really is the direct incidence of snorkelers on dolphins' behaviour and welfare? When and how do dolphins approach humans? Is physical contact really sought-after by the dolphins and what can be the consequences? What can be the global incidence of human crowd, boats, waste, etc. on the ecological balance of the lagoon in which dolphins live? All these questions should be addressed first from a qualitative point of view, but also through a quantitative approach: quantitative indexes are needed to be able to evaluate actual effects of regulations.

- Follow-up of regulation results

The actual consequences of set up regulations obviously need to be followed and regularly assessed. The first point is to control if the initial objectives are reached (expected decrease in number of snorkelers, respect of forbidden zones...). But, since the primary reason for regulation is the welfare of dolphins themselves, it is also important to check what actually are the consequences on them (number of animals, occupation of the lagoon, activity rhythm, behaviour towards people...).

- Test of zone delimitation devices

Delimitation of different zones supposes the setting up of specific devices such as buoys, floating lines, etc. The question of a possible impact of these elements on dolphins should be addressed. For instance, it is important to know if a floating line (or a row of more spaced buoys hanged to vertical lines) is perceived as a barrier by the dolphins or not. Thus, some experiments, including precise observation of dolphins' behaviour, are desirable. At any rate, the effect of any installed device on dolphins should be carefully observed.

Fundamental biology studies

As a rule, fundamental biology studies are always useful to nature preservation, even though they don't look directly linked to conservation problems. In the specific case of Shaab Samadai dolphins, there are several reasons to encourage such fundamental research.

- An exceptional situation

First, the situation in Shaab Samadai is really exceptional: it is probably the best place in the world to get in close contact with wild spinner dolphins in their natural environment. Even in Hawaii and Fernando de Noronha, where the species has been studied best, dolphins are not that easy to approach and observe underwater.

- A unique opportunity for behavioural studies

Thus, Shaab Samadai offers a unique opportunity to develop behavioural research on wild dolphins, especially in terms of underwater behaviour, a feature much too rarely studied in cetology research. The present study also showed that it was possible to run comparisons between aerial and underwater observations. Comparison between observed behaviour and sound production also seems to be a very promising field of research.

- Shaab Samadai dolphins: ambassadors of nature preservation?

Communication is important for nature preservation: it helps triggering and then increasing the awareness and good will of the general public. Dolphins certainly rank number one in terms of media impact. This is why I believe that Shaab Samadai dolphins easily could be raised to the status of ambassadors of all Red Sea underwater nature and endangered species: dugongs, sea turtles, sharks... and of course corals and the reef as an ecosystem.

From that point of view, the scientific study of Shaab Samadai dolphins could be told like an adventure the public could share through different media: local, national or international newspapers and magazines, television, books, possible educational programs in schools, hotels and diving centres, etc...

Such an approach hopefully would help Egyptian people to realise that their Red Sea coasts shelter an exceptional – and yet fragile – marine life, and tell tourists that this wonderful natural heritage should be respected and preserved for the future.

N.B. If desired after the present survey, I may possibly help conducting further studies in close collaboration with Egyptian authorities and organisations involved in Red Sea marine life knowledge and preservation. I may also propose additional research protocols and scientific cooperations to deal with the follow-up of the effects of regulations and other possible topics.

CONCLUSION

This three-day survey of Shaab Samadai spinner dolphins confirmed the general scheme of the diurnal cycle already described by scientists in Hawaii or Fernando de Noronha: spinner dolphins hunt during the night, and spend their day in protected bays where they rest and engage in various social behaviours.

This study (fortunately) also confirmed what people familiar with the place already empirically knew. But above all, it provided the first scientific results about spinner dolphins in the Red Sea. The precise assessment of lagoon areas frequented by the dolphins and the semi-quantitative description of daily activity rhythm constitute a concrete basis for further studies.

Bringing to the fore the existence of a limited “resting area” was especially interesting from the tourism management viewpoint if future zoning of the lagoon is to be considered. Also notable was the confirmed fact that, when active, dolphins readily may be interested by snorkelers: they don’t necessarily perceive human presence as a nuisance. It should be emphasised however that high human pressure may certainly have a negative effect during resting periods, especially for the “descent into rest” phase.

In the light of the survey results, it seems thus possible to envisage a balanced regulation plan, combining the isolation of a “dolphin zone” encompassing the “resting area” (where resting dolphins usually avoid human proximity), and the opening of a “snorkeling zone” partly including the “activity area” (where dolphins mainly swim when active, i.e. when they are prone to approach snorkelers).

ACKNOWLEDGEMENTS

My thanks first go to the 18 participants of the “Voyage Bio Sous-Marine” (see p. 5), all amateur divers, who generously donated their holiday time – and a lot of energy – to make this scientific project succeed.

This survey also wouldn't have been possible without the involvement of various organisations:

- The French scientific association *Peau-Bleue*, which provided the administrative frame for organizing this study,
- The French diving magazine Octopus – Bio Sous-Marine (thanks to its chief editor Paul Poivert),
- The French tour operator Nouvelles Frontières Plongée (thanks to Myriam Viennet and Véronique Cabanes),
- The Red Sea Diving Safari (thanks to Mr Hesham M. Kamel, the crew of the ship Al Bourak and the team of Ecolodge Marsa Nakari),
- The National Parks of Egypt, and especially Mr Mohamed A. Ghani, who fully participated in the field study.

The survey also benefited from the help of Angelique Berkane, a film-maker whose dedication to Egyptian marine life preservation is well known, and Frédéric Bassemayouse, an underwater photographer whose experience with cetacean studies was very helpful.

And last – but certainly not least –, I am pleased to thank Mr Hossam Helmy, founder of the Red Sea Diving Safari, whose involvement in nature preservation and especially sustainable tourism development is outstanding. He is the one who made possible this scientific adventure, of course from the practical point of view through an unfailing logistic support, but also by helping fit the study into the more general frame of tourism management policy.

REFERENCES

- CULIK (B.), 2003. *Stenella longirostris*, Spinner Dolpin. Internet site CMS (Convention on Migratory species). www.wcmc.org.uk/cms/reports/small_cetaceans/data/S_longirostris/s_longirostris.htm
- KIEFNER (R.), 2002. *Whales and Dolphin : Cetacean World Guide*. ConchBooks. 305 p.
- LOUISY (P.), 2003. Les aventuriers de Dolphin House. *Octopus - Bio Sous-Marine*, 46 : 40-45.
- NORRIS (K.S.), WÜRSIG (B.), WELLS (R.S.) & WÜRSIG (M.), 1994. *The Hawaiian Spinner Dolphin*. University of California Press. 408 p.
- RIDGWAY (S.), 2002. Asymmetry and symmetry in brain waves from dolphin left and right hemispheres: some observations after anesthesia, during quiescent hanging behavior, and during visual obstruction. *Brain, Behavior and Evolution*, 60 : 265-274.
- SYLVESTRE (J.P.), 1990. *Guide des dauphins et marsouins*. Éditions Delachaux & Niestlé. 159 p.