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Summary and Review of 'Ring Bubbles of Dolphins',
(Scientific American Article, 08.96)

In August 1996 an article was published in Scientific American entitled 'Ring Bubbles of Dolphins'. Representing a range of expertise, a team of researchers and authors of the article, funded by the non-profit conservation organization Earth Trust, are Ken Marten, Karim Sharriff, Suchi Psarakos and Don J. White. This is a fascinating article exploring the development, methodology, dynamics and learning processes prevalent in a particular study group of captive dolphins who demonstrate a most evolved example of 'Ring Culture'. This team, being one of only a few to have tested dolphins for evidence of self-awareness using mirrors and video in various capacities, here substantiate dolphin abilities for and exercise of experimentation in the deliberate fashioning of halos and helices of air. The researchers believe that the dolphins create these underwater, three dimensional rings for use in their play activities.

In the study of non-human intelligence and self-awareness, EarthTrust in association with Sea Life Park of Hawaii, supports the aquarium facility of Project Delphis for new insights with respect to dolphin behaviour. Devoted to the protection of dolphins throughout the world, captive and wild, this branch of conservationists seeks to get their message across through public education. This highly advanced marine mammal, being the only non-primate to have shown off their self-awareness characteristics, is studied at Project Delphis in a lab staffed

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(2)

by specialists in bioacoustics, fluid dynamics, computer science and experts in the behaviour of wild dolphin populations whose emphasis has been on non-intrusive research. The members of this study group, *tursiops truncatus* or bottle nose dolphins, are not 'trained' with comestible rewards so that their actions may be termed as being more voluntarily determined than if motivated by treats.

A discovery in this lab has been the observation of the creation, using a series of deliberate steps, of stable rings and helices of air, fashioned by the dolphins for their entertainment. At least the researchers lead one to think that they believe the function of the rings is for dolphin play.

By stable what is meant here is that the tubes of air, shimmery, smooth and near perfect in their three dimensional geometry, last several seconds, holding their lovely shape without breaking up into smaller bubbles.

Another marvelous and significant discovery was, in fact, that after the method of ring fashioning was invented and exercised by one dolphin, that the behaviour became acquired by others in the group through observation and practice to perfect the method. So ring fashioning is considered a learned behaviour that is part of the culture of a particular dolphin group.

Ring blowing and the acquisition of the various techniques involved to achieve the underwater multi-dimensional 'plaything' to the extent it is occurring is almost exclusive to this aquarium. It is noted, though to a much lesser degree, in the behavioural ethogram of an aquarium in California researching mirror self-recognition in the bottle nose dolphin.



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(3)

Dolphins blow a variety of bubbles and streams of air during the normal course of their being an aquatic animal. What has been astonishing to learn is that dolphins have discovered a way of using and regulating the air streams from their mouths and blow holes to modify existing air halos and assemble new ones. In assembling the new ones they which are a by-product of their breath intentionally inject air into vortices which they've stirred up with their flukes or dorsal fins.

Some studies indicate that they locate the invisible vortex by using echolocation as a series of click trains often precedes the finding of the vortex and ensuing release of air into it. Not only can they augment the size of a ring or helix by blowing another blast of air into it, they even pull rings off of it with their rostrum and steer them through the water.

There are primarily three techniques used by the dolphins in the formation of the rings starting with the the most natural of occurrences and proceeding to the manipulation of the properties of air, water and physics.

In the most basic scenario, the dolphin emits a bubble from the blow hole which becomes a halo of air. As it rises to the surface, a hole is created in it's center as it's surface tension becomes less than the pressure of the water. Since there is water rushing through this hole a vortex around the bubble is formed. This style of making a ring is fairly straight forward though requires the dolphin modulating the strength and direction of the exhalation and possibly some muscular movements inside the blow hole. Eventhough this is the simplest method, the dolphins don't produce the ring with it's staying power properties on the first few tries. They need to practice



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(4)

producing a stable ring and practice they do. In this method, with some practice, they can also blow two rings in succession fusing them into a larger single ring. The next step up in complexity of technique happens when the dolphins create rings which either traverse the horizontal plane or follow a sloping path downward through the water. They have been observed accomplishing this in two ways. One way they do this is by shifting their normally horizontal flukes to the vertical and thrashing them around to initiate an invisible swirl. They then rapidly turn around, locate the swirl, and using the blow holes on the tops of their heads, inject it with a blast of air. It seems that echolocation is sometimes used to locate the invisible vortex. This reader ventures that how they locate it without emitting sonar information retrieval signals may be one or a number of a series of other explanations. These could include a reasonable estimating acumen for target location gained from hit, partial hit or miss experience.

The air infused into the swirl gravitates towards its center where the pressure is lowest stabilizing it so that it doesn't break up on the way to the surface. Halos thusly created have been noted with dimensions of up to 60 centimeters in diameter and just over a centimeter in height and thickness. It travels horizontally in the water. It is unclear in the article if these kinds of rings ever reach the surface i.e., if they move alternately horizontally and vertically upwards or disappear in traversal of the horizontal plane while still in the depths.

It has been noted that sometimes the dolphin will 'continue' to play with the halo by



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(5)

pulling another ring off of it and propelling the smaller version through the water. Planting a bubble or stream of air in an invisible vortex is also effected by other means as in the following example.

One adult female, named Laki, situates herself vertically, nose down, stirs up a swirl with her tail then infuses it with air from both her blow hole and her mouth. This individual on occasion will capture air from the surface with her flukes.

To add to the inventiveness of sending air to the swirls she has been observed emitting a stream of bubbles from her mouth and then trailing them down the length of her body. When they reach her tail she 'flips' them into the swirl. She also has been observed enlarging her just forged ring by 'shooting' more air into it.

Method three involves the crafting of more intricate ring structures. Only one young female, Tinkerbell, has been observed generating corkscrews of air to produce helices. She has been observed spending time perfecting her several techniques to achieve the formation of the helices. Her practice has resulted in more refined helical structures.

In one system she swims in a curved trajectory emitting a stream of bubbles. As they pass over her dorsal fin they become coiled into a helix ten to fifteen feet long. She then backtracks her path and injects an airstream into the helical swirl which then shoots out in front of her as a transformed helical tube. She also pulls smaller versions off the form and steers them through the water with her jaws.

The helical tubes are stable because there is low pressure at their center and higher pressure towards their edges. This works to smooth out the ripples and creates

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(6)

what is a ring which must have reflective properties.

There are some noteworthy and coincidental points which occurred to this reader through the further reading cited at the end of the article and other sources.

Some members of the human side of Project Delphis also conducted mirror and video 'live' and playback tests on their captive dolphins. The California lab group, the only other group to note any significant ring making activity, also conducted mirror tests on their captive study group. This reader of the article believes it would be most interesting to find out if ring making occurred before the tests and if so at which rate after the tests. It is not made clear when the tests were conducted as the results of the visual tests appears in a collection of research study papers and no dates are given to the individual papers.

Whether the ring making process really got going after the mirror and video 'live' and playback tests, whether it was initially in response to the tests, as well as a number of other investigative excursions, would make a very intriguing platform for postulation.

It was concluded from those test results that dolphins do have self-recognition capabilities. A number of unique postures and behaviours by dolphins in front of the mirror were noted upon which this conclusion is based.

A rhythmic head motion in front of the mirror was frequent and not exhibited during a video playback of the particular dolphin or other dolphins. It was noted though, as occurring during live video viewing when the dolphin could see itself in real time on a



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(7)

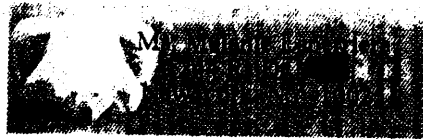
television monitor.

Dolphins arrived at the mylar mirror, which was designed to allow filming activities in front of it from behind it, mostly of their own accord. A few subjects had their attention drawn to the mirror by the humans inside the lab tapping on the other side of the lab window on which the mirror was affixed. Generally the dolphins could see the humans in the lab through the window. It is not made clear whether or not the researchers were in view of the dolphins when the mirror was up. What was made clear is that the mirror did not cover the entire window.

Postures and behaviours in front of the mirror included dolphins stretching around and angling their eyes and heads so that they could see the non-permanent dye marks that had been painted on one of their sides. The marks were placed so that they would not be visible to them without the use of a mirror or a real time action video themselves.

The dolphins also spent time doing things with their mouths in front of the mirror. These activities including bringing playthings, though we are not told what kind of playthings, in front of the mirror, passing them along its diameter and stopping it just as it or before it passed the edge of the mirror. So they were aware when it was in view in the mirror and of its passage out of view. They knew they could control aspects of the image in the mirror.

They spent time spitting out fish in front of the mirror. They also spit out fish at other times. When a dental adhesive was applied to one of their teeth, one dolphin opened its mouth much wider when it returned to the mirror to see the adhesive.



(8)

The tongue curl was a unique posture in front of the mirror.

In a commentary on the results of self-awareness tests given by the hawaiian lab team, Robert Mitchel mentions that he predicted dolphins should recognize images themselves as they are 'consummate' bodily imitators. Why the former should result from the latter quality was not made clear to this reader. He goes on to suggest that since the substances used to mark the dolphins were also tactile stimuli, that perhaps the dolphins went to the mirror and looked at the spot where the mark was because they felt it rather than noticed it as an odd color as they swam by and stopped to check. The substances used to mark the dolphins by the the Project Delphis lab were included zinc oxide, gentian violet and ichthamol. He also took issue with the control element of a group of dolphins unfamiliar to the study group placed on another side of an underwater gate. The researchers had noted that checking out the control group involved the study group facing them head on whereas the study group checking out images of themselves in the mirror involved a higher percentage of lateral positioning. It was noted that the study group spent much more time at the gate when the unfamiliar dolphin group was there than in front of the mirror or watching the video monitor whether the other group was there or not.

Mitchel points out that more and other kinds of senses were excercised in different ways, to deal with the new sounds and tastes for example, during inter-acttions with the dolphins on the other side of the gate. It was not therefore, he reasons, the best control to select.



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(9)

He also found problems with the teams use of false killer whales as the control group for the video play back for the obvious reason that they weren't other dolphins. The researchers may have been using the video to check for other kinds of recognition responses in their study group.

Whereas at Project Delphis the self-awareness study group consisted of a mix⁷ of five family and non-related dolphins, in Vallejo, California, as part of Marine World Africa USA, the study group for mirror recognition consisted of two half-brother⁸ dolphins, Pan(ama) and Delphi. Additional useful information such as interpretation of sometimes similar test results with some variance, is gained from the self-recognition tests conducted at the Vallejo facility.

Using the mirror to check for marks that were partially removed with a towel and returning to check the same spot, after more of the mark had been removed, was noted in both subjects. Only one dolphin was marked at a time and only the marked dolphin swam to the mirror to check their status of the mark removal. As the purpose of this study group was directed at comparing self-recognition in dolphins to self-recognition in primates, most of the dolphin behaviours were explained just in those terms, i.e out of their own context.

The behaviours in front of the mirror were divided into the three categories of social/aggressive, sexual and suggestive. By suggestive the researchers say that they mean behaviours that look like something is going on though there's no way of being certain. For example, they termed the mouth opening behaviour as a suggestive behaviour, because it appeared as if the animal was examining the in-



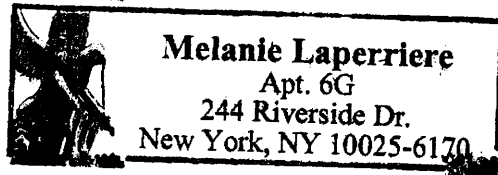
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(10)

side of his mouth though the researchers interpreted this as being indistinguishable from the otherwise occurring open mouth threats.

Exclusive in front of mirror behaviours noted at the Vallejo aquarium included the the dolphin being close to the mirror and emitting of various kinds of bubbles and bubble streams while sending out a variety of sounds. He appeared to be monitoring the bubbles in the mirror as his eyes followed their progress to the surface while he was looking at his and their reflection. The team had noted dolphins blowing bubble bursts and rings and following them visually to the surface when no mirror was present. What was so unusual when the mirror was there was that was that the dolphin was watching the bubbles rise to the surface in the mirror, with his face oriented to the mirror. He also would touch the bubbles with the top of his head while monitoring the scene in the mirror.

Project Delphis notes that the learning rate for fashioning rings in the young and adult dolphin populations had interesting variation. They give an example of an adult male, Keola, who even after living for living for several months among ring blowing dolphins did not attempt even a single ring. The story changed after his younger brother, who had exercised ring blowing techniques was introduced to the group Keola was in. After some months of intense observation of his brother, Keola attempted to blow his first rings. He practices with signs of improvement over time. These two brothers have been noted as blowing rings together while lying on the bottom of the tank, side by side. There is either a second between the rings or they are blown simultaneously.



(11)

The researches also discovered that when they blew soap bubble rings inside the lab which the dolphins could view from their tank, the dolphins would respond with a ring bubble of their own.

Aspects of the nature of intelligence are revealed by observing dolphins who use what are evidently experimentation skills during intentional learning processes.

If human beings are to learn useful things from dolphins it is imperative that captive populations be made as content as possible.

It is overall most important to keep the main objective in focus which is to educate people so that they stop the dolphin killing components in commercial fishing and that as a human presence, they exercise care and respect for dolphins on and in the seas, channels and brackish rivers which are their only available wild home.

FOOT NOTES

- 1.) EVIDENCE OF SELF-RECOGNITION IN THE BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*), Ken Marten and Suchi Psarakos in: *Self-Awareness in Animals and Humans: Developmental Perspectives*. Edited by S.T. Parker, R.W. Mitchel and M.L. Boccia. Cambridge University Press, 1994
- 2.) MIRROR SELF-RECOGNITION IN BOTTLENOSE DOLPHINS: IMPLICATIONS FOR COMPARATIVE INVESTIGATIONS OF HIGHLY DISSIMILAR SPECIES, Lori Marino, Diana Reiss and Gordon G. Gallup, Jr. in: *Self Awareness in Animals and Humans: Developmental Perspectives*. Edited by S.T. Parker, R.W. Mitchel and M.L. Boccia. Cambridge University Press, 1994
- 3.) Ibid
- 4.) op cit
- 5.) op cit
- 6.) EVIDENCE OF DOLPHIN SELF-RECOGNITION AND THE DIFFICULTIES OF INTERPRETATION, Robert W Mitchel in *Consciousness and Cognition*, Vol 4, No. 2, Academic Press, 1995
- 7.) USING SELF-VIEW TELEVISION TO DISTINGUISH BETWEEN SELF-EXAMINATION AND SOCIAL BEHAVIOUR IN THE BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*), Ken Marten and Suchi Psarakos in *Consciousness and Cognition*, Vol 4, No. 2, Academic Press, 1995
- 8.) op cit