

## VISUAL DISPLAYS FOR COMMUNICATION IN CETACEANS

Bernd Würsig, Thomas R. Kieckhefer<sup>1</sup>, and Thomas A. Jefferson

Marine Mammal Research Program, Texas A&M University at  
Galveston, Department of Marine Biology, P.O. Box 1675,  
Galveston, TX 77553, USA

<sup>1</sup>Moss Landing Marine Laboratories, P.O. Box 450, Moss Landing,  
CA 95039, USA

### INTRODUCTION

Social mammals use facial signals and body postures, often highlighted by coloration, for well-developed visual communication. African forest monkeys (Cercopithecus sp.), for example, display an impressive repertoire of stereotyped head movements and facial expressions for courtship, aggression, fear, and appeasement (Kingdon, 1980). Thomson's gazelles (Gazella thomsoni) rapidly alert conspecifics to danger by a tense, upright stance, directed gaze, and often a twitching of their edge-receptive flank, which is marked with an eye-catching black longitudinal stripe (Estes, 1967; Walther, 1969). This sequence of subtle body movements produces a "Morse code" of visual information about the potential threat of an approaching predator. To the untrained observer only obvious alarm signals and warnings, such as running and stotting (a stiff-legged, bounding gait), are appreciable (Caro, 1988). It recently has been found that some mammalian species display different warning signals for different predators (Seyfarth et al., 1980; Sherman, 1985), and this extra sophistication beyond mere communication of danger is probably widespread among animals.

### IMPORTANCE OF COMMUNICATION

Cetaceans have relatively nonexpressive faces, frozen rigid during evolution towards streamlining in water. Also, most species lack great flexibility of the neck and forelimbs, body parts that are used expressively in many terrestrial vertebrates. Yet visual communication is important to cetaceans, and this is likely true especially for social cetaceans in clear surface waters, where highly complex coloration patterns can transmit refined information. Cetaceans have remarkable abilities to communicate and to scan their environment by using sound. However, it is potentially disadvantageous to make sounds that prey or predators might hear (Myrberg, 1981); and we have found that Hawaiian spinner dolphins (Stenella longirostris), dusky dolphins (Lagenorhynchus obscurus), and killer whales (Orcinus orca) all can be remarkably silent during daytime. This is especially true when dolphins are resting and when killer whales are travelling in apparent search of marine mammal prey. In British Columbia and Washington, for example, resident killer whales that feed on salmon are quite noisy, while

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transient killer whales that feed largely on pinnipeds tend to be quiet (Ford and Fisher, 1983). We assume that their social communication at these times is largely by sight.

Visual communication is effected by the interactive traits of morphology, coloration, and postures. For visual communication to be useful, water clarity, light level, and visual acuity must be sufficient for efficient transfer of messages (Lythgoe, 1979). All cetaceans have a functional sense of sight. It is reduced in the platanistoids, but even the Amazon river dolphin, or boto (Inia geoffrensis), can see flash patterns of contrasting white and black; and its yellow-eye lens (Dawson, 1980) is believed to filter out the glare and dazzle of back-scattered light in murky water (Lythgoe, 1979; K. S. Norris, pers. comm., 1983; Walls, 1967). The Ganges and Indus river dolphins (Platanista spp.) often are referred to as blind because they have no lens at all (Dawson, 1980); nevertheless, their eyes are thought to be capable of light detection and possibly forming crude images, since the eye opening is extremely small and may operate like a pinhole camera (Purves and Pilleri, 1973). In some environments sight probably is useful only above the surface and at extremely close range. The Chinese river dolphin, or baiji (Lipotes vexillifer), for example, lives in water that is essentially opaque. It often brings its head and eyes out of water when surfacing to breathe, possibly scanning the shoreline, river vessel traffic, and conspecifics while doing so (B. Würsig, pers. observ.). However, we assume that cetaceans that live in extremely murky waters use visual communication in a less refined way than those occupying clearer habitats. Cetaceans lack some of the underwater sensing mechanisms used by many other vertebrates. For example, sophisticated chemical and electrical sensing systems and a very sensitive hydrodynamic sense are common to many fishes and amphibians, and some reptiles are extremely thermosensitive. We would expect that without the availability of a wide range of sensory capabilities, cetacean communication by sight will have evolved to the highest possible degree, given the constraints of the environment.

Visual communication has not been explored in detail for cetaceans. One of the major reasons is that visual communication and sound communication have been difficult to separate because underwater acoustic data have not been recorded with consistency during behavioral observations. Furthermore, from an observer's standpoint, subtle posturing and movements that reflect flash patterns of communicative light are often obscured by distance and various properties of the aqueous environment (i.e., refraction, turbidity, wave-induced surface scatter); and even when animals are within close range for behavioral observations, hydrophone recordings often are difficult to synchronize. Also, it is not always possible to separate the visual from the tactile modes often used by cetaceans. Yet, it is interesting to attempt to separate these sensory modes, for each has its advantages and disadvantages; and the relative use of each mode may tell us much about the behavioral and perhaps emotional states of these interacting animals. However, very few successful behavioral observations have been carried-out under water, where cetaceans spend most of their time. Our observations are usually carried-out from our own environment, and we describe those fleeting times and interactions when whales and dolphins are at the surface. What we need are more long-term behavioral observations under water, such as those on Hawaiian spinner dolphins (Norris and Dohl, 1980a; Norris et al., 1985) and those now being done by several research groups working with Atlantic spotted dolphins (Stenella frontalis) in the Bahamas. Such observations are restricted to clear waters and to animals that consistently allow approach by humans under water. Although fleeting glimpses of underwater visual communication have been gathered for humpback whales (Megaptera novaeangliae; Baker and Herman, 1984; Bauer, 1986; Madsen and Herman, 1980; Tyack, 1981; Tyack and Whitehead, 1983), very little is known about visual communication of any of the large whales.

Morphology

Sexual dimorphism is subtle in most species of cetaceans, with the majority of odontocete males being slightly larger than females, while the reverse is true for mysticetes. In odontocetes, this size disparity hints at a polygynous mating system, size and other secondary sexual characteristics being a likely display of condition in males. In most species, polygyny does not appear to be harem-like, where one male has exclusive access to several females. Instead, it appears that much mate sharing is taking place and that sexual partners may shift over a matter of hours, days, and longer times, thus combining elements of promiscuity or a multi-male/multi-female social system (Baker, 1985; Darling et al., 1983; Mobley and Herman, 1985; Norris et al., 1985; Tyack and Whitehead, 1983). Males in rut have very large testes and presumably are able to produce large quantities of sperm per ejaculation (Ridgway and Green, 1967; Kenagy and Trombulak, 1986). In these species, competition may therefore take place at the level of the sperm rather than in the direct competitive sense of a stronger male displacing a weaker one or gaining easier access to a female due to his strength or size (Kenagy and Trombulak, 1986; Brownell and Ralls, 1986). Nevertheless, size disparity may be important for communicating reproductive stamina from male to female or for sorting out access of males to females. Although male toothed whales in captivity are often aggressive, the establishment of "dominance hierarchies" has not been linked solidly to size (Tavolga, 1966). Sperm whale (Physeter macrocephalus) and killer whale males are very much larger than females of the same age. Sperm whale males are thought to battle for access to female groups (Caldwell et al., 1966; Shaler, 1873) or possibly to employ a "searching" strategy like that of African elephants (Loxodonta africana; Whitehead and Arnbohm, 1987).

The reverse sexual dimorphism of the baleen whales may have to do less with social signalling than with the need for females to build up particularly large fat reserves while developing their young during long seasonal fasts.

Several cetacean males also have secondary sexual characteristics that clearly mark them as males. Male spinner dolphins have a postanal keel of connective tissue and a triangular dorsal fin (Perrin, 1972, 1975). The extent of development of these characteristics is different for different populations and reaches its extreme in the eastern race of spinner dolphin in the Pacific; older males have developed a large postanal keel and a dorsal fin which is so erect and pointed forwards that it appears to be stuck on backwards (Figure 16 of Perrin, 1972). A similar, though less extreme, situation exists in Dall's porpoise (Phocoenoides dalli), and adult males of this species can be readily distinguished (Jefferson, 1990). It has been suggested that the male's postanal keel (which exists in many species of small cetaceans) may help provide leverage to thrust the penis into the female, thus acting like a "penile anchor," or that it acts as a means of stimulating the female during courtship by bumping the keel against the female's genitals with a quick "snapping action" (T. R. Kieckhefer, pers. observ.). Many beaked whale (e.g., species of the genus Mesoplodon) males develop particularly large and modified paired teeth that are displayed outside the mouth and are thought to be used in male/male competition (Heyning, 1984; McCann, 1974; Mead et al., 1982), and Heyning (1984) has suggested that white areas on the lower jaws of male Mesoplodon carlhubbsi may function to exaggerate apparent tooth size. The male narwhal (Monodon monoceros) apparently makes use of its spiralled tusk for ritualized sparring (Best, 1981).

Less obvious characteristics consist of the right whale (Eubalaena australis) callosity pattern differences between males and females (Payne and Dorsey, 1983); the hemispherical lobe of female humpback whales (Glockner, 1983); curved flippers of old male belugas (Delphinapterus leucas; Vladykov, 1943); serrated leading flipper edges, mainly in male Commerson's dolphins (Cephalorhynchus commersonii; Goodall et al., 1988); extensive white scarring of adult Risso's dolphin (Grampus griseus; Leatherwood et al., 1982); and a host of other morphologic distinctions between adult males and females and between adults and young. We assume that these developmental and secondary sexual characteristics are involved in social signalling and in helping to regulate mating systems; however, presently we have little data to support this assumption.

#### Coloration

Much has been written about cetacean body coloration, which consists mainly of shades of white and black (e.g., Evans and Yablokov, 1983; Mitchell, 1970; Perrin, 1972; Yablokov, 1963), but little of this attempts to address visual signalling of body color as communication. Coloration exists in three basic forms (Yablokov, 1963): uniform, countershaded with dark dorsum and light ventrum, and disruptive. Uniform and countershaded coloration types are probably most useful for hiding. Largely uniform coloration, such as in blue whales (Balaenoptera musculus), pilot whales (Globicephala spp.), and white whales, may be related to feeding on small invertebrate prey or in deep or murky water where countershading is not necessary. Countershading would seem especially useful for "sneaking up" on larger fish and squid prey which have high visual acuity and rapid escape capabilities, as well as for avoiding predators. Bottlenose dolphins (Tursiops truncatus), harbor porpoises (Phocoena phocoena), and some of the rorqual whales (e.g., fin whales, Balaenoptera physalus, and minke whales, Balaenoptera acutorostrata) may be appropriate examples.

Strong countershading does not appear to be needed in murky inshore waters, as demonstrated by the muted contrasts of the harbor porpoise, bottlenose dolphin, Burmeister's porpoise (Phocoena spinipinnis), and the river dolphins. Munz and McFarland (1977) found a similar trend of reduced countershading of fishes in silt-laden or productive waters; they attributed the decrease to the more uniform lighting in these waters. Less heavily countershaded animals have lighter backs; therefore, more light reflects off the back, resulting in a better match of their surroundings, which have brighter horizontal light. In brief, countershading appears to hide the animals from prey and possibly predators, and is probably of little communicative value.

Disruptive coloration, as in patches of white on a dark background, may also serve to hide an animal behind an illusion of visual after-images each time the white patches alight (Marler and Hamilton, 1966). On the other hand, spots and longitudinal stripes may serve to break-up the outlines of the body as a whole. For example, at close range, the conspicuous black and white bars or stripes on terrestrial animals, such as zebras (Equus grevyi), do not suggest protective value. However, it has been resolved that at some critical distance or light level, the stripes blend into the background, thus camouflaging the animal (Colt, 1957; Marler and Hamilton, 1966; see Fig. 1). We believe that conspicuous disruptive patterns of numerous delphinids may have a similar function (for example, the Pacific white-sided dolphin, Lagenorhynchus obliquidens; striped dolphin, Stenella coeruleoalba; common dolphin, Delphinus delphis; and Fraser's dolphin, Lagenodelphis hosei), and at close range their distinctive markings may facilitate intraspecific signalling and schooling. This form of crypsis is most valuable in clear waters and complex habitats (such as coral reefs) or close to the surface where the flickering of down-dwelling sunlight entering

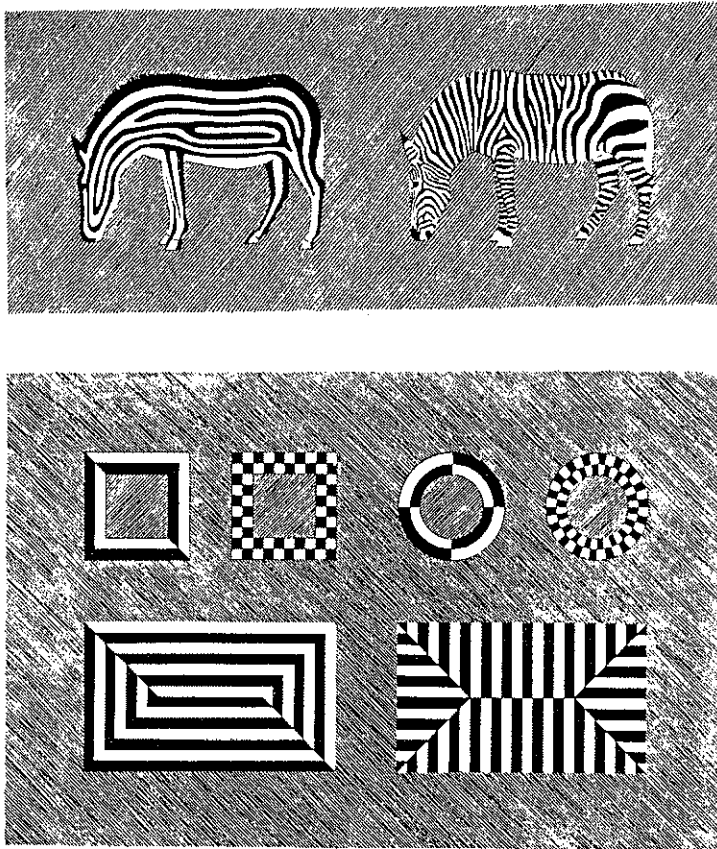


Fig. 1. An illustration of the principle of disruptive margins. As one backs away from the photo, the zebra (as opposed to the "pseuozebra") and the figures with disruptive margins disappear first. (After Cott, 1957)

the water can cause disruptively colored animals to be difficult to see (Munz and McFarland, 1977). McFarland and Loew (1983) point-out that the stripe patterns of some fishes, particularly those that live just below the water's surface, also may serve to camouflage the fish against the natural light-flickering action at shallow depths. Numerous dolphins have recurrent types of body marks (Mitchell, 1970). Common are spots, saddle patches, capes, and longitudinal striping, which are associated with those animals living in clear tropical and temperate pelagic waters where surface flickering may be of special importance. However, much of cetacean disruptive coloration probably has evolved for social signalling and perhaps to communicate false information to prey.

While many pelagic dolphins<sup>of</sup> the tropics have color patterns of varying shades of gray, those dolphins and porpoises that live in offshore areas in higher latitudes tend to have very bold patterns of distinct black and white areas (Heyning, 1988). There also is a tendency for those species that live in the largest schools and that most often engage in interspecies associations (e.g., species of Stenella, Delphinus, and Lagenorhynchus) to have the most complex color patterns of the small cetaceans. This complexity may be important for individual recognition

in schools of many individuals, and for efficient species recognition in multi-species aggregations.

Social signalling by disruptive coloration is particularly likely for those species which have patches of white on a dark background that can be rapidly exposed or "flashed" at a conspecific. The belly patches of killer whales and right whales, for example, can be exposed or hidden by the tilt of the body; and the small axillary white patches of the Chilean dolphin (Cephalorhynchus eutropia) can be exposed or hidden by small movements of the flippers (Norris and Dohl, 1980b).

Commerson's dolphin has body coloration that probably obscures its true shape in poor light levels and murky waters; and the same situation is certainly true for Dall's porpoises, southern right whale dolphins (Lissodelphis peronii), hourglass dolphins (Lagenorhynchus cruciger), killer whales, and Hector's dolphin (Cephalorhynchus hectori). We suspect that these striking markings (e.g., a large white spot behind the eye) may serve to confuse predators and prey, perhaps by obscuring the position of the animal's mouth. But such blatant markings may also serve to coordinate activities of dolphins swimming side-by-side (Norris and Schilt, 1988) and may even serve as individual identification cues, for there are slight differences in angles and extents of coloration between most individuals (Mitchell, 1970; Yablokov, 1963).

Disruptive coloration is likely useful for interspecies recognition. It has been pointed-out (Norris and Dohl, 1980b) that the white snout tips of adult pan-tropical spotted dolphins (Stenella attenuata) contrast remarkably well with the black snout tips of spinner dolphins, with whom they often travel in multispecies aggregations. Indeed, one of us (B. Würsig) has seen both species together at a distance > 100 m under water, and all that could be seen upon first approach were the "flashlight noses" of the spotted dolphins. Upon closer approach, it was easy to make-out the species, despite a generally similar body morphology. It also is possible that the particularly enlarged postanal keel and high dorsal fin of adult male spinner dolphins, which travel with other species in the tropical Pacific, help to distinguish those animals not only as males, but emphatically as spinner dolphin males in multispecies aggregations (Perrin, 1972).

Many cetaceans are shaded differently when they are young, consistent with the general trend for birds and mammals. Coloration tends to be muted, and young animals usually blend into the surrounding habitat. Appropriate examples are Dall's porpoises (Jefferson, 1990) and northern right whale dolphins (Lissodelphis borealis; Leatherwood and Walker, 1979). A striking young-adult difference is shown by the spotted dolphin (Perrin, 1969). The young are a uniform or lightly countershaded gray, while the adult coloring consists of a profusion of black and white mottling. The difference in color probably helps to rapidly identify a calf or subadult as a nonreproductive member of the social unit and may thereby alleviate aggression and, perhaps, identify it as one of lower social status. The crisscross "hourglass pattern" found on common dolphins, and to lesser degree on some other delphinids (Mitchell, 1970), may serve to countershade and probably provide position cues to conspecifics of a school (Norris, et al., 1985). But it also may tend to hide the very young calves, for they ride above or below the midline of the body (usually above it, just behind the dorsal fin) at precisely the location where the hourglass pattern widens and presents a large, uniformly shaded patch similar in size to a newborn (Yablokov, 1963; Mitchell, 1970). In many other species as well, uniform coloration of the young may provide camouflage against the background color in a particular position along the mother's body.

Quite a few darkly shaded cetaceans that feed, at least partly, on squid in deep water have white noses, heads, or lips. The sperm whale (which also has a white inner mouth), many of the beaked whales (e.g., Cuvier's beaked whales, *Ziphius cavirostris*; melon headed whales *Peponocephala electra*; and pygmy killer whales, *Feresa attenuata*) are particularly good examples. Gaskin (1967) suggested that sperm whale lips might attract bioluminescent squid. Indeed, bioluminescence (probably transferred from squid) has been noticed on sperm whale lips; and the luminescent effect was intensified due to the whiteness of the lips (Gaskin, 1967). Many squid have light-sensitive vesicles that monitor light from themselves and others, and this adaptation may further serve to attract prey (Young, 1978). It is

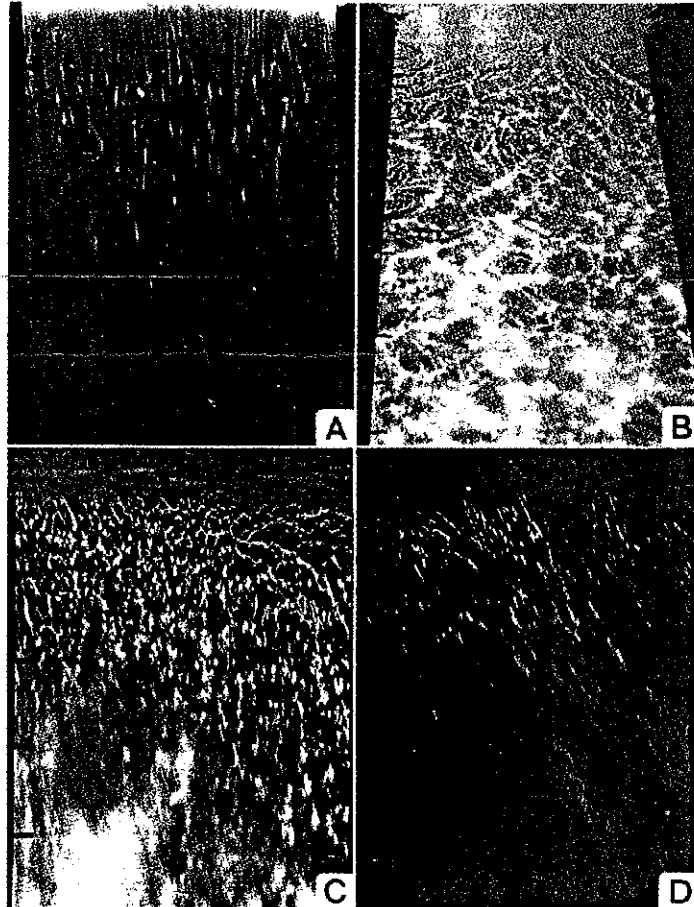


Fig. 2. Wave-induced flickering patterns produced below the surface. A. Vertical orientation of a white reflector with sun directly overhead. B. Reflector  $30^\circ$  from vertical, sun overhead. C. Reflector vertical, sun  $45^\circ$ . D. Reflector  $45^\circ$ , matched with sun altitude of  $45^\circ$ . Two basic patterns occur: vertical linear grating and reticulated mosaic. (After McFarland and Loew, 1983)

presently unknown whether this head coloration is predator-related in any of the squid feeders, including the sperm whale, but experiments with squid in controlled environments could provide better information.

A device for preventing the escape of prey may exist in the long, often partially white, flippers of humpback whales and in the white chin patches of bowhead whales (Balaena mysticetus). It has been suggested (Brodie, 1977) that humpback whales throw their flippers forwards to effectively corral prey during feeding lunges, and the flashing white of the flippers would tend to keep small schooling fishes and euphausiid prey concentrated in front of the lunging mouth. In addition, during a laboratory experiment in Southeast Alaska, one of the authors (T. R. Kieckhefer) found that krill (Euphausia pacifica) were attracted to the reflection of their own bioluminescence off a white sheet of paper placed at either end of a tank, which may provide a possible hint to an alluring nature behind the brilliant white undersides of humpbacks' flippers. The fin whale's asymmetrically colored lower jaw, with a white right lower lip and palate, may serve to keep prey concentrated in a feeding lunge. It also is possible that white marks near the mouth, including the white flipper bands of northern hemisphere minke whales, are used to coordinate actions in a group. Humpback whales and fin whales, which often lunge in groups (Baker, 1985; D'Vincent et al., 1985; Tershy, 1990) may coordinate lunges by these easily seen points of reference.

Furthermore, the disruptive white flank patches on numerous delphinid species, such as the dusky dolphin, may serve as a mechanism to attract and/or herd prey. Würsig and Würsig (1980) found that dusky dolphins in the South Atlantic fed primarily on large schools of anchovy (Engraulis anchoita), driving them up to the surface waters from below around mid-day, in contrast to the daily twilight or crepuscular periods that are critical for many predator-prey interactions (e.g., Major, 1977). A possible explanation may be that changes in orientation of the reflective flank patch of the dolphin to the sun and water surface will produce two primary patterns--vertical linear grating and reticulated mosaic (McFarland and Loew, 1983; Fig. 2). Vertical linear grating occurs when the sun is overhead (at mid-day) and the dolphin is oriented vertically or swimming on its side (reflecting its white underside) in the water column. However, with sun angled (at dawn and dusk) or when the reflective surface of the dolphin is angled upwards towards the water's surface, a reticulated mosaic scattering of light is created. We suspect that this flickering light off the white flank patches of numerous delphinid species not only may increase the efficiency of their visual communication system by enhancing the near-field contrast between schooling members, but also may be used in cooperative herding of fish and squid. This would operate by attraction of prey when using vertical linear grating and repulsion when reticulated mosaic light is employed, controlled by shifting and turning of the body axis (Fig. 3).

In a laboratory study, Koike (1985) found a remarkable difference in fish-school behavior of horse-mackerel (Trachurus japonicus) in response to reflected intermittent or flickering light compared to that in constant light. Flickering light provoked an erratic response, with fish observed chasing after the disappearing light, very similar to the earlier findings of Shaw and Tucker (1965) wherein schooling carangid fishes followed vertically moving light and dark lines, termed the "optomotor reaction."

The ecological importance of white flank patches is that they may serve as a valuable predatory tool in mimicking the attracting stimulus of schooling prey, since one of the primary sensory mechanisms that attract fish to other companions is vision (Breder, 1959; Morrow, 1948; Radakov, 1972; Shaw, 1961). There is, in fact, some evidence to indicate that conspicuous black and white patterns in piscivores can cause depolarization in schools of prey



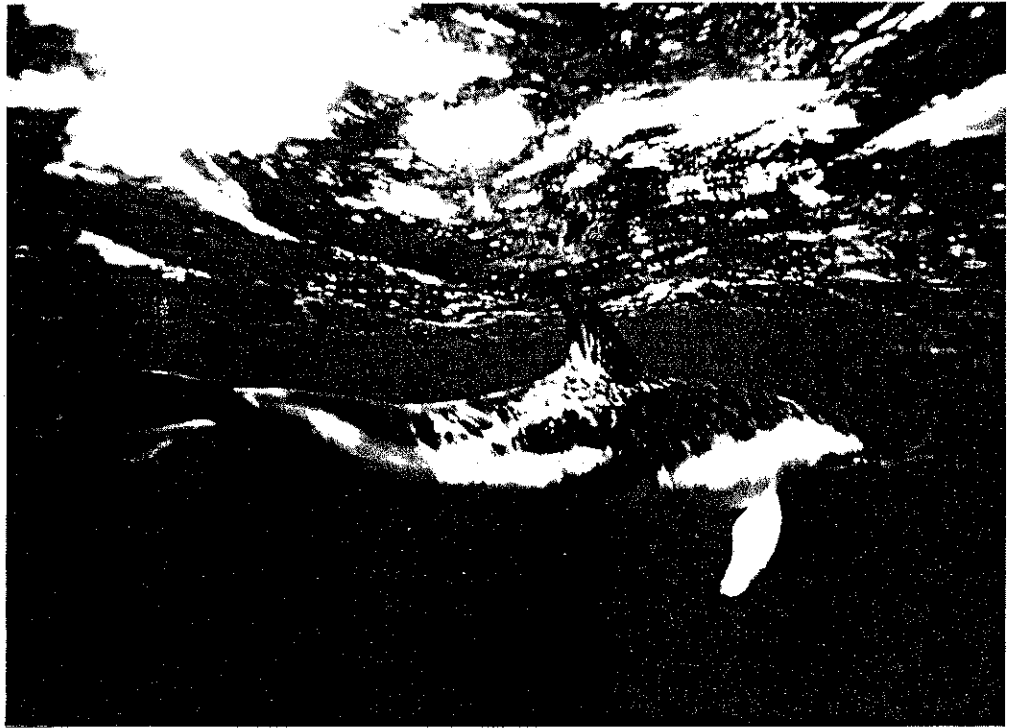


Fig. 3. An example of a vertical grating along a dusky dolphin's flank.

fish (Wilson et al., 1987), thus enhancing their predatory efficiency. However, Pitcher et al. (1976) found that temporarily blinded fish could maintain a polarized state within a school despite their clumsiness and slowness of reaction. Detailed field work is necessary, possibly with the use of an underwater stereo-video (or "video-grammetry") system to measure distances between predator and prey, to determine if reflected flickering light off the white patches of a specific cetacean plays a role in coordinating and facilitating the capture of elusive prey.

#### Postures

When we think of communication, we generally assume a purposeful action to obtain some kind of result (Myrberg, 1981). Morphology and coloration are not behavioral communication tools unless used posturally by the animals. Dolphins use their shape and color patterns for communication by changing positions relative to conspecifics and, possibly, to predators and prey. We assume that large whales do this as well, but we have less information for them.

Changes of posture may signify turning or reorganizing of a school, with animals paying attention to the sides of nearby conspecifics. This use of patterns to synchronize social action is well known for schooling fishes (Partridge, 1981, 1982) and flocking birds (Major and Dill, 1978). It is even likely that fast response time to one individual's turning is mediated by a type of sensory integration system called the "chorus line effect"

(Potts, 1984), whereby animals pay attention not just to nearest neighbors but to conspecifics some distance away. Hence, they can anticipate the timing and extent of position changes necessary to remain synchronized members of the group (Norris and Dohl, 1980b; Norris and Schilt, 1988). As mentioned previously, the slight movement of a flipper, especially if enhanced by white on the flipper or a white patch behind it, may signify a turn or other change in position.

Dolphins and whales are almost always on the move and as a consequence are usually oriented in the same direction. It appears that in dolphins a direct facing towards another animal is usually an intentional act, charged with aggressiveness; it may be accompanied by opening of the mouth, exposing the teeth, and arching of the back. This arch presumably makes the approaching dolphin look somewhat bigger. Aggressive posturing reaches its extreme in the shark-like "S" posture of, for example, spinner dolphins, which "hang" in front of the object of threat (such as a human swimmer) with arched back, rostrum pointed towards the object, rapid head movements, and often jaw clapping. Because of the similarity to a threat position of several sharks, Norris et al. (1985) suggested that dolphins mimic sharks in order to make themselves appear more fierce. We think it doubtful that aggressive dolphins have evolved to behave like sharks *per se*, but we can visualize the aggressive stance as being related to the humpbacked stance of any threatening (and often fearful) terrestrial mammal.

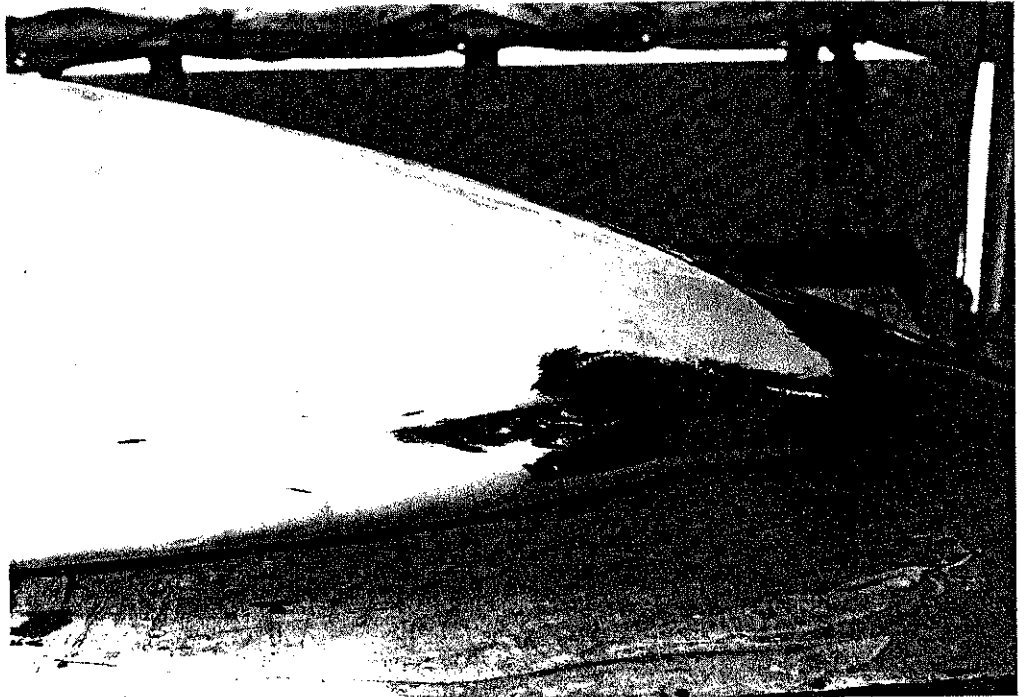


Fig. 4. The uro-genital color pattern of a female Dall's porpoise (the head is to the left), showing black "fingers" pointing to the genital opening and to the mammary slits.

Submissive posturing is indicated by closed mouth, facing side or belly towards a conspecific, and a straight back. Norris and Møhl (1983) propose that if dolphins are able to stun prey by projecting intense sounds beamed at them, it may be a threatening act to point the snout towards another dolphin simply because of the potential of inflicting a painful sound; and that, therefore, normal interactions as well as submissive gestures should never be carried out head-on. In fact, such "echolocation manners" have been observed in spinner dolphins (Norris et al., 1985). It is difficult, as in many other mammals, to separate some submissive gestures from those of sexual intent or solicitation, where a belly might be submitted for view or touch or a side nuzzled with head or body. Sexual solicitation by displaying the genitals--in dolphins, often by rapidly swimming ahead of another animal, then turning or curving the body so that the genital area is exposed (Caldwell and Caldwell, 1977)--certainly is enhanced by the very disruptive marks many species have near their genitals. In fact, several species have patterns in the uro-genital area that appear almost as "pointing fingers," leading towards the genitals or mammarys (for example, killer whales, Bigg et al., 1987; Dall's porpoises, Morejohn et al., 1973; Fig. 4).

Visual signalling beyond coordinating movements and bouts of aggression or submission tends to grade into the tactile sense for dolphins. This is because dolphins are usually quite close together and are very tactile creatures with a sensitive skin (Ridgway, 1986). For example, the act of approaching a neighbor can rapidly turn into a bout of rubbing, with one animal placing a flipper along the side of another or--as often happens in spinner dolphins during social-sexual bouts--inserting the rostrum or tip of the dorsal fin into the genital slit of a partner (Norris and Dohl, 1980b).

It is likely that vision and tactile sense are especially closely linked in baleen whales, for their sheer size makes it important that they be close together in order to see a portion of each other during social interactions. It is very difficult for observers to differentiate between vision and touch when observing a group of up to one dozen rolling, twisting, turning right whales (Payne, in press) or bowhead whales (Everitt and Krogman, 1979) in mating aggregations. We suspect that the light-reflective callosity patterns of right whales, the white chin patches of bowhead whales, and the highly variable white marks of both species around the genitals function for recognition of position and of individuals.

#### OVERVIEW

We know lamentably little about visual communication in cetaceans, although we suspect that body shape, coloration, and body movements are important for recognition of species, sex, age, individual identity, behavioral intent, and emotional state. Our interpretation of visual communication patterns is clouded not only by the fact that little has been done in this field for odontocetes, and even less for mysticetes, but also by the fact that the capabilities of expression of cetaceans are so different from those of most four-legged terrestrial mammals with which we are familiar. Even with terrestrial mammals, much observational time needs to be expended before we can hope to describe some of the nuances of expressions and actions which make-up the visual communication modality. With cetaceans, we are still in a very primitive stage of describing blatantly obvious events, comparable to, in human terms, the frantic waving of a hand. When we can learn to recognize a subtle wink, blush, or eye movement with consistency of expression and intent, then we can truly say that inroads are being made into understanding the visual communication of these most fascinating creatures.

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