

Possible aetiologies of yellow coloration in dolphin calves

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Abstract

We report on two incidences of yellowing of the skin and mucus membranes: one involving three wild bottlenose dolphins (*Tursiops truncatus gilli*) in Monterey Bay, California and one involving a live-stranded rough-toothed dolphin (*Steno bredanensis*) calf in French Polynesia.

The three calves in Monterey Bay were observed between April and July 1994 and appeared to be in their first month of life. They had a lemon-yellow coloration, prominent around the rostrum and mucus membranes, but evenly distributed over the body. This coloration persisted for at least 48 days, after which the calves returned to a light gray color. None of the adults, including the mothers showed any sign of yellowing.

A female rough-toothed dolphin calf that stranded in October 1997 and was estimated less than two months of age had broad yellow lateral streaks, which lightened during rehabilitation with minimal yellowing persisting for 6 months after the calf was found.

The following paper discusses some of the probable causes of the observed coloration patterns: (1) physiologic jaundice of the newborn, (2) the presence of an algal film on the skin, and (3) diet induced yellowing.

Key words: jaundice, carotenoids, diatoms, skin coloration, dolphin, calf, *icterus*

Introduction

Yellowing of skin and mucus membranes has been noted for numerous species of marine mammals, although the majority of these observations are not published. In the Pacific Northwest, wild killer whale calves (*Orcinus orca*) usually have yellow-orange eye patches and bellies (Heimlich-Boran & Heimlich-Boran, 1994). This phenomenon is so consistent that researchers in the area often use this characteristic to identify new calves (Barrett-

Lennard, pers. comm.; Parsons, pers. comm.). In 1993, a tucuxi calf (*Lipotes vexillifer*) in Ilha Grande Bay, Brazil had an orange colored throat and chest (Hetzl, pers. comm.). Adult minke (*Balenoptera acutorostrata*), blue (*Balenoptera musculus*), bottlenose (*Hyperodon ampullans*), and strap-toothed whales (*Mesoplodon layardii*) displaying a yellowish coloration have been reported (Nemoto *et al.*, 1980; Hetzel, pers. comm.). Yellow-orange coloration also has been noted in conjunction with skin lesions in free-ranging bottlenose dolphins (*Tursiops truncatus*) in the Moray Firth, Scotland (Wilson *et al.*, 1997).

Materials and Methods

We report two incidences of yellowing in free-ranging dolphins. The first was observed in a coastal bottlenose dolphin population residing between San Diego and San Francisco (Feinholz, 1996). This population has been studied since 1981 in multiple locations along the California coast (Hansen, 1990; Feinholz, 1996; Defran & Weller, 1999; Defran *et al.*, 1999). Here, wild bottlenose dolphin calves displaying a moderate to marked yellowing of the body and mouth are encountered frequently (Weller, pers. comm.; Kieckhefer, pers. comm.).

In Monterey Bay, we observed this coloration in three calves on 10 occasions in 1994. Between April and July 1994, while in close proximity to a group of bottlenose dolphins for photo-identification purposes, we were able to monitor at least three different newborn calves affected by this condition. Each calf's mother was a well-known individual, photo-identified several times in Monterey Bay (Feinholz, 1996).

The second incidence of yellow coloration in a free-ranging animal was a female rough-toothed dolphin (*Steno bredanensis*) calf, live-stranded in French Polynesia and subsequently rehabilitated at the Sea Quest facility on Moorea (Gaspar *et al.*,

2000). The calf stranded in October 1997, possibly after having been separated from its mothers, and was estimated between 4–6 months of age.

Results

All affected calves in Monterey Bay appeared to be within their first month of life, based mainly on size, the presence of fetal folds at the time of sighting, and the fact that the mothers were known individuals seen with no calf a few weeks before. The yellow coloration was detected visually and contrasted sharply with the dark gray coloring of the mothers and other adults. All calves presented the same coloration pattern and appeared lemon yellow in full sunlight. The color was more vivid around the rostrum and inside the mouth and was less pronounced, but evenly distributed over the entire body surface. The calves' mouth was visible because of the characteristic swimming pattern of neonatal dolphins, which tend to stick their head out of the water at each surfacing. The skin coloration in the calves persisted for at least 48 days (29 April to 27 July), while none of the mothers showed signs of yellowing. The same mothers were sighted with their calves after July 1994, but all calves at that time were light gray in color, indicating the yellowing was transitory.

The rough-toothed dolphin calf in French Polynesia had broad yellow lateral areas when found. These areas lightened during rehabilitation, with minimal yellow coloring persisting for the next 6 months.

Total bilirubin concentrations were measured for the stranded rough-toothed dolphin calf in blood collected routinely throughout the first six months of rehabilitation. Total bilirubin concentration was 1.5 mg/dL on October 13 (a day after the calf was found) and was higher than the normal range for dolphins, which is between 0 and 0.3 mg/dL (Sweeney, pers. comm.). Five days later, total bilirubin concentration in the calf's blood was 0.3 mg/dL, and by June 1998 it was down to 0.1 mg/dL, indicating a gradual return to levels considered normal. Because no specific tests were performed to confirm the diagnosis no final conclusions can be drawn.

Discussion

Several causes can be postulated for the yellowing of the skin in these calves. We discuss four, which we believe most closely match the observed patterns: (1) physiologic jaundice of the newborn; (2) the presence of an algal film on the skin; and (3) or diet-induced yellowing and, (4) adaptive coloration.

Firstly, physiologic jaundice of the newborn is a form of haemolytic jaundice, caused by a break-

down of red blood cells with the production of bilirubin (a yellow-brown substance), at a rate which exceeds the capacity of the liver to conjugate and eliminate it (Jubb & Kennedy, 1970; Jones & Hunt, 1983). The clinical manifestation of physiologic jaundice of the newborn, cutaneous and scleral *icterus*, can be seen in approximately one-half to two-thirds of all newborn humans on the third to the sixth days of life. In most cases, this condition, when untreated, resolves by the third to the sixteenth week of life (Gartner & Alonso, 1993).

Gartner and Alonso (1993) believe 'all species of mammals share with the human the same basic developmental phenomena that produce physiologic jaundice in the newborn human', but also state that 'the occurrence of a similar clinical manifestation or even biochemical evidence of hyperbilirubinemia in other mammals is controversial and uncertain'. Nonetheless, the phenomenon has been documented in a few species. Newborn non-human primates, for example, have a pattern of physiologic jaundice that closely parallels that of the human infant, including the transient appearance of cutaneous *icterus* (Lucey *et al.*, 1963).

Documented cases of jaundice among marine mammals include 22 premature or young harbour seal (*Phoca vitulina*) pups (≤ 10 days old) either abandoned, separated from their mothers, or stranded in the wild (Dierauf *et al.*, 1986), and a bottlenose dolphin bred in captivity which died 93 hours after birth (Thurman & Williams, 1986).

Bilirubin is not ordinarily a seriously harmful substance, although it possibly contributes to the development of necrosis of the renal epithelium. In general, accumulation of bilirubin in blood and tissues does not appear particularly harmful in the adult human or other mammals, but it does seriously affect the developing neonatal brain (Jones & Hunt, 1983).

In Monterey Bay, only visual observations of wild bottlenose dolphin calves were available. Nonetheless, the progression in the skin coloration observed in these calves parallels the pattern seen in the stranded rough-toothed dolphin calf, human infants, and other mammalian neonates affected by jaundice. The yellow coloration was, in fact, present within the first month of life, was especially apparent around the mouth, and was temporary, lasting at least 48 days.

The appearance of a yellow coloration in the Polynesian rough-toothed dolphin was associated with elevated blood bilirubin levels. It is therefore reasonable to postulate a potential, though unproven, link between these two phenomena. Meyer and Harvey (1998) stated that only bilirubin concentrations greater than 2 to 3 mg/dL impart a

yellow coloration to tissue other than plasma but these authors were not specifically referring to dolphins when making this statement.

Secondly, a variety of diatom taxa occur in patches or colonies on the skin of cetaceans (Hart, 1935; Usachev, 1940; Okuno, 1954; Nemoto, 1956; Holmes *et al.*, 1993). Several species of diatoms, such as *Cocconeis ceticola* and related forms thrive in waters 13°C or colder, and skin infestations in cetaceans tend to disappear after migration to warmer waters (Nemoto *et al.*, 1980). Infestations generally appear brown, greenish-brown or orange in color (Holmes *et al.*, 1993), and the diatoms causing them currently are considered primarily non-planctonic and found exclusively on the skin of cetaceans (Holmes & Nagasawa, 1995). In Monterey Bay, Morejohn (1980) reported observing at least 15 species of diatoms on the skin of the Dall's porpoise (*Phocoenoides dalli*), the harbour porpoise (*Phocoena phocoena*) and the Pacific white-sided dolphin (*Lagenorhynchus obliquidens*). Van Bonn and Denys (1997) reported the occurrence of 'coffee-colored' skin films of the diatom *Epipellicis oiketis* on bottlenose dolphins in San Diego Bay, California. This same diatom was reported from killer whales and Dall's porpoises north of Monterey Bay, California (Holmes, 1985).

There currently is no evidence for a distinct pattern of diatom infestation among age classes in cetaceans, and Holmes *et al.* (1993) postulated that bodily contact is the most likely form of transfer for these diatoms. No skin scrapings were collected from any of the dolphin calves that we report on. However, if the presence of an algal film is accepted as a possible explanation for the Monterey Bay bottlenose dolphin calves' yellow color, then it is unclear why the same infestation was not observed on any of the adults in the school. Perhaps the newborn dolphin skin is more sensitive to infestation, lacking the necessary defense mechanisms to prevent it.

If an algal film was the aetiology for the yellow coloration of the rough-toothed dolphin calf, despite the elevated total bilirubin concentration found in the blood, then the temperature range for these diatoms must be greater than that reported by Holmes *et al.* (1993) and Nemoto *et al.* (1980), because sea surface temperature around French Polynesia ranges between 23–26°C.

Thirdly, carotenoids are essential to the well being of living organisms and only certain microorganisms, fungi, algae, and higher plants are able to synthesize them 'de novo'. Animals, therefore, depend on a dietary supply of carotenoids (Estermann, 1994). Ingestion of high levels of carotenoids produces a markedly yellow or orange skin pigmentation in human infants, and is caused by higher than normal dietary intake of carotenoids,

which also can be transferred to an infant in breast milk during lactation (Massam & Heycock, 1981). Carotenoid concentration in human milk is extremely variable within and between individuals, depends heavily on the mother's dietary intake, and is particularly elevated in human *colostrum* (Patton *et al.*, 1990; Giuliano *et al.*, 1994; Jackson *et al.*, 1998; Liu *et al.*, 1998).

Yellowish-orange pigmentation due to high dietary intake of carotenoids was observed in minke whales from the Antarctic (Koto, 1979). Cetaceans' prey, such as fish and crustaceans are rich in carotenoids, which color their integuments and other organs yellow, orange, or red (Estermann, 1994; Torrissen, 1995; Wozniak, 1996). Over 20 different types of carotenoids have been isolated from fish, the dominant pigment being astaxanthin (Tanaka, 1978; Wozniak, 1996).

Fish and crustaceans constitute the main diet of coastal bottlenose dolphins in California (Defran & Weller, 1999) and presumably that of the rough-toothed dolphins in French Polynesia. We were not able to locate published reports on carotenoid content in cetacean milk, but we assume that dolphin mothers dispense dietary carotenoids to the newborn through milk much like other mammals.

A carotenoid induced yellowing of the Monterey Bay calves' skin would be possible if the neonates were absorbing high levels of carotenoids from their mothers' milk. Why this should be the case is presently unclear, although bottlenose dolphins in Monterey Bay occasionally feed on salmon, a prey item with potentially high carotenoid content (Simpson, 1982). This explanation is less tenable for the rough-toothed dolphin calf in French Polynesia since it may have been separated from its mother for a period of time before stranding.

Finally, the skin coloration of these dolphin calves may be adaptive, perhaps serving the function of calf recognition within the social system, or it may be in some way cryptic. Change from neonatal to adult color has been documented in other odontocetes. To name a few examples, Commerson's dolphins (*Cephalorhynchus commersonii*) are born completely brown and develop their black and white markings with age, northern right whale dolphins (*Lissodelphis borealis*) are light gray to creamy white at birth but assume the adult coloration within their first year, and belugas (*Delphinapterus leucas*) are slate grey to pinkish brown at birth and develop into a uniform blue or bluish gray as juveniles before attaining their snow white coloration as adults (Leatherwood & Reeves, 1983).

If the reported yellowing is adaptive this coloration should be common within the two species in question as it is in killer whale calves in the Pacific Northwest (Heimlich-Boran & Heimlich-Boran,

1994). Not enough data is currently available to evaluate what proportion of calves in the California dolphin population, or in rough-toothed dolphins in French Polynesia has this coloration pattern.

We ultimately cannot make any conclusive statement about the nature of the causes of the yellow coloration observed in the two cases we reported. We nonetheless note that the coloration exhibited by the Monterey calves was different from that typically observed in dolphins covered with algal films (Feinholz, personal observation), which normally are found in patches and are a darker yellow-brown color as opposed to the bright lemon-yellow observed.

It would be interesting to test the levels of bilirubin in captive calves routinely to refine what is known about the normal range for a calf. Routine collection of skin samples from stranded animals also would greatly enhance the understanding of patterns of diatom infestation. In the case of carotenoid induced pigmentation, we could not find any documented cases in mammals, other than humans, but the possibility of such an occurrence could be tested in captive animals by feeding mothers a diet high in carotenoid content during lactation. This should be done after assessing normal levels of carotenoids in dolphin milk.

Yellow coloration in dolphin calves may have a variety of aetiologies, and certainly the first two we proposed have been documented. Nonetheless, the amount of available information is very limited, and, in many cases, observations of yellow calves in various species of cetaceans are not reported.

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