

## **Depth of sperm whales' dive according to the acoustic device "Fin whale."**

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The question of the possible depth of whales dive has been raised repeatedly in the scientific literature, but is still poorly understood. For the first time such a debate raged in the pages of the British journal "Nature" (Nature ", 1935). The reader Robert W. Gray, referring to the famous observation by harpooner Willem Tribulation, Jr., pointed out that a harpooned bowhead whale calf in a vertical dive takes the line from 730 to 1100 meters, and an adult whale - from 1280 to 1460 meters. Adult bottlenose bull takes line at 1300 m, while females and young are half of that. In this discussion, Dr. F.D. Ommaney noted that statements by W. R. Gray about the vertical dives of injured whales are unfounded. He believed that whales dive to a maximum of 360 m, because they can not withstand high water pressure. In the 40-s - 60-s P.F. Sholander (Hvalradets Skrifter, No. 22, Oslo, 1940) based on observations by whalers and his own, claimed that bottlenoses can stay underwater for up to 2 hours, and sperm whales for about an hour. After exploring the muscle tissue of these species of whales, P.F. Sholander found that they contain a large amount of oxygen. The assumption has been confirmed that while staying under water, the supply of oxygen in muscle tissue is sharply reduced because of the special system of blood vessels, so-called "miracle network." This gave reason to believe that whales can dive deeper. Problems with diving of marine mammals are widely considered in domestic literature (Tarasov, 1935, 1938; Yablokov, 1962, 1965, Berzin, 1970; etc.).

Let's consider the known facts of whales dive depth, rather than assumptions and theoretical arguments. So, harpooned fin whale dived and broke his neck vertebrae on the bottom, which was located at a depth of 502 m (Wood, 1979). In 1957, VS Hizen (Heezen, 1957) in the journal "Deep Sea Research" reported on 14 cases where sperm whales entangled in underwater cables. In fact, in six cases, the cables were lying at great depths - from 900 m to 1100 m.

For the instrumental determination of the depth of diving whales, already mentioned above P.F. Shondler constructed a primitive, but quite a clever device, a glass capillary tube and the dye. After testing the device, P.F. Shondler attach it to a harpoon for hunting fin whales. The device showed that harpooned fin whale dived to a depth of 365 meters. Other fin whale, received fatal injuries, sank to 230 meters. With the help of sensors attached to the body of a whale on a rubber suction cup, a dive of fin whales in the Mediterranean Sea at a depth of 450 m was recorded (Panigata et al., 1999). That is, the maximum diving depth of the baleen whales was within 500 meters.

For commercial purposes (and not scientific) in the seventies on whaling ships of the Soviet fleets were established acoustic devices "fin whales." The instrument kit not only detects whales, but also determine the depth of their location under water. Talking about the possibilities of this device, it should be noted that it has the "dead" zone down to 40 meters. At a high speed of a vessel it was impossible to detect whales due to high level of hydrodynamic noise. Because of the pitching of the vessel on strong waves the contact with whales became unstable. Good results were obtained at swell up to 4-6 points and vessel speed of 8 knots.

Naturally, most attention was paid to sperm whale, which can spend long time under water, so it is harder to locate them during whaling. We provide in this summary report data about 876 sperm whales, detected under water. All these whales were caught: 677 of them were males and 199 females. It is clear that at the time when they were located under water not all of them were at an extreme point of its immersion: sperm whale could be located both at the time of diving and at the time of emerging. Also we should note the frightening effect of acoustic stations – when they

were turned on the whales (especially baleen ones) immediately began to emerge. Therefore, the recorded points do not indicate the final depth of diving did not accurately define the horizon, where the whales hunt and feed. Also some other factors affect the accuracy of determining of the immersion depth of the whales: the hydrological conditions, presense of plankton, large aquatic organisms (such as squid and fish, which is especially characteristic of the Antarctic waters), the experience of the operator of acoustic instrument.

Based on this numerical data we have constructed a variational series of sperm whale depth distribution of different length, with the class interval of one meter. The average depth at which the male sperm whales were recorded, was as follows:

Size class, m	10.1-11.0	11.1-12.0	12.1-13.0	13.1-14.0	14.1-15.0	15.1-16.0	16.1-17.0	17.1-18.0
Number of measurements	10	19	109	242	212	70	13	2
Average depth, m	385	450	442	454	522	519	642	725

Not clearly expressed, but noticeable that on average the larger the sperm whale, the greater depth, he dives. Average depth of dives to all male sperm whale was 677 meters, the maximum recorded diving depth was 1600 m. Also the depths more than 1000 m for male sperm whales were recorded 42 times, which is to 6.2%. Between limits from 1000 m to 1600 m the depth frequency was as follows:

Depth, m	1000	1100	1200	1300	1400	1500	1600
Number, n	14	11	8	4	2	2	1
Occurrence, %	2,0	1.6	1.2	0.6	0.3	0.3	0.15

Range of sizes of females sperm was divided into three classes: 9-10 meters 10-11 meters 11-12 meters. Average depth of dives was significantly lower than in males, and was 334 meters. The reason may be not only in the fact that females are twice smaller than males, but that they live in lower latitudes, where the concentration of food objects (squid and fish) are at higher horizons. The peculiarities of sperm whale feeding at different latitudes should be considered separately at a much larger material. In the first size class of females dive depth was recorded in 34 cases. The maximum depth was 800 meters. The average value was equal to 319 meters. Pregnant and lactating females in this class amounted to 9,1 percent. Most female sperm whale dives recorded in the second size class - 130 measurements (pregnant and lactating females accounted for 68,2%). The depth of dives, on average, was equal to 350 meters, and four females were found at a depth of 750 meters, and two - at a depth of 800 meters. The depth of dives of the largest females (35 measurements), was somewhat less and averaged 292 m. The percentage of pregnant and nursing among them was 22,7%. From this material it is not noticeable that pregnant and lactating females dive to a smaller depth. It is necessary to collect much more material to compare the depth of dive separately barren and pregnant females separate sperm.

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