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True Hermaphroditism in a St. Lawrence Beluga Whale (*Delphinapterus leucas*)

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ABSTRACT: A hermaphrodite beluga whale (*Delphinapterus leucas*) was found in the St. Lawrence Estuary, Québec, Canada. This animal had two testicles, two separate ovaries, and the complete ducts of each sex; cervix, vagina and vulva were absent. Mature spermatozoa were found in the lumen of seminiferous tubules in the testicles, and numerous involuted corpora lutea were recognized in the ovaries. This represents the first case of true hermaphroditism in a cetacean, and is the fourth hermaphrodite mammal with two testicles and two separate ovaries.

Key words: True hermaphrodite, beluga whale, *Delphinapterus leucas*.

In the course of a study on the pathology and toxicology of stranded beluga whales (*Delphinapterus leucas*) in the St. Lawrence Estuary, Québec, Canada, a 4.16-m-long animal weighing 1,045 kg was found drifting at Ste-Flavie (48°39′N, 68°17′W). It appeared externally to be a male, and was transported to the University of Montreal and necropsied. Sections of skin, lungs, mediastinal lymph nodes, heart, aorta, kidneys, spleen, adrenals, the four gastric compartments, intestine, testes, ovaries, uterus, and urinary bladder were fixed in 10% neutral buffered formalin, embedded in paraffin, cut into 5 μm sections and stained with hematoxylin, phloxin and saffron (Luna, 1968). Age was determined by tooth section (Sergeant, 1973). A spondylosis ankylosans, an ulcerative enteritis, gastric papillomas and a periodontitis also were found in this animal aged >26-yr-old.

The penis was normally located in the genital slit, halfway between the anus and the umbilicus. Internally, two small testicles, 350 g and 400 g respectively, were found, along with normally located epididymis and vas deferens. A complete female genital tract also was present. An ovary was located dorsally to the caudal pole of each testicle (Fig. 1). Ovaries measured 4 × 3 × 2 cm, had an irregular surface, with reddish nodules resembling corpora hemorrhagica, and were hidden in an ovarian bursa (Fig. 2). Uterine horns, 1 cm in diameter and prolonged by a short uterine tube, followed their normal course, fusing into a 4-cm-long uterine body (Fig. 3). The abdominal urethra formed a urinary meatus where it joined the uterine body, and the urethra and the uterus both opened into the beginning of the penile urethra. Thus, this animal had two testicles, two ovaries, and the complete ducts of each sex; cervix, vagina and vulva were absent. Examination of mammary glands was omitted.

Histologically, mature spermatozoa were found in the lumina of seminiferous tubules in the testicles (Fig. 4). Despite moderate to severe autolysis, numerous involuted corpora lutea were recognized in the ovaries. These appeared as irregular nodules ≤5 mm in diameter showing various



FIGURE 1. The left ovary (long arrow) of the beluga whale was located dorsally to the caudal pole of the testicle (T). The uterine horns (short arrow) and the penis (P) also are seen.

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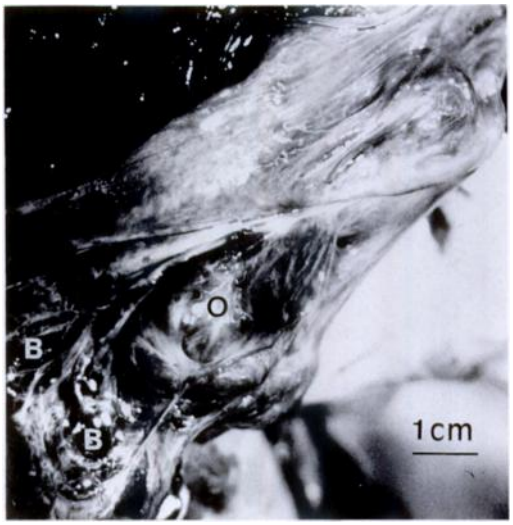


FIGURE 2. The right ovary (O) of the beluga whale was located in the ovarian bursa (B) and had an irregular surface.

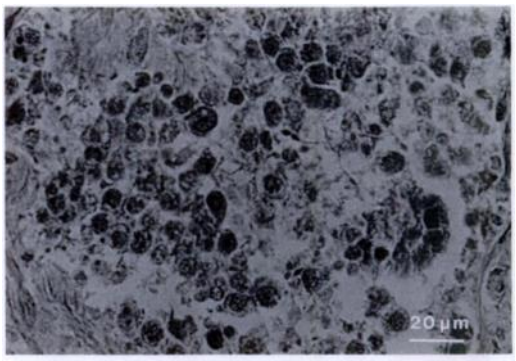


FIGURE 4. Mature spermatozoa in the lumen of an autolyzed seminiferous tubule of the beluga whale. Hematoxylin, phloxin, saffron stain.

degrees of fibrosis in the ovarian parenchyma (Fig. 5). Remnants of large cells (luteal cells) were recognized in these nodules. Also, some small cysts probably corresponded to follicles. Autolysis of the uterus was severe and the mucosa was totally desquamated. Unfortunately, a karyotype was not done on this animal because of autolysis and lack of unfixed frozen tissues.

Hermaphroditism is a rare condition in animals. Pseudohermaphroditism already has been reported in a bowhead whale (*Balaena mysticetus*) (Tarpley et al., 1990), a fin whale (*Balaenoptera physalus*) (Bannister, 1962) and a dolphin (*Prodelphinus caeruleoalbus*) (Nishiwaki, 1953), but true hermaphroditism has never been reported in a cetacean.

True hermaphroditism can be bilateral (two ovotestes), unilateral (one ovotestis), or lateral (an ovary and a testicle) (Tangner et al., 1982). The present case, two rabbits (Sheppard, 1943; Frankenhuis et al., 1990) and a pig (Walentowicz, 1888),



FIGURE 3. The opened uterine horns (arrows) of the beluga whale were fused into a short uterine body (B). The scissors were inserted in the abdominal urethra to show the urinary meatus (point of insertion of the scissors), just proximal to the entry into the penis (under the visible part of the scissors).

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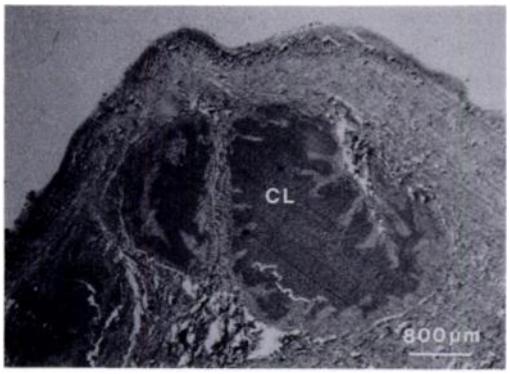


FIGURE 5. Three involuted corpora lutea (CL) of the beluga whale appeared as irregular nodules up to 5 mm in diameter in the ovarian parenchyma. Hematoxylin, phloxin, saffron stain.

with separate gonads of both sexes on each side, probably should be classified as atypical bilateral hermaphrodites.

Speroff et al. (1989) summarized the normal development of the genital tract. Normally the genetic sex is fixed at the time of fertilization, and then imposed on the undifferentiated bipotential gonad. The conversion of this gonad to a testis would require a single gene determinant on the Y chromosome, the testis determining factor (TDF). This gene produces a protein that would be the "master switch" for male differentiation because of its capacity to activate the expression of other genes elsewhere on X, Y, and autosomes, including the H-Y locus (or loci). These H-Y genes code for the H-Y antigen invariably expressed in individuals with testes. In the absence of a Y chromosome, the undifferentiated gonad develops into an ovary. The formation of the testicle precedes and controls any subsequent sexual development (Speroff et al., 1989).

Duct primordia of both sexes coexist temporarily. In males, mesonephrotic ducts develop under the influence of androgens, while the Müllerian inhibiting factor (MIF) induces the regression of the paramesonephrotic ducts. In females, the lack of MIF allows development of the paramesonephrotic ducts, while the mesonephrotic ducts regress without testosterone. Bipotential external genital primordia develop as male under the influence of dihydrotestosterone, or as female in its absence.

In the present case, male development would have been complete. The simultaneous development of separate ovaries must have required the duplication of the undifferentiated bipotential gonads, with a lack of response of the future ovaries to TDF. The development of the paramesonephrotic ducts into a uterus must reflect a lack of MIF, a deficient timing in MIF production, or a lack of response to it (Sommer and Meyers-Wallen, 1991). The absence of vulva and outer vagina is expected since they originate from the single external genital primordia that developed as male, but the absence of cervix and inner vagina remains unexplained.

Questions arise about the hormonal balance that would allow simultaneous testicular and ovarian activity in this animal, but pregnancy has already been noted in true hermaphrodite individuals: a sow (Hulland, 1964), a dog (Selden et al., 1978), a few humans (Williamson et al., 1981) and two rabbits (Sheppard, 1943; Frankenhuis et al., 1990), in one of which autofertilization occurred (Frankenhuis et al., 1990).

To our knowledge, this case of true hermaphroditism in a beluga whale represents the first report of this condition in a cetacean, and is the fourth report in animals or humans of coexistence of distinct pairs of testes and ovaries in the same individual; no clear explanation could be provided for this phenomenon.

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