

# An Annotated List of Extant Skeletal Material of Steller's Sea Cow (*Hydrodamalis gigas*) (Sirenia: Dugongidae) from the Commander Islands

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## Abstract

A new survey has permitted us to ascertain that at least 27 skeletons, 62 additional skulls, and more than 550 bones of *Hydrodamalis gigas* from the Commander Islands are currently stored in 51 museums in 42 localities. It is possible that only two to four skeletons originate from a single individual. The other skeletons are assemblages of bones from two to 16 animals. After 27 years of heavy persecution, the Steller's sea cow was exterminated in about 1768. For decades after extinction, no osteological evidence indicated the existence of *H. gigas*. The first bones were likely retrieved shortly before 1840, the first partial skull was collected in 1844, and the first skeleton was unearthed in 1855. Most of the skeletal remains were found under the supervision of N. A. Grebnitskiy, A. E. Nordenskiöld, B. Dybowski, and L. H. Stejneger. One skeleton and several bones have also been collected in recent decades.

**Key Words:** *Hydrodamalis gigas*, Steller's sea cow, skeletons, skulls, museums, extinction, Commander Islands

## Introduction

The Steller's sea cow (*Hydrodamalis gigas*) was discovered in 1741 by the crew of Captain Vitus Bering's ship, *Sviatoi Petr* (*St. Peter*), near one of the Commander Islands. Only 27 years later, the species was exterminated by fur hunters (Sauer, 1802; Brandt, 1868; Stejneger, 1887; Gibson, 1999, 2002). For decades thereafter, explorers stopping at the Commander Islands did not find any solid evidence of the existence of this sirenian. In the early 19th century, belief in extinction gained ground (von Baer, 1840), and high museological interest arose.

The aims of this paper are (1) to provide a comprehensive inventory of the skeletal material preserved in museum collections and (2) to reconstruct the main events of the search and discovery of the sea cow remains. At the present, a partial and dated inventory exists, with modest additions (Kleinschmidt, 1951, 1982, 1983). This appears to be the first historical reconstruction of the quest for skeletal material of Steller's sea cow.

## Materials and Methods

The survey was conducted by preparing a simple questionnaire (Table 1). This questionnaire was submitted to museums worldwide, particularly to institutions (1) known from literary sources to possess *Hydrodamalis* remains, (2) indicated by colleagues involved in research on sirenians or in museology, or (3) selected for their historical or geographical connection to the Commander Islands and their exploration.

Each museum is indicated by its original name (where necessary, the English translation) and, when present, the internationally recognized acronym.

Historical information derived from both the collection survey and literature has permitted us to draw the historical background and particularly to reconstruct the most important moments of the search for skeletons of Steller's sea cow.

## Results

### *Inventory*

*Extant Specimens*—The main results of the survey are summarized in Tables 2 to 5. Recent or subrecent skeletal remains of *Hydrodamalis gigas* are presently preserved in at least 51 institutions at 42 localities in 16 different nations. The number of institutions rises to 55 if collections with lost specimens are considered: 38 in Europe (including European Russia), eight in Asia (including the

**Table 1.** Questionnaire

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Does your museum have a skeleton of <i>Hydrodamalis gigas</i> ?
Is it a complete or partial one?
How many vertebrae are preserved?
Is it mounted?
Is it a composite one (i.e., assembled from different individuals) or an associated one (i.e., originating from one individual)?
Are additional skulls or bones stored as well?
Is it possible to reconstruct the origin of the preserved skeletal material (date of collection; of acquisition by the museum; name of the collector, the donor, or the seller)?

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Russian Far East), eight in North America, and one in Australia. Skeletons are now stored in 24 museums, additional skulls are preserved in 25 museums, and ten collections have only one or a few bones.

Twenty-seven partial or nearly complete skeletons exist. Additional complete or substantially complete skulls number at least 62. The Washington and St. Petersburg museums have the richest collections, with 19 and 13 specimens, respectively. Aside from skeletons and skulls, several collections store more than 550 other bones, mainly vertebrae and ribs.

*Lost and Undocumented Specimens*—To the 27 extant skeletons, six to seven other skeletons may be added to take into consideration lost specimens. The overall number of documented collected skeletons is thus 33 to 34. Three skeletons that were likely destined for the Academy of Sciences in St. Petersburg were lost with the 1882 sinking of the steamship *Moskva* in the Gulf of Aden (Tanasychuk, 2002). A supposedly composite skeleton, donated by B. Dybowski to the University of Warsaw, was lost when moved to an unknown destination (Brzęk, 1994). A skeleton donated to San Francisco was destroyed by the fire following the 1906 earthquake (Stejneger, 1893). Two skeletons were lost to bombing in Germany (Hamburg and Munich) in 1943. A skeleton found in 1891 and said to be “very nearly complete” was acquired in 1892 for the Smithsonian Institution in Washington (U.S. National Museum of Natural History: USNM) (Evermann, 1893), but only parts of this specimen are now identifiable in the USNM collection (see Table 2).

A skull was lost in Warsaw in 1944 (Kazubski, 1996). There are also several skulls on record for which we have no recent information: the skull in Vladivostok illustrated by Anonymous (1911), three skulls recovered in 1967 by Chelnokov (1969), and the possibly stolen skulls seen by Furusawa (1995) at the Aleut Museum on Bering Island.

*Composition of Specimens*—Almost all the preserved skeletons are composite, derived from the assembly of bones of different individuals. Only the specimens stored in Helsinki and Nikolskoye (Bering Island) are considered to be genuinely

associated (von Nordmann, 1862; Rich, 1983; Domning, 1984), although the mounted skeletons in St. Petersburg and Lvov and an unmounted specimen in Paris are also likely to derive in whole or in part from single individuals. The Washington specimen is derived from up to 16 individuals (J. Gold, pers. comm., 2004), and the Vienna specimen is from about 12 (von Lorenz, unpublished note, 1897). Of the 27 extant skeletons, 11 are almost complete and mounted, seven are partial and mounted, and nine are not mounted. The rarest bones are the sternum and the innominate (rudimentary pelvis), present respectively in nine and five collections. To date, not a single element of the manus of *H. gigas* has been recovered. A bone identified by Nordenskiöld (1885) as a metacarpal has been shown to be the transverse process of a sacral vertebra (Domning, 1978).

For about 20 of the 54 institutions that presently possess or formerly possessed Steller’s sea cow remains according to this survey, there was no previously published information; while for others, there were only vague or scanty reports scattered in diverse sources.

*Geographic Origin*—All of the above specimens are Recent or subrecent specimens from the Commander Islands. There are also indications of the sea cow’s occurrence in the western Aleutians—at Attu in the Near Islands, with apparent survival into historic times (Domning, 1978), and at Kiska in the Rat Islands, where a rib was recently collected (J. Thomason et al., in prep.). Savinetskiy et al. (2004) report the recent discovery of *Hydrodamalis* remains at archaeological sites on two Aleutian islands—Buldir in the Rat Islands and Adak in the Andreanofs. Pleistocene fossils of *H. gigas* are reported from Honshu, Japan (Furusawa & Kohno, 1994); Amchitka Island, Alaska (Whitmore & Gard, 1977); and Monterey Bay, California (Jones, 1967). These are not included in Table 2. They serve, however, to document the prehistoric range of *Hydrodamalis*, which extended from Japan to Baja California (Domning, 1978).

#### *History*

*The Fur-Hunting Period*—After 1743, the Commander Islands were regularly visited by fur

**Table 2.** Skeletal remains of *Hydrodamalis gigas* ordered by localities and museums, with some details on their origin

City/town	Institution	Specimen/type of bones	Origin	Literary source	Other sources
Basel	Naturhistorisches Museum (Natural History Museum) (NMB)	1 skull with mandible	Donated by Dr. A. Bunge, zoologist and explorer; Dorpat (presently Tartu), in 1890	Kleinschmidt, 1982; Pilleri, 1988	B. Engesser, 2004; A. Miljutin, 2005
Berkeley	Museum of Paleontology, University of California (UCMP)	1 skull (23001), 1 other skull and incomplete skeleton (23050) (41 vertebrae, 4 cervicals, 19 thoracics, 4 lumbo-sacral, 14 caudals), including right innominate; 3 other isolated periotics and numerous ribs	Property of Alaska Commercial Company; donated in 1904	Donning, 1978	P. Holroyd, 2004
Berkeley	Museum of Vertebrate Zoology, University of California (UCMVZ)	1 skull with mandible (107764)	Property of Alaska Commercial Company; donated originally to the Museum of Paleontology	Donning, 1978	P. Holroyd, 2004
Braunschweig	Staatliches Naturhistorisches Museum (SNMB)	1 almost complete skeleton, composite, 7.05-m long; mounted; 84 original bones, 60 vertebrae (7+19+8+26), of which 13 artificial, 27 ribs; includes right innominate	Found by Brasche in 1900; donated by A. Dattan from Vladivostok	Kleinschmidt, 1951	G. Pohl, 2004
Budapest	Magyar Természettudományi Múzeum (Hungarian Natural History Museum) (MINH)	1 skull with mandible	Donated by the Zoological Museum of Leningrad in 1957	Csorba et al., 2004	G. Csorba, 2003
Cambridge (UK)	University Museum of Zoology, Cambridge (UMZC)	1 very incomplete skeleton (C.1020 and C.1021) (1 skull, 1 mandible, 16 dorsal vertebrae, 1 caudal vertebra, 1 humerus, 1 radius-ulna)	Exchange with Washington, 1887	Clark, 1889	A. Friday, 2004
Cambridge, Massachusetts (USA)	Museum of Comparative Zoology (MCZ)	1 skull 1 almost complete skeleton (59412), composite, mounted, 5.65-m long, with many elements artificial; 52 vertebrae of which 27 artificial; 36 ribs of which 15 artificial	Donated by Guillemard, 1884 Exchange with Washington, 1890 or soon thereafter		A. Friday, 2004 J. Chupasko, 2005
Darmstadt	Hessisches Landes Museum, Zoologische Abteilung (HLD)	1 skull	No data	Kleinschmidt, 1983	U. Joger, 2003

Dresden	Museum für Tierkunde (MTKD)	1 incomplete skeleton (B 2076) (78 total bones), composite (35 vertebrae, of which 6 cervicals, 19 thoraco-lumbar, and 10 caudals; 36 ribs, 1 scapula, 2 humeri, 1 radius-ulna), originally 5.2-m long, mounted; includes the sternum, 9 ribs, 1 basioccipital	Skull collected by O. Herz in 1890 and acquired by the Museum in 1891; post-cranial skeleton obtained in 1903; requisitioned by Soviet Army in 1945 and brought to Moscow; returned in 1982; donated by U. Wannhoff in 1992 and 1996	Jacoby in Kleinschmidt, 1951; Feiler, 1999; Stefen, 2003	F. Uwe, 2002; C. Stefen, 2003
Edinburgh	Royal Museum (NMS)	1 partial skeleton (NMSZ 1956.57.1); skull and mandible on display; post-cranial portion disarticulated since 1995	Bought from T. Simitis in 200 rubles by D'Arcy W. Thompson in 1897 on Medny Island for the Queen's College of Dundee; transferred in 1956 to Edinburgh	Thompson, 1958	A. Kitchener; J. Herman, 2005
Ekaterinburg	Munitsipalnyi Muzei Istorii Ekaterinburga (Municipal Museum of History of Ekaterinburg)	1 rib	Donated by S. G. Kondrashin, diver, in 1989		A. A. Lissovsky, 2004
Göteborg	Naturhistoriska Museet (NHMG)	1 incomplete skeleton (4582), partly mounted, 1 partial skull, 38 vertebrae (5 cervical, 19 thoracic, 14 lumbo-sacral and caudal), 1 scapula, 2 humeri, 1 radius-ulna, 13 right costae, 7 left costae	Donated by Nordenskiöld; collected in 1879	Nordenskiöld, 1885; Kleinschmidt, 1983	F. Johansson, 2003
Hamburg	Zoologisches Museum (ZMH)	1 skeleton	Acquired between 1906 and 1915; destroyed in 1943	Mohr, 1950; Kleinschmidt, 1951	H. Schliemann, 2003
Hannover	Niedersächsischen Landesmuseums, Naturkunde Abteilung (NLMH)	1 skull with mandible	Sold to the Museum by R. E. Hoffmann for 600 Marks in 1904		K. Gesterding, 2005
Helsinki	Luonnontieteellinen Keskusmuseo (Finnish Museum of Natural History) (UZMH)	1 mounted skeleton of a subadult, almost complete (710), 5.3-m long, 58 vertebrae (5 caudals are artificial), 17 pairs of ribs, sternum	Donated in 1860 by J. H. Furuholm, governor of Alaska from 1859 to 1864	Nordmann, 1862	R. A. Vaisanen, 2003
Hildesheim	Roemer- und Pelizaeus-Museum	1 skull, on loan to Braunschweig since 1982	Sold by the Ruhe-Company in Alfeld/Leine in the 1880s	Kleinschmidt, 1982	J. Vespermann, 2004
Irkutsk	Oblastnoi Kraevedcheskii Muzei (Regional Lore Museum)	1 partial skeleton from 4 individuals (56 bones); includes sternum, 1 additional skull	Found in 1879 under order of N. Grebnitskiy	Vaksmut, 1899; Isakova, 2002	E. V. Novomodniy, 2003; O. Elina, 2004
Khabarovsk	Gosudarstvennii Muzei Dalnego Vostoka im. N. I. Grodekova (N. I. Grodekov State Museum of Far East)	1 partial skull and partial skeleton; originally 6.14-m long, 97 bones, now reduced to 4.65 m; 43 vertebrae, right innominate	Found in 1895; brought to Khabarovsk in 1897; damaged during World War II	Vaksmut, 1899; Grevè, 1905; Birulia, 1929; Kleinschmidt, 1951; Sysoeva, 2001	E. V. Novomodniy, 2003

Kharkiv	Muzej Prirody Kharkhivs'kogo Natsionalnogo Universitetu im. V. N. Karazina (Nature Museum at the V. N. Karazin Kharkov National University)	1 skeleton (7628), composite, mounted; 23 original vertebrae (5 cervical, 18 thoraco-lumbar), caudal portion artificial; 2 scapulae, left humerus, left radius-ulna, 2 complete ribs, 3 incomplete ribs; sternum 2 ribs	Donated in 1971 and 1978 by the University of Lvov; restored and mounted by V. N. Svistun in 1988; displayed since 1989	L. Shevchenko, 1982; V. Krivolapov, 2003
Kyiv	Zoolohychnyi Muzej Kyivskoho Natsionalnogo Universitetu imeni Tarasa Shevchenka (Zoological Museum of the Shevchenko National University) (ZMKU) Naukovo Prirodnychoho Muzei Natsionalnoi Akademii Nauk Ukrainy (Palaeontological Museum, Museum of Natural History of the National Academy of Sciences of Ukraine) Museum Zoologiczne Uniwersytetu Jagiellonskiego (Zoological Museum, Jagiellonian University) (MZUJ)	1 almost complete skeleton (1936642), composite, mounted, 6.53-m long, 58 vertebrae (7+19+32), 19 pairs of ribs, sternum 1 skeleton (0001), composite, 5.72-m long, 54 vertebrae (6+19+29, of which 9 terminal caudals artificial), sternum	Collected in 1979 by L.V. Korabelnikov, former Director of the Museum Collected probably by B. Dybowski in 1882; brought to Lvov; transferred to Kiev in 1951 Collected by B. Dybowski in 1882; brought to Lvov in 1884; transferred to Kiev in 1955; mounted in 1966	V. Krivolapov, 2003 L. Shevchenko, 1982; A. E. Zukov, 2003; O. Bidzilya, 2005 L. Shevchenko, 1982; D. V. Ivanoff, 2003; Y. A. Semenov, 2005
Kraków		1 skull	Donated by B. Dybowski in 1893; collected in 1882; from 1906 to 1969, moved to the Zoological Museum of the Polish Academy of Sciences	J. Wojtusiak, 2002
London	Natural History Museum (BMNH)	1 complete skeleton (ZD1984.2092), composite, mounted, 5.94-m long; skull and mandible, 52 vertebrae (10 plaster replicas: C6, C7, L7-L12, L15, L16), 18 pairs of ribs (one plaster on right side), left and right scapula, humerus, radius-ulna 1 incomplete skeleton (no registration number) (25 genuine vertebrae, partial humerus, partial scapula, partial mandible, skull fragment) 2 skulls (one complete without mandible, C.1947.10.21.1; 1 partial, no registration number)	Sold by R. Darnon in 1885 for £200 (acquired in 1882 through B. Dybowski?); mounted by E. Gerrard Woodward, 1885	M. C. Sheldrick, 1981; A. Riedel, 1982; R. C. Sabin, 2005 M. C. Sheldrick, 1981; R. C. Sabin, 2005 M. C. Sheldrick, 1981; R. C. Sabin, 2005

	2 ribs		Sent by N. Grebniatskiy in 1878	Vaksmut, 1899; Lucas, 1891	M. C. Sheldrick, 1981 R. C. Sabin, 2005
	1 os petrosium with tympanic annulus, 1 complete mandible 2 tympanic bones		No data		
	1 incomplete skeleton (5863), mounted, 3.80-m long; 6 cervical, 19 thoracic, 5 lumbo-sacral, no caudal; 13 ribs		No data; transferred from Geology Department		
Lund	Zoologiska Museet (Museum of Zoology) (ZMLU)		Donated in 1882 by Nordenskiöld; collected in 1879; assembled by Holmqvist	Nordenskiöld, 1885; Kleinschmidt, 1983; Kärnefelt & Bengtson, 2004	S.-A. Bengtson, 2002; R. L. Lundqvist, 2005
Lviv	Zoologichnyi Muzei Lvivskoho Natsionalnoho Universytetu imeni Ivana Franka (Benedykt Dybowski Zoological Museum, Ivan Franko National University of Lvov)	1 almost complete skeleton (3464), 6.20-m long, 54 vertebrae (the last artificial), 6 cervical vertebrae, 19 pairs of ribs	Found before 1903 by T. Sinitin; brought to Lvov in 1904 by Prof. J. Morozewicz as a gift to B. Dybowski by Aleuts	Domaniewski, 1954; Sukhanov & Manzi, 1986; Brzęk, 1994	I. V. Shostakovskaya, 1982; I. Shydlovskyy, 2003
	78 bones: 4 incomplete skulls, 3 man- dibles, 2 scapulae, 7 humeri, 4 radius- ulnae, 33 complete vertebrae, 20 partial vertebrae, 5 ribs; the innominate bone illustrated by Lorenz (1904) is now absent		Collected probably by B. Dybowski in 1882		I. V. Shostakovskaya, 1982; I. Shydlovskyy, 2003
Lyon	Musée d'Histoire Naturelle	1 almost complete skeleton (50002637), 5.60-m long; 49 vertebrae (6 cervicals, 19 thoracics, 24 lumbo-sacral-caudals), partial right innominate; composite, mounted up to 2004	Collected under order of N. Grebniatskiy in 1897; donated in 1898 via San Francisco, thanks to De Lalande and V. Artsimovich	Jousse et al., in press	M. Philippe, 2002, 2005; H. Jousse, 2005
Manchester	Manchester Museum	1 skull with mandible (50001007) 1 skull (50002635) 1 mandible (50002636) 1 vertebra	Collected under order of N. Grebniatskiy	Jousse et al., in press	M. Philippe, 2002, 2005; H. Jousse, 2005 R. Smith, 2005
Monaco	Musée Océanographique	1 skull with mandible, right scapula, right humerus, left radius-ulna, 1 lumbar vertebra, 1 rib	Possibly acquired in 1906, together with casts of a skull and of post- cranial bones		
Montreal	Redpath Museum, McGill University	1 mandible, 2 vertebrae, 2 humeri, 1 radius-ulna	Donated by J. Nussbaum- Hilarowicz, University of Lvov, in 1910; from the collection of B. Dybowski		F. Boriero, 2004

Moskva	Zoologicheskii Muzei (Zoological Museum) (ZMUM)	1 skeleton (1076), 5.40-m long, skull, mandible, left and right scapulae, humeri, and radius-ulnae, 57 vertebrae (6 cervicals, 19 thoraco-lumbar, 32 caudals), 36 ribs 23 bones: 4 partial braincases, 2 rostra, 3 mandibles, 6 hemimandibles, 2 squamosals, 1 thoracic vertebra, 2 scapulae, 3 radius-ulnae 61 bones: 29 ribs, 24 vertebrae, 2 scapulae, 2 humeri, 2 radius-ulnae, 1 mandible, skull fragment 4 dozen bones, including at least 2 braincases 25 ribs, 1 partial mandible Some bones (including 1 mandible and 1 hemi-mandible)	Donated by the Russian-American Company in 1837 by N. B. Isakov, according to the catalogue; more probably around 1860 Partly collected by O. L. Rossolimo and I. Dubrovo in 1960 to 1974 Collected in 1991 by zoologist P. D. Sarichev; donated in 1992 No available data Collected in 1991 by A. B. Savinetskiy Collected in 1979 by I. Kirillova, palaeontologist Destroyed in 1943 Received before 1903 Donated by J. Merriam (Berkeley) in 1914 Found in 1983 by A. Grekov Collected by H. Furusawa No data	Brandt, 1868; Grevé, 1905 O. L. Rossolimo, 1982; I. Y. Pavlinov, 2002 S. Pantulina & L. Levik, 2004 I. A. Dubrovo, 2004 Savinetskiy, 1992; Savinetskiy et al., 2004 A. B. Savinetskiy, 2004 A. Miljutin, 2005; I. Kirillova, 2006 R. Kraft, 2004 R. Kraft, 2004 J. P. Alexander, 1984 N. Tatarenkova, 2002 V. A. Lobkov, 2003
München	Zoologische Staatssammlung (ZSM)	1 skeleton	Destroyed in 1943	Firtkau, 1976; Kleinschmidt, 1982
New York	American Museum of Natural History (AMNH), Department of Vertebrate Paleontology	1 skull 1 skull	Received before 1903 Donated by J. Merriam (Berkeley) in 1914	Sysoeva, 2001 R. Kraft, 2004 J. P. Alexander, 1984
Nikolskoye, Bering Island	Aleutsky Kraevedcheski Muzei (Aleut Museum of Local Lore)	1 incomplete skeleton of a young individual; 23 vertebrae, 17 left ribs, 1 left scapula, humerus, radius-ulna 2 premaxillae, 1 scapula	Found in 1983 by A. Grekov Collected by H. Furusawa	Rich, 1983 Furusawa, 1995
Numata-cho, Hokkaido	Numata Fossil Laboratory	1 skull	Collected by H. Furusawa	Furusawa, 1995
Odessa	Zoological Museum, National University	1 skull	No data	V. A. Lobkov, 2003

Ottawa	Canadian Museum of Nature (CMN)	1 partial skull, sternum, 22 vertebrae, 5 ribs, 2 scapulae, 1 humerus, 1 radius-ulna	Collected under N. Grebnitskiy in 1891	M. Gosselin, 2004
Paris	Museum National d'Histoire Naturelle (MNHN)	1 skeleton (A.14516), composite, complete, 6.47-m long, mounted; 36 ribs (2 artificial), 61 vertebrae (7 cervicals, 19 thoracics, 8 lumbar, and 27 caudals; 15 caudals are artificial)	Possibly found in 1894; bought in 1895	F. Renault, 1982; D. Robineau, 1982; J. Roche, 1982; E. V. Novomodni, 2004; C. Lefèvre, 2005
Petrovavlovsk-Kamchatka	Kamchatskii Oblastnoy Kraevedcheskii Muzei (Kamchatkan Museum of Local Lore)	1 incomplete skeleton (A.14228), possibly from one individual, not mounted (56 vertebrae, 36 ribs)	Found in 1895; brought to Khabarovsk in 1898 and sold for 5,000 francs in 1903	D. Robineau, 1982; C. Lefèvre, 2005
San Francisco	California Academy of Sciences, Academy Museum	1 skull	One given as exchange in 1886 by USNM, Washington, from the Stejneger collection	E. V. Novomodni, 2004
Sankt Peterburg	Zoologicheskii Muzei Rossiskoi Akademii Nauk (Zoological Museum of the Russian Academy of Sciences) (ZMAS)	1 complete skeleton, mounted in 1892; destroyed by earthquake and fire, 16 April 1906. Casts of 2 lumbar transverse processes made for Stejneger in 1883; copies preserved in Washington (USNM 218325) and in Wien	Property of Alaska Commercial Company; collected in 1881-1882	Holder, 1893; Stejneger, 1893; Lorenz, 1904; Domning, 1978
Stockholm	Naturhistoriska Riksmuseet (NHRM)	1 almost complete skeleton (O.3445), 6.86-m long; 60 vertebrae (7 cervicals, 19 thoracics, 3 lumbar, 1 sacral, 30 caudals of which 5 are artificial)	Found in 1855; sent by A. Gusev in 1856; gift of the Russian American Company	R. A. Pierce, 1981; G. F. Baryshnikov, 2003
		Palatine rostral pad	Sent by G. W. Steller in 1743; re-discovered by J. F. Brandt in 1832	Brandt, 1833
		Several bones: 13 skulls, 13 vertebrae, 3 ribs, 10 limb bones	Collected by I. Voznesenskiy, 1844 and 1846; Russian-American Company, 1848; Semashko, 1851; Filippus, 1878; N. Grebnitskiy, 1883-1884	G. F. Baryshnikov, 2003
		1 incomplete skeleton (8385), mounted, 3.81-m long (32 vertebrae out of 60, only 2 caudals)	Donated by Nordenskiöld; collected in 1879	B-O. Stolt, 1981; O. Grönwall, 2002
		1 skull, 47 ribs, 1 fragmented sternum	Donated by Nordenskiöld; collected in 1879	B-O. Stolt, 1981



Sydney	Australian Museum, Paleontological Collection (AM)	1 mandible, 1 left hemimandible, 1 right humerus, 1 right scapula	Registered in 1884; gift from Dr. Schmidt, Sweden	Flannery, 1988	R. Jones, 2004
Uppsala	Evolutionsmuseet, Zoologiska Museet (ZIUU)	1 skull, post-cranial skeletal material not inventoried	Donated by Nordenskiöld; collected in 1879	Nordenskiöld, 1885; Kleinschmidt, 1983	J. S. Peel, 2004
Vladivostok	Oceanarium TINRO	1 skull	No data		E. V. Novomodniy, 2004; O. A. Burkovskiy, 2004
	Primorskiy Gosudarstvennii Obiedinennyi Muzey imeni V. K. Arseneva (Primorsky Museum of Local Lore)	1 skull	Collected in 1951 by F. G. Fedmin		E. V. Novomodniy, 2004; O. A. Burkovskiy, 2004
	Zoologicheskii Muzei Dalnevostochnii Gosudarstvennii Universitet (Zoological Museum, Far Eastern State University)	Occipital bone, 2 vertebrae, 1 rib	Collected in 1987 to 1990 on Medny Island by zoologists S. Zagrebnyi and D. Ryzanov		E. V. Novomodniy, 2004; O. A. Burkovskiy, 2004
Warszawa	Instytut Anatomii-Porównawczej (Institute of Comparative Anatomy, University)	1 skeleton	Gift of B. Dybowski; mounted by A. Słóarski; moved by Russians to an unknown collection	Domaniewski, 1954; Brzęk, 1994	
	Gabinet Zoologiczny (Zoological Cabinet), then Państwowe Muzeum Zoologiczne (State Zoological Museum)	1 skull with mandible	Gift of B. Dybowski; destroyed during the suppression of the Warsaw uprising in October 1944	Taczanowski in Dybowski, 1883; Brzęk, 1994;	A. Riedel, 1982
Washington	National Museum of Natural History (USNM)	1 nearly complete skeleton (21966), composite, mounted, 6.43-m long; includes sternum	Collected by L. Stejneger in 1882- 1883; assembled by F. A. Lucas and J. W. Scollick in 1885-1886	Lucas, 1891; Scheffer, 1972	C. Potter, 2004
		1 supposedly complete skeleton (35638); now present as partial and disarticulated	Found in 1891 by T. Sinitisin; bought for \$150 by J. S. Carpenter and B. W. Evermann in 1892	Evermann, 1893	
		Over 250 officially inventoried bones, including 35638 above (about 19 com- plete, disarticulated, or incomplete skulls, 19 mandibles, 98 vertebrae, 97 ribs, 4 scapulae, 5 humeri, 7 radii, 7 ulnae)	Collected mainly by L. Stejneger in 1882-1883, with some bones bought by J. S. Carpenter and B. W. Evermann in 1892; mal- leus and incus received from N. A. Grebniński, 1888		
Wien	Naturhistorisches Museum (NHMW), Zoologische Abteilung	1 almost complete skeleton (614), com- posite, mounted, 6.4-m long (59 verte- brae); includes the left innominate	Donated by B. Dybowski to L. von Lorenz in 1897; supposedly from 12 individuals	von Lorenz, 1904	K. Bauer, 1981; B. Herzig, 2003
		2 fragmented innominates	Donated by B. Dybowski to L. von Lorenz in 1897	von Lorenz, 1904	B. Herzig, 2003

**Table 3.** List of skeletons ordered according to the type of specimens and collections

Almost complete; mounted	Braunschweig (SNMB), Cambridge, USA (MCZ), Helsinki (UZMH), Kyiv (ZMKU), London (BMNH), Lviv, Moskva (ZMUM), Paris (MNHNP), Sankt Peterburg (ZMAS), Washington (USNM), Wien (NHMW).
Partial; mounted	Dresden (MTKD), Göteborg (NHMG), Khabarovsk, Kharkiv, Kyiv-Ak., Lund (ZMLU), Stockholm NHRM)
Not mounted	Berkeley (UCMP), Cambridge, UK (UMZC), Edinburgh (NMS), Irkutsk, London (BMNH), Lyon, Nikolskoye, Paris (MNHNP), Washington (USNM)

**Table 4.** List of museums known to be connected with the principal collectors

N. Grebnitskiy	Budapest (MNH), London (BMNH), Lyon, Ottawa (CMN), Paris (MNHNP), Sankt Peterburg (ZMAS), Washington (USNM)
A. E. Nordenskiöld	Göteborg, Lund (ZMLU), Stockholm (NHRM), Sydney (AM), Uppsala (ZIUU)
B. Dybowski	Kharkov, Kyiv-Ak., Kyiv (ZMKU), Kraków (MZUJ), London (BMNH) (?), Lviv, Monaco, Warszawa-Univ., Warszawa-ZM
L. H. Stejneger	Cambridge, USA (MCZ), Cambridge, UK (UMZC), Paris (MNHNP), Washington (USNM)

**Table 5.** List of known most recent collectors of skeletal remains, with dates of collections

1997	Kovalev
1995	Furusawa
1992-1996	Wannhoff
1991	Sarichev
1991	Savinetskiy
1987-1990	Zagrebelniy and Riyzanov
1989	Kondrashin
1983	Grekov
1979	Kirilova
1979	Korabelnikov
1967	Chelnokov
1960-1974	Rossolimo and Dubrovo
1951	Fednin

hunting expeditions, which used meat and fat of Steller's sea cow as supplies (Stejneger, 1887; Makarova, 1975). At first, the islands were the final or main destination; later, only an initial stop was made to stock up on provisions before leaving for richer lands such as the Aleutian Islands or Alaska. This over-exploitation of a species with retarded sexual maturation and long birth intervals (Anderson, 2002) brought about an extraordinarily rapid extinction. A recent simulation has estimated that the harvesting rate was more than seven times the maximum sustainable catch (Turvey & Risley, 2005). The last sea cows were probably seen on Mednyi Island in 1753 (Yakovlev, 1867; English translation in Domning, 1978) and on Bering Island in 1768 (Sauer, 1802; Stejneger, 1884).

The Commander Islands were gradually abandoned. For several years, every attempt to collect proof of existence of the species was in vain. The

only surviving testimonies on the sea cow seem to be the detailed scientific description by the naturalist G. W. Steller (1751); a popular version of it in his journal (1793, 1988); accounts by other members of the Bering expedition such as S. L. Waxell (1940, 1962), K. Yushin, and S. Khitrov (Golder, 1922); and reports by seafarers and merchants such as P. Yakovlev, V. Shilov, and S. Cherepanov (Yakovlev, 1867; Pekarskii, 1869; Brandt, 1871; Andreev, 1948; Domning, 1978). The first published drawing, made in 1742 by F. Plenisner under the supervision of Steller (Stejneger, 1936), did not appear until sometime between 1834 and 1842 (Pallas, 1842).

*Early Russian Collecting*—In 1831, J. F. Brandt, newly appointed Director of the Zoological Museum of the Russian Academy of Sciences in St. Petersburg, found in the Imperial Kunstkammer one horny, palatine “masticatory plate” (rostral pad) (Brandt, 1833, 1846). This is likely the same item sent by Steller in 1743 (Stejneger, 1936). Brandt and K. E. von Baer, after contacts with explorers, geographers, merchants, and managers of the Russian American Company, were convinced of the extinction of the sea cow and proposed offering a reward to any who sent skeletal remains to the Academy of Sciences.

F. Wrangell, explorer and governor of Russian America from 1830 to 1835 (Pierce, 1990), reported mysterious big bones on the coasts of the Commander Islands and sent a rib fragment to the Academy of Sciences in St. Petersburg (Brandt, 1846). Shortly before 1840, K. T. Khlebnikov, manager of the Russian American Company, sent two complete ribs to St. Petersburg. In 1844, the preparator of the Zoological Museum of St. Petersburg, I. G. Voznesenskiy, was sent for

exploration to the North Pacific. He spent two days on the Commander Islands and collected the first incomplete skull of Steller's sea cow (Alekseev, 1988). In 1846, Voznesenskiy obtained a complete skull and some ribs. In 1851, Y. I. Semashko sent ribs, a humerus, and a radius-ulna.

The first nearly complete skeleton was found on 18 September 1855 on the northern part of Bering Island. It was unearthed by A. Gusev, the administrator of the Commander Islands. The skull was emerging from the grass 20 sazhen (42.6 m) from the beach; the body rested under the turf (from unpublished letters to the chief manager of the Russian American Company in Sitka, Alaska, November 1856; translated by Professor R. A. Pierce; *in litteris*, 1982). In 1857, this skeleton arrived at the Zoological Museum of the Academy of Sciences in St. Petersburg. Probably around 1860, another skeleton was sent to Moscow (the date of 1837 on the original label is unreliable). In 1861, the governor of Alaska, J. H. Furuhjelm, of Finnish origin, sent the first skeleton out of Russia to Helsinki.

*Late 19th-Century Collecting*—The most productive period in terms of collected skeletal material was from 1878 to 1883; during this time, 12 of the 22 skeletons having known dates of collection were found. In 1877, N. A. Grebnitskiy had been appointed administrator of the Commander Islands (continuing in that position until 1907). As a member of the Russian Geographical Society, he tried to facilitate the recovery of the skeletons and their distribution inside and outside Russia. For three decades, most of the shipments of skeletal material were under his direct supervision. In August 1879, the Swedish explorer A. E. Nordenskiöld (1881, 1885) stopped on Bering Island for five days and bought enough bones to fill 21 cases. In 1882, the Commander Islands hosted two important scientists, B. Dybowski, a Polish medical doctor, zoologist, and ethnologist (Brzęk, 1994), and L. H. Stejneger, an American zoologist of Norwegian origin, later biographer of Steller (Wetmore, 1946). The skeletal remains collected by Dybowski during that year, or sent to him later, enriched the collections of at least seven museums. Stejneger, by bribing the excavators who had boxed some other bones for shipment to St. Petersburg, succeeded in deviating the shipment from Russia (Scheffer, 1973), and collected others himself, thereby securing for the Washington museum the largest number of bones in any collection. Thanks to subsequent donations, three other museums now also possess some skeletal material provided by him.

Several skeletons collected during and after the 1880s were found by Trifon Sinitsin (also misspelled as Tephann Sennitsen or Trifon Sinech in various

sources), a resident of Nikolskoye, Bering Island. He was a Creole, son of a Russian from Vologda and an Aleut woman, born in 1843 (N. Tatarenkova, curator of the Aleut Museum, *in litteris*). The following information is from two unsigned, undated manuscript pages (quoted here in full) found in the Smithsonian Institution Archives (Leonhard Stejneger Papers, Record Unit 7074, Box 24, Folder 5). An accompanying cover note explains that these were written by B. W. Evermann about the skeleton he and U.S. Navy Paymaster J. S. Carpenter purchased (Evermann, 1893):

The skeleton of Steller's Sea Cow was purchased for \$150.00, June 2, 1892, from Trifon Sinech, a Creole of Nikolski, Bering Island, he being the man who found it. He says he found the skeleton on western side of Bering Island near Tonki Point, about 12 miles west from Nikolski. It was covered up by the sand about 3 feet, some bones sticking out a little. It was lying about 3 versts back from the water, and lay upon right side. Found it in May, 1891.

Says he has found 4 skeletons altogether, sold one to the Czar for 200 rubles (and a medal); found one for Dr. Stejneger; another he sold to the agent of the Russo-American Co. for 100 rubles; and this one.

Says this (ours) is the best one; the one sent to the Czar was less perfect, a part of the tail being missing. He found ours and the one sold to the Co.'s agent at same place & the other two on north side of island, not near the rookery, about 12 miles east. Says small pieces of bones have been found on Copper Island.

All four of these skeletons present unsolved mysteries:

1. Sold to the Czar: present location unknown.
2. "For Dr. Stejneger": unknown. Was this (or the others) really one skeleton, or just a pile of bones buried together? This was apparently not the "rotten" skeleton excavated by Stejneger on 27 August 1882, which was found by a Mr. Osche (Stejneger, 1883). Only three bones were collected of the articulated partial skeleton, all bearing Stejneger's field number 1601. One is the occiput, now USNM 218376; the others were right ribs 1 and 7, present locations unknown.
3. Sold to Russo-American Company: present location unknown. Conceivably it was resold to the Alaska Commercial Company and ended up at Berkeley or the California Academy of Sciences; or it might have gone to some other museum.

4. Sold to Evermann and Carpenter in 1892: at least part of this one is now disarticulated in the USNM collection. It was given accession no. 26094, which is the number attached to USNM 35638, now comprising a skull, manubrium, right scapula, right and left humeri, and 10 ribs. Another skull, two mandibles, and a left scapula (not from the same individual as the right scapula) are also recorded as purchased by Carpenter and are now assigned USNM nos. 35639, 218407, 218408, and 218409, respectively. These are the only Carpenter specimens now identifiable in the USNM *Hydrodamalis* collection. Since Evermann (1893) described the skeleton as “nearly perfect” and “very nearly complete,” including seven cervical vertebrae, obviously some pieces are now missing (or mislabeled as Stejneger specimens, or without data). Evidently, the skeleton was not sent as a whole to another institution. Possibly some parts (vertebrae, etc.?) were exchanged with some other museum, maybe to eke out a skeletal mount; but no record of this has emerged.

In 1897, the distinguished Scottish biologist D’Arcy Wentworth Thompson, appointed commissioner in a joint British-American survey of fur seal hunting in the Bering Sea, visited the Commander Islands. He bought a skeleton from Medniy Island for the Queen’s College, Dundee (Thompson, 1958). This was also one of Sinitsin’s discoveries, and he found yet another skeleton just before 1903. In 1903, the Polish geologist J. Morozevich was given a skeleton by Aleuts of the Commander Islands as a gift to Dybowski to express their gratitude for the help received from him 20 years before; the specimen was already packed and ready to be sent to St. Petersburg (Domaniewski, 1954). It is now in Lvov.

At the end of the 19th century, many museums yearned for a specimen of Steller’s sea cow, and a few were prepared to pay a sizeable sum. Since the museums of St. Petersburg and Moscow did not have sufficient economic resources, the Governor General of the Amur Region, who had received at Khabarovsk a new skeleton in 1898, gave to the mining engineer K. E. Pfaffius the task of contacting European museums and negotiating with them. The museum of Stuttgart offered 10,000 rubles for the specimen in 1900. In 1901, Pfaffius went to Europe, visiting Vienna, Budapest, Paris, Milan, and Munich. Paris made the highest offer, and in 1903 the skeleton was delivered to France via Japan (Syssoeva, 2001).

*20th-Century Collecting*—The collection of skeletal remains diminished after 1900, but significant collecting has still occurred in recent decades (Table 5). There are recent reports that

sea cow bones are being commercially collected and exported, either from the Commander Islands or from St. Lawrence Island. Since *Hydrodamalis* is not known to have ever occurred at the latter location, many if not all of these bones entering commerce may represent other marine mammals, whose identity is falsified on customs declarations in order to evade prohibitions on trade in extant endangered species.

### Discussion

From this survey, it is clear that Steller’s sea cow is represented by a greater quantity of skeletal material than hitherto known. Limiting the analysis to the skeletons, Kleinschmidt (1951) listed 11 specimens, but it is established that there are presently at least 27. For two skeletons believed irreparably lost during World War II, a completely or partially different fate was ascertained. The specimen in Dresden was confiscated by the Soviet Army and moved to Russia; it was then returned in 1982. Of the skeleton in Munich, the skull was saved from the wartime destruction by transferring it to safety together with part of the zoological collection. On the other hand, the skeleton in Khabarovsk was severely depleted by thefts and vandalism during the World War II period.

Contrary to the opinion of Heptner (1967), who did not believe possible the recovery of further significant skeletal material from the Commander Islands, single collectors or teams have been able to unearth additional bones of *Hydrodamalis*. A skeleton was found in 1983, and in 1991, two zoologists collected about 90 bones.

Although several museums own skeletal remains of Steller’s sea cow, not all of them are fully conscious of the importance of their patrimony. Some of them have not yet inventoried the items, others have lost all information about their origin, and others have fewer actual items than listed in their official catalogue. Still others display outdated osteological reconstructions.

Rather than complete skeletons, Nordenskiöld, Dybowski, and Stejneger had obtained large numbers of isolated bones, from which mounted specimens were then assembled. Skeletal remains were almost always found on the coast in large accumulations, many or most of which probably resulted from the systematic slaughters and butchering committed by fur hunters from 1743 to 1768 (Chelnokov, 1969; Domning, 1978), even though some cases of natural stranding cannot be excluded. Some of the bones in collections show marks of axes and are blackened by fire (Domning, 1978). The effects of such butchering help explain why articulated skeletons were rarely found. At any rate, most of the preserved specimens are composite ones, made up

of bones from two to 16 individuals, sometimes of different age classes and size. For example, the Braunschweig skeleton includes some bones that are clearly smaller than others (e.g., a 41-cm long innominate, attributable to a subadult).

Based on radiocarbon dating of some subfossil ribs as being some 500 to 2,200 years old, Savinetskiy (1992) hypothesized demographic crashes connected with Late Holocene cooling periods (but presented wholly inadequate evidence for this). Even if this were the case, the existence of some specimens much older than the 18th century would not disprove a probable recent date for the majority of the bones in collections.

Despite the considerable quantity of preserved skeletal material, we must admit that the osteology of Steller's sea cow is still incompletely known. After the firsthand description by Steller (1751) and the monumental treatises of Brandt (1846, 1868) and von Nordmann (1862), few authors studied the morphology and morphometry of this species, and generally only of selected elements like the auditory apparatus (Claudius, 1867; Doran, 1884; Robineau, 1965) and the innominate bone (von Lorenz, 1904; Birulia, 1929). Despite the present availability of at least 86 skulls in all, most of which are complete, craniometric data are published only for a relatively modest sample (Stejneger, 1883; Anonymous, 1911; Kleinschmidt, 1951; Heptner, 1967; Domning, 1978; Pilleri, 1988; Stefen, 2003; Csorba et al., 2004). Domning (1978 and subsequent work, e.g., Domning & Furusawa, 1995) has placed *Hydrodamalis* in the wider perspective of the evolutionary history of sirenians.

A few important details of the anatomy of this species are still not fully clear such as the morphology of the manus (which Steller described as totally lacking phalanges—an observation supported by fossils of *Dusisiren dewana*, Takahashi et al., 1986) and the number of ribs (17, 18, or 19 pairs?). Consequently, careful excavations of new specimens in the Commander Islands would be most desirable, both to acquire associated skeletons or parts thereof (especially bones of the manus) and to shed light on the stratigraphic occurrence and taphonomy of the sea cow remains, which have never been properly investigated.

A greater collaboration among museums also would be very welcome, with exchange and cession of skeletal elements, which could allow more complete osteological reconstruction of some specimens, favoring therefore a better knowledge of this extinct species.

Finally, we will be grateful to readers for any further details to correct and fill out the data compilation presented here, which we recognize to be incomplete.

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