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A NEW HARBOR PORPOISE OF THE GENUS *PHOCOENA* FROM THE GULF OF CALIFORNIA

BY KENNETH S. NORRIS AND WILLIAM N. MCFARLAND

On March 18, 1950, a single bleached skull of the porpoise described in this paper, was found by the senior author, on the beach above high tide line, along the north shore of Punta San Felipe, in the northern Gulf of California, Mexico. This skull is designated as the type specimen. Two other skulls of the species were available for study. These were obtained by James Warren and Paul Kellogg during December, 1951, at San Felipe Bay, Baja California Norte, Mexico, and are considered paratypes.

Seth Benson, of the Museum of Vertebrate Zoology at Berkeley, California, first noticed the striking differences that the type series shows, when compared with skull of *Phocoena phocoena* (auct. *P. vomerina*) in the MVZ collection. With this stimulus we have tried to obtain specimens of the entire animal, but have been unsuccessful thus far. We have, however, seen it alive, close at hand. On April 28, 1955, the senior author and James S. Long sighted what must have been *Phocoena sinus*, about 8 miles NE of Punta San Felipe, in the Gulf of California. This locality is a short distance out into the Gulf from the type locality. Three animals were seen. They were slightly less than 5 feet in length. Each animal was a uniform brown color dorsally and had a small triangular dorsal fin. Their blunt snouts were once observed. All were quite wary and were seen only briefly before they submerged. Our attention was first called to the animals by their sharp, loud breathing.

The field journal of the senior author contains the following notation on January 22, 1951: "Topolobampo Bay, Sinaloa, Mexico. The others (Boyd W. Walker and George A. Bartholomew of U.C.L.A.) had done some poisoning in a mangrove lagoon. They caught a few fish, mostly anchovies. When the dead fish drifted down the lagoon with the current they said the water was boiling with snappers taking the anchovies. They saw two bay porpoises (*Phocoena*) with their backs and blowholes out of the water, in one of these

lagoons. The animals inch-wormed themselves rapidly into deep water when the boats approached." Unfortunately, Dr. Bartholomew cannot recall the incident with enough precision to verify the identification, so the record must remain doubtful. He remembers only that the animals in question were small.

The junior author, on February 7, 1953, in company with several students from U.C.L.A., observed two small porpoises in close company in very shallow water in Puerto San Carlos, Sonora, Mexico. The animals were dark in color with a small triangular dorsal fin, but unfortunately it cannot be recalled whether they possessed blunt snouts or not. It is probable that these animals were also *Phocoena*, but the record must remain doubtful.

On May 3, 1956, in Ensenada Bocochoibampo, just north of Guaymas, Sonora, Mexico, the senior author and the Chief Collector of Marineland of the Pacific, Frank Brocato, were cruising about $\frac{3}{4}$ mile offshore when a small porpoise was seen. It was probably of the genus *Phocoena*. Its dorsal surface was very dark and it had a very low triangular dorsal fin. It blew with the characteristic loud puff. Its weight was estimated at 80 pounds. This would tend to support the previous report.

Mickey Vrooman, of the U.S. Fish and Wildlife Service, reported seeing a large group of porpoises in Conception Bay, Baja California, in the month of February, 1956. He was able to verify that the animals were small, possessed no beak, had a small dorsal fin and no white stripes. It would appear that this sight record definitely represents *Phocoena* (personal communication, Raymond Gilmore).

Phocoena has been reported by Scammon (1874) from Banderas Bay, Jalisco, and in the estuary of the Piginto River, Jalisco, Mexico. These were sight records and Scammon considered them identical with the *Phocoena* of the Pacific coasts of California, Oregon and Washington. Nelson (1899) reported *Phocoena* from the nearby Très Marias Islands. He said: "Porpoises supposed to belong to this species were common around the shores of the Très Marias Islands and also in bays and mouths of streams or lagoons along the coast of the mainland. They were seen in the belt of shallow discolored water within a short distance of shore. As soon as blue water, with a depth of over 40 fathoms, was reached the other porpoise (*Prodelphinus longirostris*) was encountered. The common porpoise was seen in schools of 10 to 40 individuals, swimming in loose order. At Maria Madre they came into the shallow bay in front of the settlement in the early morning and followed close along shore."

It is evident that the genus *Phocoena* on the west coast of North America is composed of two distinct species, the northern *P. phocoena* ranging from the coast of southern California northward at least to Pt. Barrow, Alaska, and a southern entity, certainly occurring in the upper Gulf of California, and probably extending far south along the Mexican coast. We describe this southern form as follows:

Phocoena sinus sp. nov.
GULF OF CALIFORNIA HARBOR PORPOISE

Type specimen.—Museum of Vertebrate Zoology (MVZ No. 120933, skull only), from the northeast shore of Punta San Felipe, Baja California Norte, Gulf of California, Mexico; collected March 18, 1950, by Kenneth S. Norris. Paratypes are MVZ No. 120934 (cranium only), and USNM No. 303308 (cranium only); collected in December, 1951, at San Felipe Bay, Baja California Norte, Gulf of California, Mexico, by James Warren and Paul Kellogg.

Comparative material.—Twelve skulls of *Phocoena phocoena* from the Museum of Vertebrate Zoology have been examined. Three skulls of *phocoena*, all representing southward extensions of known range, have been examined from collections at the University of California, Los Angeles. Photographs and literature plates of all known species in the genus have been examined.

Diagnosis.—*Phocoena sinus* is a distinct species, in some respects intermediate in morphology between *phocoena* of the temperate and cold water coasts of North America and Europe, and *spinipinnis* and *dioptrica* of the temperate and cold water coasts of South America and outlying islands. *P. sinus* is the smallest species in the genus, at least with respect to the size of the adult skull. It is distinct from *phocoena* in the following ways: In *sinus*, (1) cranium smaller in adult, with a relatively much broader and shorter rostrum; (2) basi-cranial axis deflected downward at a greater angle, in relation to the horizontal axis of the rostrum; (3) foramen magnum relatively larger; (4) maxillary bone not entering the orbit but excluded from it by the lateral margin of the frontal bone, instead of completely covering lateral margin of frontal and entering the orbit; (5) maxillary leaving a relatively larger exposure of dorsal aspect of frontal bones, where the latter contact the supraoccipital; (6) antero-ventral extension of nasal bones covered by mesethmoid; (7) posterior edge of the palate with medial U-shaped indentation, formed of the medial edges of the rounded, roughly triangular pterygoid bones and the ventral extension of the vomer, which enters the palate just posterior to the palatine bones. In *phocoena* the posterior edge of the palate has a W-shaped indentation, formed by the pointed, usually acutely triangular pterygoid bones and a central, pointed extension of the palatines, which sometimes cover the ventral extension of the vomer completely, but more often leave it as a small point of bone at their apex; (8) lower maxillary and mandibular tooth count. *P. sinus* differs from *phocoena* in other minor ways that will be discussed in the section of description.

Phocoena sinus appears different from *spinipinnis* in the following respects: In *sinus*, (1) cranium smaller in adult, with relatively shorter rostrum; (2) higher total tooth count, with teeth distributed along nearly the entire margin of mandible and maxillary, instead of with a distinct posterior diastema; (3) dorsal aspect of supraoccipital bones (in lateral view) tilted at an angle of slightly over 20°, instead of in the same plane as the rostrum; (4) maxillary bones exposing smaller relative portions of the frontals on the dorsolateral

surface of the brain case; (5) a more flattened, more asymmetrical and less prominent vertex; (6) posterior margin of palate with U-shaped indentation, instead of W-shaped.

Phocoena sinus appears different from *dioptrica* in the following respects: In *sinus*, (1) cranium smaller in adult; (2) dorsal aspect of supraoccipital bones (in lateral view) tilted at an angle of slightly over 20°, instead of the same plane as the rostrum; (3) posterior margin of palate with U-shaped indentation instead of broadly W-shaped; (4) maxillary portion of palate flat or slightly concave instead of definitely convex; (5) maxillary bones exposing relatively larger portions of the frontals on the dorsolateral surface of the brain case; (6) vertex relatively much smaller; (7) intermaxillaries standing above the maxillaries throughout the length of the rostrum, instead of level with the maxillaries; (8) no evidence of the striking white ventral and lateral coloration of *dioptrica*, though the entire animal has not been examined closely. The data on *dioptrica* listed here are from Hamilton (1941) and from plates kindly supplied to us by F. C. Fraser of the British Museum. Comparative measurements of the four species are given in Table 2.

Description of type specimen.—A fully adult specimen, judging from the complete fusion of the postorbital processes of the frontals and the zygomatic processes of the squamosals, forming complete arches. Also, the intermaxillary bosses are large and overhanging, seemingly indicative of adult condition. Ankylosis is complete between many cranial bones to the point where the sutures are no longer evident. For example, the basisphenoid is completely continuous with the surrounding basioccipitals. The cranium is 211 mm. total length, from the tip of the rostrum to the dorsal point of the foramen magnum. Ratio of width across zygoma of squamosals to total length: 0.637 (see Table 1 for comparisons). Rostrum relatively short and broad. Intermaxillaries stand up above adjacent maxillaries throughout their length, imparting an arched cross section to the rostrum. Vomer entering palate at two points, anteriorly appearing in the mid-palate as a small elongate diamond and posteriorly on the posterior margin of the palate as an oval process. The ventral wings of the pterygoids are missing in the type, but present in the paratype (USNM 303308) in which they are roughly triangular, rounded bones forming a U-shaped margin of the palate in conjunction with the vomer.

In the type the palatine portion of each maxillary is creased by a fissure extending posteriorly from about the mid-point of the anterior insertion of the vomer, down the mid-line of the maxillary, one-third its length.

The mesethmoid defines the nares dorsally and covers the anteroventral extension of the nasal bones along the mid-line. The nasals are crossed horizontally by a well-defined ridge which invades the medial edges of the maxillary bones. The maxillaries are arched upward at the anterior edge of the temporal fossae, exposing the posterior extensions of the frontal bones for a maximum of 12.1 mm. The vertex is markedly asymmetrical, being undercut nearly to the mid-line on the right side, while the left side is solid and only slightly undercut.

The dorsal edge of the orbit is defined by a lateral edge of the frontal bone, the maxillaries failing to enter the orbit by a minimum of 4 mm.

The supraoccipitals slope down sharply from the vertex to the condyles, meeting along the mid-line in a broadly U-shaped furrow. The foramen magnum is large (34.0 mm. along dorsal axis) and egg-shaped, with the apex pointing dorsad. The condyles are large and ventrolaterally placed. The basi-cranial axis is formed of broad basioccipitals which are joined completely to the basisphenoid and sutured to the rather thin exoccipital. The jugular protuberances of the exoccipital are composed of thin ridges of bone, compared to the heavy bosses found in *phocoena*. The indentation of the glenoid fossa is much weaker and smaller than in *phocoena*. The condylar foramen is a deep, open, U-shaped furrow.

Internally a low ridge runs transversely across the base of the cranium at the junction of the basioccipital and basisphenoid. This ridge is much more pronounced than in *phocoena*.

The mandibles are short and stout. The coronoid border is straight and does not bend laterally to form a small flange, as in *phocoena*. The teeth are spade-shaped, with some tendency to exhibit extra cusps on the posterior teeth in upper jaws. Tooth counts and measurements are given in Table 1. See Plates I-III.

TABLE 1.—A comparison of the type and paratypes of *P. sinus*

CHARACTER	TYPE (MVZ NO. 120933)	USNM NO. 303308	MVZ NO. 120934
Skull length	211.0 mm.	226.0 mm.	218.0 mm.
Zygomatic width, across squamosal processes	135.8 mm.		
Greatest breadth at maxillary notches	73.8 mm.	75.5 mm.	77.0 mm.
Length of rostrum, from tip of rostrum to anterior edge of left naris	117.0 mm.	120.0 mm.	117.2 mm.
Ratio: Width/length of rostrum	0.630	0.629	0.657
Height of foramen magnum	34.0 mm.	38.0 mm.	37.8 mm.
Deflection of rostrum*	14.5°	13.5°	13.5°
Depth of skull†	115.0 mm.	122.5 mm.	116.0 mm.
Greatest breadth of brain case across temporal fossae	113.5 mm.	114.5 mm.	113.0 mm.
Shape of pterygoid- palatine-vomer complex‡	—	Broad U	
Exposure of frontals§	11.8 mm.	14.0 mm.	10.0 mm.
Condylar foramen shape	U	U	U

* Deflection of rostrum expressed by angle between horizontal axis of rostrum and a line from midpoint of occipital condyles to tip of rostrum.

† Depth obtained by placing skull on a table and measuring from point of contact of basioccipital to dorsal extremity of vertex.

‡ This refers to the shape described by the bones listed at the posterior edge of the palate.

§ The frontal bones are covered by the maxillary bones except for a margin at their posterior edges. Measurement is widest exposure on right side.

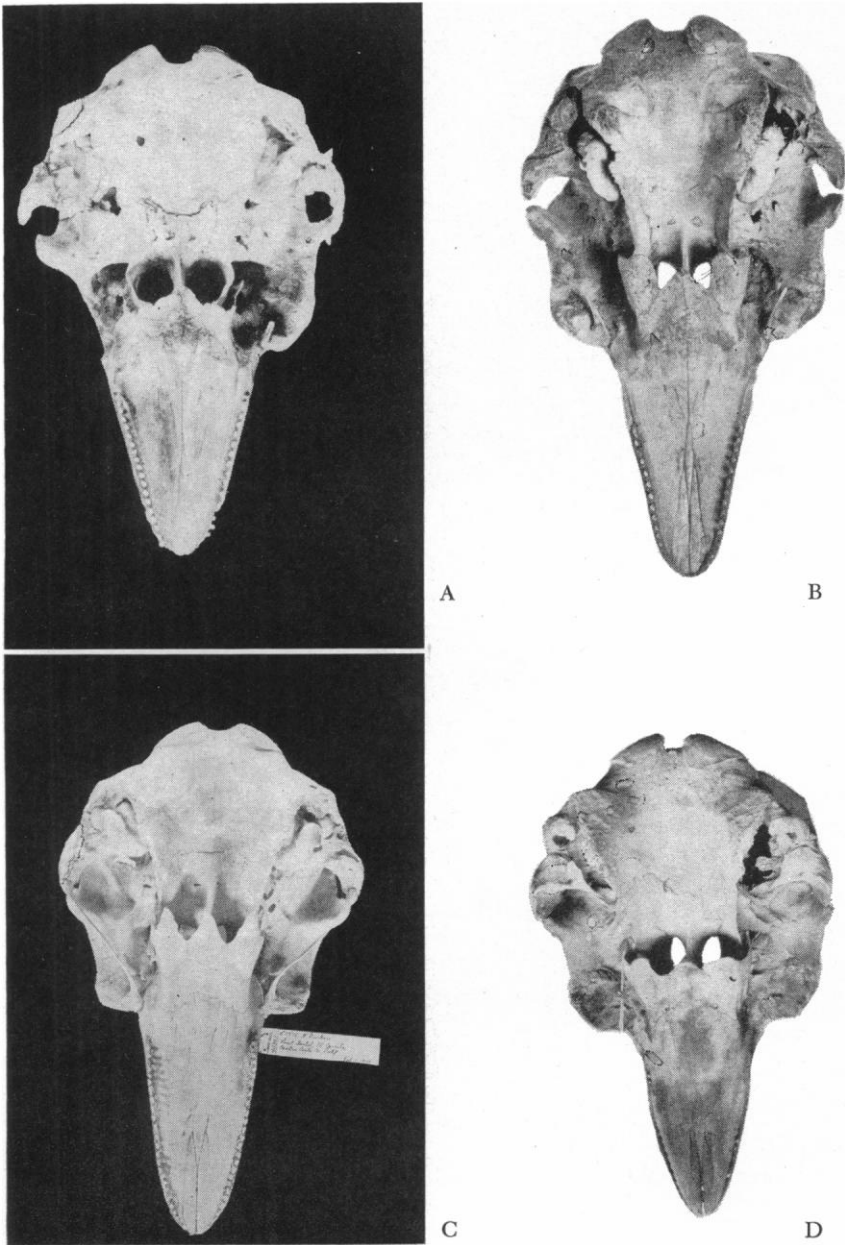
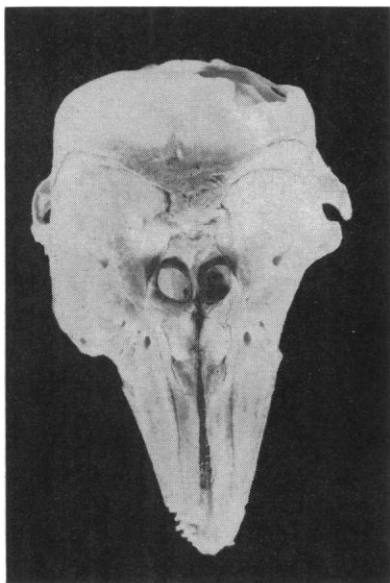
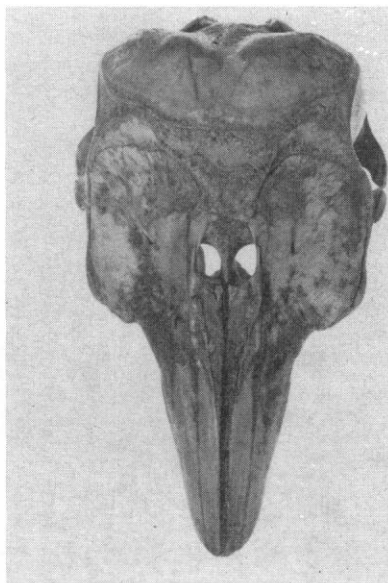


PLATE I

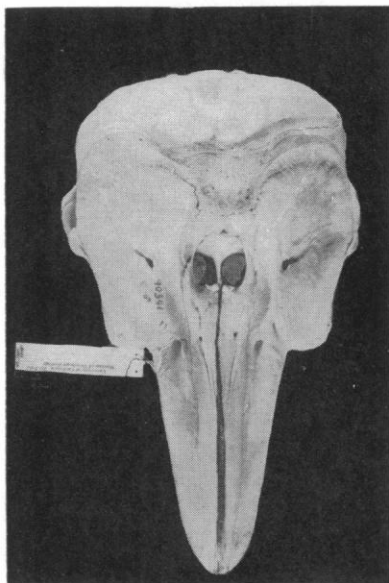
Ventral view of crania: A, *Phocoena sinus* (type); B, *P. spinipinnis* (MCZ specimen described by Allen, 1925); C, *P. phocoena* (MVZ 90341); D, *P. dioptrica* (British Museum specimen described by Hamilton, 1941).



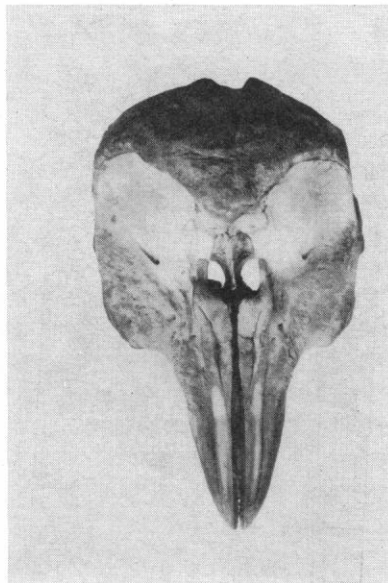
A



B



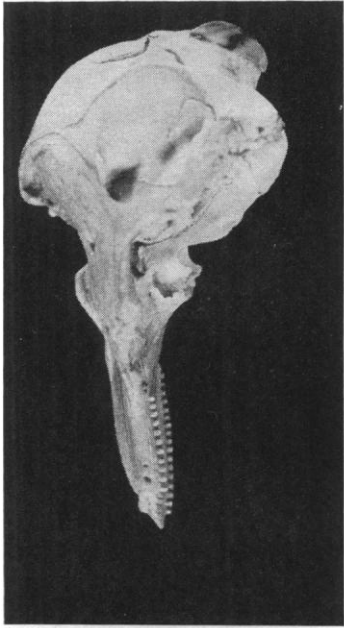
C



D

PLATE II

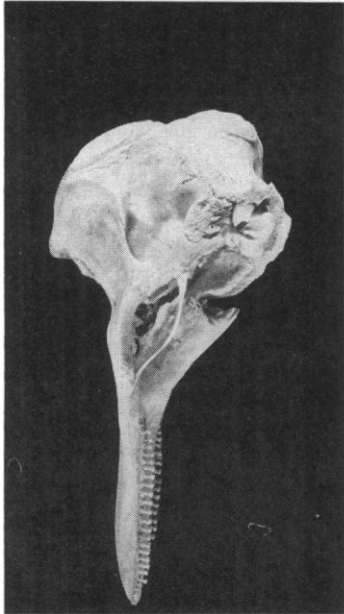
Dorsal view of crania: A, *Phocoena sinus* (type); B, *P. spinipinnis* (MCZ specimen described by Allen, 1925); C, *P. phocoena* (MVZ 90341); D, *P. dioptrica* (British Museum specimen described by Hamilton, 1941).



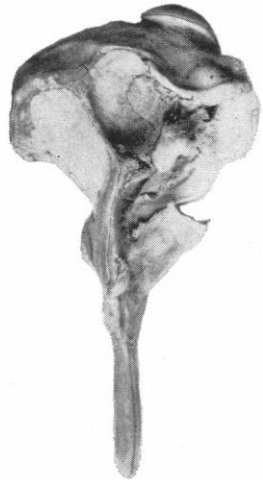
A



B



C



D

PLATE III

Lateral view of crania: A, *Phocoena sinus* (type); B, *P. spinipinnis* (MCZ specimen described by Allen, 1925); C, *P. phocoena* (MVZ 90341); D, *P. dioptrica* (British Museum specimen described by Hamilton, 1941).

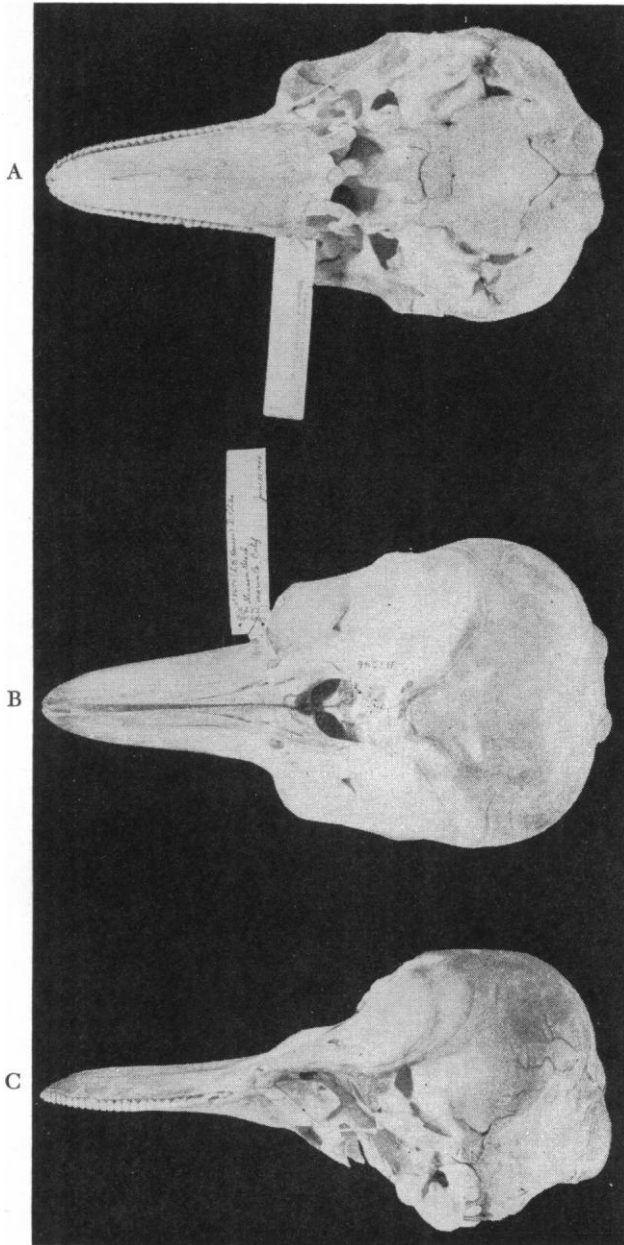


PLATE IV

Juvenile specimen of *Phocoena phocoena* (MVZ 112246). A, ventral view; B, dorsal view; C, lateral view. Note incomplete ossification of bones.

Paratypes.—The two paratypes (MVZ 120934, USNM 303308) are both bleached and cracked skulls which had obviously spent much time on the beach before being picked up. As a consequence some comparisons are impossible. However, where comparison is possible they are remarkably similar to the type and indicate that the type is not just an aberrant specimen but a representative of a distinct species. The three skulls are compared in Table 1.

Comparisons.—A number of genera have at one time or another been lumped with *Phocoena* as it is presently recognized. For example, Owen (1866) described *Orcella brevirostris* in *Phocoena*. *Phocoena pectoralis* Peale (1848) of the Hawaiian Islands, appears close to or identical with *Cephalorhynchus heavisidei* Gray. There are many other examples of this sort.

Several small, blunt-snouted delphinids, possessing a dorsal fin and spade-shaped teeth, have been described in the genus *Phocoena*. Of these only three

TABLE 2.—A comparison of *Phocoena sinus*, *P. phocoena*, *P. spinipinnis* and *P. dioptrica*

CHARACTER	<i>P. sinus</i> (type)	<i>P. phocoena</i> *	<i>P. spinipinnis</i> †	<i>P. dioptrica</i> ‡
Skull length, from tip of rostrum to condyles	211.0 mm.	278.0 mm.	273.0 mm.	288.0 mm.
Length of rostrum, from tip to edge of left naris	117.0 mm.	156.8 mm.	141.0 mm.	152.0 mm.
Palate length, from tip of rostrum to median spine of palate	111.6 mm.	169.6 mm.	152.0 mm.	164.5 mm.
Length of tooth row, including alveoli	73.2 mm.	117.1 mm.	79.0 mm.	
Zygomatic width, across squamosal processes	134.5 mm.	149.5 mm.	153.0 mm.	168.0 mm.
Greatest breadth of rostrum at maxillary notches	73.8 mm.	73.7 mm.	83.0 mm.	88.0 mm.
Greatest breadth across brain case at temporal fossae	113.5 mm.	128.0 mm.	127.0 mm.	
Ratio: Width/length of rostrum	0.630	0.470	0.517	0.727
Ratio: Skull width/skull length	0.637	0.537	0.560	
Shape of pterygoid-palatine-vomer complex	U	W	W	Broad W
Widest dorso-posterior exposure of frontals	11.8 mm.	9.0 mm.	25.0 mm.	Slight exposure
Tilting of dorsal aspect of supraoccipital bones with relation to axis of rostrum (in lateral view)	22°	23°	0°	0°
Teeth	$\frac{20-21}{18-18}$	$\frac{27-28\ddagger}{26-26}$	$\frac{16-16}{17-18}$	$\frac{21-21}{17-17}$

* MVZ 96089.

† Measurements and counts taken from Allen (1925).

‡ Measurements and counts taken from Hamilton (1941).

§ Alveoli counted in lower jaw.

seem to be valid species. *Phocoena dioptrica* Lahille 1912 and *Phocoena spinipinnis* Burmeister 1865, of the coasts of Argentina, Chile, Peru and certain outlying islands, are now well enough known to be generally accepted. *Phocoena phocoena* (Linnaeus) of the coasts of Europe and the Atlantic and Pacific coasts of North America is the remaining form.

Philippi (1893) described seven forms in the genus *Phocoena* from South America, and none of them seem valid; *philippii* is almost certainly synonymous with *spinipinnis*. True (1903) allocated *posidonia* to the genus *Lagenorhynchus*, and suggested that *P. obtusata* appeared to belong to *Cephalorhynchus*. *P. d'orbignyi* is synonymous with *Lagenorhynchus cruciger* (d'Orbigny and Gervais); *lunata* and *cruciger* were species described by Philippi based solely on sight records and have no validity. True (1903) considered Philippi's *P. albiventris* to be probably synonymous with *Cephalorhynchus eutropia*.

Phocoena storni described by Marelli (1922) from Tierra del Fuego, was described from a single cranium. The animal was differentiated from *dioptrica* as a new species on the basis of a number of proportions and tooth counts. All the proportional differences which separate it from *dioptrica* appear to be related to individual variation, which is great within the genus, or to the apparent old age of the specimen. Tooth counts were taken on one side of the upper jaw only because of missing teeth on the other side. The photograph given shows the alveolar border running a short distance posterior to the last tooth on the counted row. It is probable that the 18 teeth counted do not represent the true total in the intact animal, and the count is of dubious diagnostic value at any rate, from the count of 21 given by Hamilton (1941) for *dioptrica*. We conclude from these facts and examination of a photograph of the type that *storni* represents a synonym of *dioptrica*.

Phocoena vomerina Gill 1865, of the Pacific coast of North America is indistinguishable from *phocoena* of the Atlantic, on the basis of the original description. Adequate samples are now available from both populations for a final solution of the validity of *vomerina*.

Phocoena tuberculifera Gray 1865, from the mouth of the River Thames, is based on a specimen of *phocoena* having a tuberculate dorsal fin. This anomaly seems to occur with fair regularity in the species. A tuberculate dorsal fin is apparently always present in *spinipinnis*.

Phocoena brachycium Cope 1865 and *Phocoena lineata* Cope 1876, appear to be synonymous with *P. phocoena*, Cope's diagnosis being based mainly upon the development of the vomer, a character which we have found to be highly variable in Pacific members of this species. Flower (1883, p. 471) showed this variability to be present in Atlantic populations of *phocoena*.

There has long been a controversy concerning the generic status of the small finless porpoise, *Neomeris phocaenoides* Gray (1846), of the Indian and Pacific oceans. This small animal ranges from the Cape of Good Hope to Japanese waters and appears to be the ecological counterpart of the genus *Phocoena* in the Far East. It is certainly very closely allied to *Phocoena*, having a blunt snout and

spade-shaped teeth. The major separating characters are its finlessness and the relation of the plane of the rostrum to the basicranial axis. The rostrum is bent downward with relation to the basicranial axis at about 45° , while in *Phocoena* this angle is about 30° . Blanford (1891) placed the form in *Phocoena*, while Flower (1883) and True (1889) called attention to the fact that the generic name *Neomeris* was preoccupied by a genus of polyps. However, both workers continued to use this name. Palmer (1899) again called attention to this preoccupation and proposed a new name, *Neophocoena*. However, in 1925, Thomas showed that *Meomeris* had priority, an apparent misprint in Gray's List (1847). Allen (1923), in a discussion of the affinities of this porpoise with *Phocoena*, considered it as closely related to *Phocoena*, but more primitive. He retained the genus name of *Meomeris*. Thomas (1925) suggested that since the polyps, originally considered as preoccupying the name *Neomeris*, have been subsequently identified as a species of alga, the name was still available for the porpoise. We accept this nomenclatorial decision, which is very fortunate due to the common usage of the name *Neomeris*. Its relationships are clear and its taxonomic allocation is therefore a matter of particular emphasis of generic or specific categories.

Having thus limited the previously known living representatives of the genus *Phocoena* to three species, we can restrict our comparisons to these species. The general comparisons are listed in Table 2. See also Plates I–III

Miller (1923) discussed the evolution of the cetacean skull, showing how it has become telescoped, particularly by the process of movement of the nares to the top of the head, from the terminal position on the snout. In the Cetacea, he considered complete coverage of the posterior extension of the frontal bones by the overlapping maxillaries to be an advanced state. It is interesting that in *Phocoena* various degrees of coverage of the frontals are found. While there is a wide individual variation, *P. phocoena* and *dioptrica* have by far the greatest relative coverage of the frontals, of the four species. *P. sinus* and *spinipinnis* are linked by having a rather wide exposure. In this regard, Allen (1925) considered *P. spinipinnis* as a much more generalized form than *phocoena* on the basis of several criteria other than frontal exposure.

The skull of a very young female *phocoena* (MVZ 112246) shows affinities with the southern species that are not shown in any of the adults examined. See Plate IV. Since the animal was picked up on Stinson Beach, (June 25, 1944, by D. Politeo) and was small (length 465 mm. nose to fluke notch; weight $19\frac{1}{4}$ lbs.) it most likely represents a newborn calf. Evidence of its youth other than its size comes from the incomplete ossification of many bones, such as the pterygoids, and the open sutures connecting others which are normally fused in adults. Even though the skull of this animal is about one-third smaller than any other examined, the posterior exposure of its frontals by the maxillaries is nearly the greatest measured (16 mm.). Proportionately, it is allied to *sinus* and *spinipinnis* in this respect. Unlike adults of its species the dorsal aspect of the supraoccipitals is nearly flat, like the condition of *spinipinnis* and *dioptrica*.

The ventroposterior extension of the vomer enters the palate in variable amounts in Pacific specimens of *phocoena*, as mentioned. Sometimes it is completely absent from the palate, covered by the palatines. The extension of the vomer into the posterior margin of the palate is relatively greater in the juvenile specimen than in any of the adults. In this respect, the young animal is linked more closely to *sinus* and apparently *dioptrica* than to *spinipinnis*.

These ontogenetic changes in *phocoena* are of interest as they tend to confirm the idea of Allen (1925) that *spinipinnis* is a more generalized form than *phocoena*. We extend this idea to both *sinus* and *dioptrica*, considering both of them and *spinipinnis* closer to the stem stock than is *phocoena*, which is considered consequently as the most highly evolved member of the genus.

Phocoena sinus is allied to the South American members in a number of ways, in particular to *spinipinnis*. Tooth counts for all three forms are low compared to *phocoena*. The wide extent of dorsoposterior exposure of the frontals links *sinus* and *spinipinnis*. Cross sections of the rostra of *spinipinnis* and *sinus* are arched throughout their lengths, whereas *phocoena* has the base of the rostrum flattened due to a depression of the intermaxillaries at that point. Toward the tip of the rostrum the intermaxillaries arch upward forming a rounded cross section. The rostrum of *dioptrica* is seemingly flat throughout its length. *P. phocoena* has the slimmest skull of the four forms, considering the breadth of the brain case at the squamosal processes of the zygomatic arch (zygomatic width) in relation to total skull length. The temporal fossae of *phocoena* are generally smaller than in the three southern species. Although the characters are intermingled in various proportions amongst the four species, we feel that *spinipinnis*, *sinus* and *dioptrica* form a natural group, more primitive than *phocoena*.

The species *phocoena*, *spinipinnis* and *dioptrica* are approximately of equal size when adult; *sinus*, judging from the skull length of the adults and the small size noted in the sight records, is probably a considerably smaller animal.

Zoogeography.—Allen (1925) described the known range of *spinipinnis* as follows: "in the cooler waters off the South American coast from the La Plata region, around Cape Horn, and northward in the Humboldt Current to northern Peru, a range closely similar to that of several other marine vertebrates as shown by Dr. R. C. Murphy (1923)." The northernmost record on the Pacific coast is Payta (or Paita), Peru, near the Ecuadorian border. This locality is approximately 2,450 airline miles south of the southernmost sight record for *Phocoena* (probably *P. sinus*) and 3,300 miles south of the type locality of *sinus*.

P. dioptrica is known only from the South Atlantic coast of South America (Rio La Plata, Rio Santiago, Falkland Islands, South Georgia; see Hamilton, 1941). The species is little known and its range probably far exceeds that reported.

P. phocoena ranges throughout the littoral waters of Europe to the North Sea and into the Arctic Ocean. It is quite common around the British Isles. To the South it extends into tropical waters, having been taken at Dakar, West Africa,

by Cadenat (1949). A probable subspecific differentiate, *P. p. relicta*, occurs in the Black Sea (Zalkin, 1938). A recent Russian paper (Kirpichnikov, 1952) was unfortunately not available to the authors. In the Western Atlantic it occurs along the coast of North America from Davis Strait southward to at least the Delaware River. In the Pacific it ranges from the northern tip of Alaska at Point Barrow (see Miller and Kellogg, 1955) to the San Pedro Channel in southern California. Previous to this report the southern record has been considered Rockaway Beach, San Mateo County, California (Orin, 1937). Through the courtesy of G. A. Bartholomew of the Department of Zoology at the University of California, Los Angeles, we obtained three specimens of *phocoena* from the osteological collection, all of which represent considerable southward extensions of known range. UCLA cranium No. 1184 was found on the beach at Point Mugu, Ventura County, California, by Loye Miller in March, 1931. UCLA cranium 1440, was picked up at Hyperion Beach, Los Angeles County, California, also by Dr. Miller in 1934. The third and southernmost record (UCLA 1439) is a female captured by fishermen in the San Pedro Channel off San Pedro, California. The animal was exhibited in the window of Bernstein's Fish Grotto in Los Angeles for a few days before being given to Miller by J. R. Pemberton. These records seem to represent an extension of range due to unusual conditions, as the species is not a common resident until one goes northward to the vicinity of San Francisco Bay. All three specimens are large adults. UCLA 1440 is as large as the largest animal measured in the MVZ collection (MVZ 21509, 289 mm. condylobasal length). The heavy ossification of the vertex in this UCLA specimen and the great width of the rostral base (94.5 mm.) suggest old age. It is our feeling that these range extensions represent old animals that have wandered far beyond their normal range. Fraser (personal communication) states that Cadenat's specimens from Dakar are all larger than any of 33 skulls from British waters. The largest Dakar skull is 300 mm. total length.

With the possible exception of *phocoena* in subtropical waters at Dakar, West Africa, the ranges of *dioptrica*, *spinipinnis* and *phocoena* are strongly antitropical in character. Thus, the discovery of a species of *Phocoena* in the subtropical waters of the upper Gulf of California and probably extending into truly tropical seas around the Très Marias Islands and Banderas Bay, Jalisco, Mexico, is unexpected and unusual. This form shows its closest affinities with the distant South American species and not with the geographically nearest form (*phocoena*) which occurs 325 airline miles north of the type locality and about 1,500 miles along the coastline.

With the passage of geologic time two factors have been at work that could have given rise to *P. sinus*. First, during a time when seas were cooler, many temperate species of marine animals have crossed the equatorial barrier, resulting in bitemperate distributions. After discussing a number of fish species that seem to have crossed the equator, perhaps by descending to deep cool waters, Hubbs (1952) discusses the passage of surface-bound forms. He says:

Many other antitropical fishes of the temperate zones, including most of the pantemperate types, have attributes that lead us to believe that they crossed the tropics when surface waters were considerably cooled, presumably during late Pleistocene time. Ecologically they are surface-bound; therefore incapable of transgressing equatorial water by the cool deep-water routes. That they crossed the tropics during the last cold period of the Pleistocene is suggested by their incipient speciation.

In this category of surface-bound recent transgressors of the tropics we must include such shore-pelagic fishes as the sardine or pilchard genus *Sardinops* (of California, Japan, and Chile, and Australia and New Zealand, and South Africa); the round herrings of the genus *Etrumeus* (of the western North Atlantic, California, Hawaii, Japan, Australia, and South Africa); the anchovy genus *Engraulis* (of Europe, Japan, South Africa, and Australia and New Zealand); the similar anchovies of California, Peru and Chile, and Argentina, which, as I shall presently show, constitute a distinct genus; the even more strikingly pantemperate jackmackerel (*Trachurus*) and chub mackerel (*Pneumatophorus*) groups; the saury genus *Scomberesox* (of North Atlantic and South Temperate waters); the species of *Seriola* related to *S. dorsalis*; *Centrolophus*; several tunas (Thunnidae) and tuna-like fishes; also *Alepisaurus* and various other rather pelagic types.

As emphasized by Berg (1933) not only these fishes, but also various other organisms almost certainly had a surface-water connection between the northern and southern hemispheres at a geologically very recent time, very probably, in large part, during the last period of continental glaciation. Notable examples are sea lions (Otaridae), right whales (*Eubalaena*), and the giant kelp *Macrocystis*, which is said to be represented in both hemispheres by the same two ecotypic varieties of a single species.

To this list mentioned by Hubbs, Ekman (1953) adds several other fishes as well as citing data on the distribution of invertebrates. In addition he mentions the "Bipolar" (= Antitropical) distribution of the genus *Macrorhinus* (sea elephants) and the genus *Arctocephalus* (fur seals) all of which have specific differentiates in the North and South Temperate Hemispheres. Ekman further stresses the importance of the Eastern Pacific as a route of migration during the Pleistocene Epoch to explain these distributions (see Ekman, 1953, p. 248).

Very probably, a form ancestral to *P. spinipinnis* crossed the tropical latitudes at such a time, when the South American Humboldt current (in which *spinipinnis* now occurs) converged with an extension of a northern counterpart (see Hubbs, *op. cit.*). It should be stressed that this possibility is even more probable in light of the presence of *sinus* and *phocoena* in tropical or at least subtropical waters. The presence of *phocoena* at Dakar is best considered as a penetration of a temperate form into a subtropical region. Ekman (1953, p. 55) considers the Dakar area as a transitional faunal area between the tropical and temperate regions. In addition, it is interesting that *Neomeris phocoenoides*, the Western Pacific and Indian Ocean generic counterpart of *Phocoena*, is strongly tropical in its distribution. Such evidence suggests the possibility that the ancestral forms of the genus *Phocoena*, or even its earliest members, could withstand higher temperatures. If this was the case, *P. sinus*, or more probably its ancestors, might readily have penetrated the equatorial regions during the Pleistocene, only retreating at the close of this epoch or during one of the interglacial periods. The affinities of *sinus* to the South American members of the genus, rather than

to *phocoena*, are thus readily explained by the action of continental glaciation and its effect upon the surface water temperatures. Lowering of a few degrees would be sufficient to explain the present distributions.

The second factor which may have acted in the evolution of *P. sinus* is the configuration of sea and land forming the Gulf of California. This Gulf has acted as a *cul-de-sac* in trapping and isolating a considerable number of temperate species in its upper reaches, as faunas became displaced during the Pleistocene (see Hubbs, *op. cit.*). Many of these forms have been recorded in the region of upwelling adjacent to Angel de la Guarda Island. *Sebastes sinensis*, the only member of this bitemperate genus in the Gulf, occurs only at this location. The fish collections at the University of California, Los Angeles, collected by Boyd W. Walker and students, contain such temperate fishes from this region as *Triakis semifasciata*, the leopard shark, and a skate which is identical, or nearly so, with the California species, *Raja inornata*. The sargo, *Anisotremus davidsoni*, and the black croaker, *Sciaena saturna*, also have restricted populations in the upper Gulf of California. The northern spiny lobster, *Panulirus interruptus*, is also isolated in the vicinity of Angel de la Guarda Island. This list of isolated forms could be extended and would include several phyla.

The sight records of Scammon and Nelson, cited earlier, would extend *P. sinus* beyond the confines of the Gulf of California. However, in the absence of specimens from these regions, the comments about *sinus* by Mexican fishermen at San Felipe, near the type locality, are most interesting. These men know the little porpoise well and speak of it leaving the upper Gulf in the summertime. They say it is found in the vicinity of Los Angeles Bay and Angel de la Guarda Island at this time. During the summer months the upper Gulf becomes very warm (surface temperatures as high as 88°F.) while the upwelling area near Angel de la Guarda Island remains cool. However, if *sinus* occurs as far south as Jalisco, Mexico, a summer migration from this region to the cool water area at Angel de la Guarda, as might be the case with the northern Gulf population, would be a spectacular phenomenon and would probably have been noticed before this time.

It would appear possible that after the ancestor of *P. sinus* had reached the Gulf of California from South America and waters began to warm with the retreat of the continental ice sheets, the porpoise retreated northward with the cooler waters and was isolated in the upper Gulf.

The possibility exists that *sinus* was derived from ancestral *phocoena*, as the latter species moved southward with cold water, and became trapped in the Gulf as the parent stock moved northward when waters warmed again. In this case *sinus* would be considered as a slightly paedogenic or "larvalized" form because it resembles the postembryonic *phocoena* considerably more than it does the adult. However, we tend to favor the idea that *sinus* was derived directly from a South American form, because it resembles *dioptrica* and particularly *spinipinnis* more than it does even the young of *phocoena*. Perhaps

proof or disproof of this theory will come when a whole specimen of *sinus* is obtained. If *sinus* possesses a peculiarly shaped tuberculate dorsal fin similar to that of *spinipinnis* and similarities of the axial skeleton, the historical continuity of the two forms must then be considered highly probable.

We wish to thank Dr. Seth Benson for loaning us specimens in his care and for his generous assistance with other phases of this study. Dr. Carl L. Hubbs has helped in many ways, particularly in suggesting the specific name which we have given the species. Dr. F. C. Fraser has assisted by obtaining the plates of *P. dioptrica* and reviewing the manuscript. Drs. G. A. Bartholomew and Boyd W. Walker have loaned specimens and records in their care. We thank James Warren for providing us with two paratypes of *P. sinus* and for access to his field records. Dr. Barbara Lawrence of MVZ kindly had photographs prepared for us of the skull of *P. spinipinnis*.

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THE PREHISTORIC DISTRIBUTION OF THE OPOSSUM

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The opossum, *Didelphis marsupialis virginiana* Kerr, is widely distributed throughout the eastern United States. It occurs as far north as southern Ontario (Peterson and Downing, 1956). Hamilton (1943) gives its range as including Connecticut, Rhode Island, Massachusetts, southern Vermont and southern New Hampshire. It does not occur in the Adirondack Mountains nor in the uplands of New England.

The opossum has migrated northward within historic times. Along the Atlantic coast the animal was formerly found no further north than the Hudson