THE STATUS OF CRAVERI'S MURRELET *SYNTHLIBORAMPHUS CRAVERI* AND REOCCUPATION OF A FORMER NESTING AREA

ENRIQUETA VELARDE[1], CARLOS J. NAVARRO[2], ENRICO A. RUIZ[3] & ANDRES AGUILAR[3]

[1]*Instituto de Ciencias Marinas y Pesquerías, Universidad Veracruzana, Hidalgo 617, Col. Río Jamapa, C.P. 94290, Boca del Río, Veracruz, México (enriqueta_velarde@yahoo.com.mx)*
[2]*ONCA MAYA A.C. Playa Copacabana 3049, Col. Primavera, C.P. 64830, Monterrey, Nuevo León, México*
[3]*School of Natural Sciences and Sierra Nevada Research Institute, University of California Merced, 5200 N. Lake Road, Merced, CA 95344, USA*

Received 13 February 2011, accepted 20 October 2011

This work is dedicated to Jesús Ramírez Ruiz who, in 1995, achieved the eradication of introduced rodents in Isla Rasa.

Craveri's Murrelet *Synthliboramphus craveri* is a poorly studied marine bird and the most tropical member of the Alcidae. It is closely related to the Xantus's Murrelet *S. hypoleucus*, which also has a southern distribution, although it is absent from the Gulf of California, where Craveri's is considered quasi-endemic (Anderson 1983).

Craveri's Murrelet is distributed from southern California south to Nayarit in Mexico, including the entire Gulf of California (20°N to 36°N, 104°W to 121°W; Bent 1919, Bancroft 1927, Banks 1963, DeWeese & Anderson 1976, Harrison 1983, American Ornithologists' Union [AOU] 1998, BirdLife International 2000, 2008, Velarde 2000) (Table 1). Its distribution outside the breeding season includes the marine biogeographic regions known as San Diego, Mexican and Gulf of California Provinces (Anderson 1983), including the California and Northern Equatorial Currents and the Gulf of California. Craveri's Murrelet is restricted mainly to the cold, deep waters associated with the eastern coast of Baja California, the open pelagic zone of the mouth of the Gulf of California after breeding, and the southern reaches of the colder waters of the California Current System. It feeds on small pelagic fish, icthyoplankton such as juvenile pelagic and rock fish, and small crustaceans (DeWeese & Anderson 1976, Harrison 1983, Anderson & Palacios 2008).

Craveri's Murrelet is considered vulnerable by the IUCN and endangered under Mexican environmental law (Diario Oficial de la Federación [DOF] 2010). It was formerly listed as threatened under Mexican law, meaning that it is now considered to be at a greater risk. The classification decision is based on the following criteria:

A. Characteristics of geographic distribution: Although the species has a wide distribution during its nonbreeding season, its nesting areas are relatively restricted.

B. Habitat characteristics: The species has very specific nesting habitat requirements, and several of the islands where it nests support introduced predators that could, very likely, extirpate the local nesting populations.

C. Intrinsic biological vulnerability: The species vulnerability is high, owing to its small size and habit of nesting in scattered burrows, and the presence of introduced predators in several of the islands where it nests or used to nest.

D. Impact of human activities: Some human activities have a high negative impact on the species, mainly the high potential for the introduction of exotic species to the islands where the Craveri's Murrelet nests, the risk from pesticides and oil spills (from boats that transport oil to Puerto Libertad, in the state of Sonora on the northeastern coast of the species' core nesting area), and entanglement in fishing nets.

Nesting areas of Craveri's Murrelet have diminished because of direct and indirect human disturbance, such as gill-nets, marine pollution and introduced cats and rodents in the islands where they nest (DeWeese & Anderson 1976, BirdLife International 2000, Mellink 2002). Approximately 95% of the total breeding population is concentrated in the Gulf of California, where it is the only alcid nesting (DeWeese and Anderson 1976, Anderson 1983, Velarde & Anderson 1993). It is reported by the American Ornithologists' Union (AOU 1998) as nesting in most of the Gulf of California and Islas San Benitos, off the Pacific coast of the Baja California peninsula. Although the species has been documented in several islands in the past (Bent 1919, Bancroft 1927, Banks 1963), more recently the species was documented on only some of these islands (Table 1) (DeWeese & Anderson 1976), but no further ground searches have been reported since the 1970s, as is shown in several reviews of the species (Harrison 1983, AOU 1998, BirdLife International 2000, Velarde 2000). Here we report on a review of the historic nesting records published in the literature, and a recent finding demonstrating the reoccupation of a former nesting island by the species.

In comparison with the Xanthus's Murrelet, which has a year-round distribution between British Columbia and the southern tip of the Baja California Peninsula, and a southernmost nesting site at 28°N, the Craveri's Murrelet is definitely a more tropical alcid, distributed between southern California and Nayarit, Mexico, with its southernmost breeding site at 24°N. Both species have been recorded nesting on the San Benitos Islands, where the two subspecies of the Xanthus's Murrelet intergrade (Jehl & Bond 1975).

Craveri's Murrelets begin to arrive in the Gulf of California in January, when they are probably already paired. Nesting occurs on rocky islands, in burrows and crevices or among dense vegetation from just above the high-tide mark to several dozen meters up sea-facing slopes. This is the only time of their life cycle when they return to land (Bancroft 1927, DeWeese & Anderson 1976, Manuwal 1984, BirdLife International 2000, Anderson & Palacios 2008). Nests are generally scattered under rocks and taluses facing the sea. The size of the nesting population in each area may vary from a few nests to several dozens. It is believed that individuals use the same nesting site every year, but they nest only on islands free from introduced ground predators and excessive human disturbance (Table 1) (DeWeese & Anderson 1976, Anderson & Palacios 2008). The species usually lays two eggs during the first two weeks of February (Bent 1919). With a development rate probably similar to other alcids, Craveri's Murrelet chicks depart for the sea after only 2–4 d in the nest (Gaston & Jones 1998). The flightless chicks leave during the night and remain with their parents for up to several months. They are fed larval fishes, small invertebrates and small adult pelagic fishes (Bent 1919, Bancroft 1927, DeWeese & Anderson 1976, Breese *et al.* 1993). The estimated population size is between 10 000 and 20 000 individuals (BirdLife International 2000, 2008).

TABLE 1
Islands with confirmed nesting of Craveri's Murrelets; only records of nesting adults and/or eggs seen or collected, or nests and/or eggshells found are considered

Name of island	Location	Current nesting likely	Date of last survey
Gulf of California Islands:			
Alcatraz[11]	28°49'N, 111°55'W	x	March 2009
Ánimas[5]	28°41'N, 112°54'W	x	May 1974
Bahía de los Ángeles Is.[5]	28°59'N, 113°30'W	x	May 1974
Coronado[8]	26°07'N, 111°16'W	x	April 1920
Encantadas[3]	30°01'N, 114°28'W		April 1970
Espíritu Santo[6]	24°29'N, 110°21'W		March 1887
Estanque[4]	29°03'N, 113°05'W		March 1962
Mejía[5]	29°33'N, 113°34'W		May 1974
Partida Norte (also known as Cardonosa)[5,10]	28°53'N, 113°02'W	x	March 1974
Pelícano[5]	38°48'N, 111°58'W	x	March 1974
Rasa[2]	28°49'N, 112°59'W	x	April 1875
Roca Consag[1,3]	31°07'N, 114°29'W	x	Date not available
Salsipuedes	28°43'N, 112°57'W		Date not available
San Esteban[5]	28°42'N, 112°34'W	x	April 1972
San Francisco[2]	24°50'N, 110°34'W		March 1930
San Ildefonso[2,6,8]	26°37'N, 111°25'W	x	March 1930
San Jorge[3,5,8]	31°00'N, 113°14'W		April 1954
San José[2]	24°58'N, 110°36'W		Date not available
San Luis[3,5]	29°58'N, 114°24'W	x	April 1970
San Pedro Mártir[5,7,9]	28°23'N, 112°18'W	x	March 1991
San Pedro Nolasco[9]	27°58'N, 111°22'W		Date not available
Tiburón[9]	29°00'N, 112°24'W		December 1931
Pacífic Islands:			
San Benitos[5]	28°18'N, 115°35'W		June 1968

[1]AOU 1957, [2]Bent 1919, [3]Bancroft 1927, [4]Banks 1963, [5]DeWeese & Anderson 1976, [6]Grinnell 1928, [7]Breese et al. 1993, [8]van Rossem 1926, [9]van Rossem 1945, [10]Velarde pers. obs., [11]Hurley & Blinick 2011.

Craveri's Murrelet probably is affected by the same predators that affect Xanthus's Murrelet, such as Peregrine Falcon *Falco peregrinus*, Barn Owl *Tyto alba* and Yellow-footed Gull *Larus livens* (in place of the Western Gull *L. occidentalis*), as all of these species are common in the Craveri's Murrelet nesting areas (Drost & Lewis 1995). Owing to the presence of introduced predators, Craveri's Murrelets have been extirpated from some of the islands where they used to nest; for example, Isla Rasa (Bent 1919, Bancroft 1927, Banks 1963, DeWeese & Anderson 1976, AOU 1998, BirdLife International 2000, Velarde & Rodriguez 2000) and presumably San Pedro Martir Island, although one pair of this species was found nesting in 1991 on one of the San Pedro Martir Island satellite offshore rocks (Tershy & Breese 1997) (Table 1). San Pedro Martir supported introduced black rats *Rattus rattus* and house mice *Mus musculus* from the late 1800s until 2007, when an eradication program was successful (http://www.islandconservation.org/accomplishments/?id=3).

In recent years there has been an increased effort to eradicate introduced species from islands in the Gulf of California and the Pacific coast of Baja California (Tershy *et al.* 2002, Velarde *et al.* 2007, http://www.islandconservation.org/accomplishments/?id=3), allowing the Craveri's Murrelet to re-colonize former nesting islands spontaneously. Isla Rasa is a small (approximately 60 ha) rocky island located in the Gulf of California's Midriff Region and the type locality of both adults and eggs of this species. Some adults and eggs were collected by the Craveri brothers, later deposited at the Milano Natural History Museum and described by Salvadori in 1865. The specimens of both adult birds and eggs deposited in the US National Museum (Bent 1919) also came from Isla Rasa. In the late 1800s guano mining took place on several of the Gulf of California islands, and it is believed that black rats and house mice were introduced to Isla Rasa and other islands during this period. By the mid-1900s the nesting populations of both Heermann's Gulls *Larus heermanni* and Elegant Terns *Thalasseus elegans*, of which about 95% of both species' populations nest on Isla Rasa, were greatly reduced, and there were no further records of nesting Craveri's Murrelets (Bahre & Bourillón 2002, Danemann *et al.* 2008).

In 1964 the island received protected status from the Mexican government (DOF 1964), and by the mid-1990s an intensive campaign successfully eradicated all rodents from the island (Velarde *et al.* 2007, Danemann *et al.* 2008). Almost immediately the nesting success of the Heermann's Gull and the population numbers of Elegant Terns increased dramatically (Velarde *et al.* 2007). However, despite 31 consecutive years of seabird population studies on the island, there had been no positive records of nesting Craveri's Murrelets since April 1875 (Bent 1919), although Grinnell (1928) reported collection of these alcids in the Isla Rasa area, and there are records of adult–chick groups at sea from the vicinity of the island (DeWeese and Anderson 1976). The latter authors present a table where they summarize all information available to that date. However, they list all types of records, including those of individuals seen in the vicinity of islands or island groups. In Table 1 we list only reports that indicate records either of nesting adults, or eggs seen or collected, or of nests and/or eggshells.

On 28 May 2007, one of us (C.J.N.) saw and photographed several Craveri's Murrelets on the sea a few meters off Isla Rasa, in a place where no murrelets had been seen during the previous hours. Although the blackish spots or bars on sides of breast characteristic of a juvenile (Harrison 1983) were not visible on the photographs, C.J.N. felt that at least some individuals were young of that year. Although this sighting is inconclusive, there is a possibility that Craveri's Murrelet may be nesting again on Isla Rasa. On 16 May 2010 one of us (E.V.) found an empty eggshell at the entrance to a crevice at the base of one of the cliffs in the south shores of Isla Rasa. From the size and markings of the eggshell it was thought to be a Craveri's Murrelet egg.

To confirm the identity of this eggshell, we sequenced a portion of the mitochondrial cytochrome b gene and compared this sequence to a reference panel of bird species known to nest in Isla Rasa, and other species of the same genus. Previous studies have found eggshells to contain DNA suitable for amplification via polymerase chain reaction (PCR) (Schmaltz *et al*. 2006, Eglob *et al*. 2009, Oskam *et al*. 2010).

To ensure that no foreign DNA could contaminate the sample, and to avoid incorporating sediments and other surface contaminants, eggshell fragments were cleaned on both the inner and outer surfaces with 100% alcohol. Following this, eggshell fragments were weighed and ground with a mortar and pestle. Powder was subsequently transferred to a 2 mL sterile microcentrifuge tube and stored at room temperature for later digestion. All laboratory protocols were done in a dedicated clean room, and the sampling area and tools were decontaminated between processing of the samples to prevent sample contamination. To extract the DNA from eggshell powder, we followed the method of Oskam *et al*. (2010) with slight modifications. We used 500 mg of ground eggshell instead of 100 mg.

The cytochrome b gene was chosen because it has been sequenced for most of the extant avian species nesting on Isla Rasa, allowing for easier and more comprehensive phylogenetic comparison. PCR amplification of approximately 1100 base pair fragment of the cytochrome b gene was carried out using primers L14841 and H16065 (Friesen *et al*. 1996). Amplification was performed using an Applied Biosystems Veriti gradient thermal cycler (Applied Biosystems, Foster City, CA) with the following temperature profile: initial denaturation at 94 °C for 5 min, followed by 35 cycles of 94 °C for 1 min, 51 °C for 1 min and 72 °C for 1 min. After this, a final extension at 72°C for 5 min was applied. Each PCR reaction contained 50–100 ng of DNA, 1× PCR buffer (Applied Biosystems, Foster City, CA), 0.167 µmol/L of each primer, 0.3 mmol/L of each dNTP, 2.5 mmol/L $MgCl_2$, and 0.5 units of AmpliTaq (Applied Biosystems) in a 30 µL reaction. We included negative and extraction controls to detect possible contamination. Amplicons were sequenced with BigDye chemistry (Applied Biosystems) on an Applied Biosystems 3730 DNA Analyzer. Sequences were aligned using Malign v2.7 (Wheeler and Gladstein 1994) and aligned by eye.

To reconstruct the phylogenetic relationships, we used the maximum-likelihood (ML) algorithm in the program PHYML v3.0 (Guindon *et al*. 2010). We determined the appropriate model of DNA evolution and model parameters using both the Akaike information criterion corrected for small sample sizes (AICc) and Bayesian information criterion (BIC) with jModeltest v0.1.1 (Posada 2008). Both of these tests supported the use of the Tamura–Nei model (Tamura and Nei 1993) with a gamma shape parameter (0.226). These model and parameter values, along with optimized base frequency and transition/

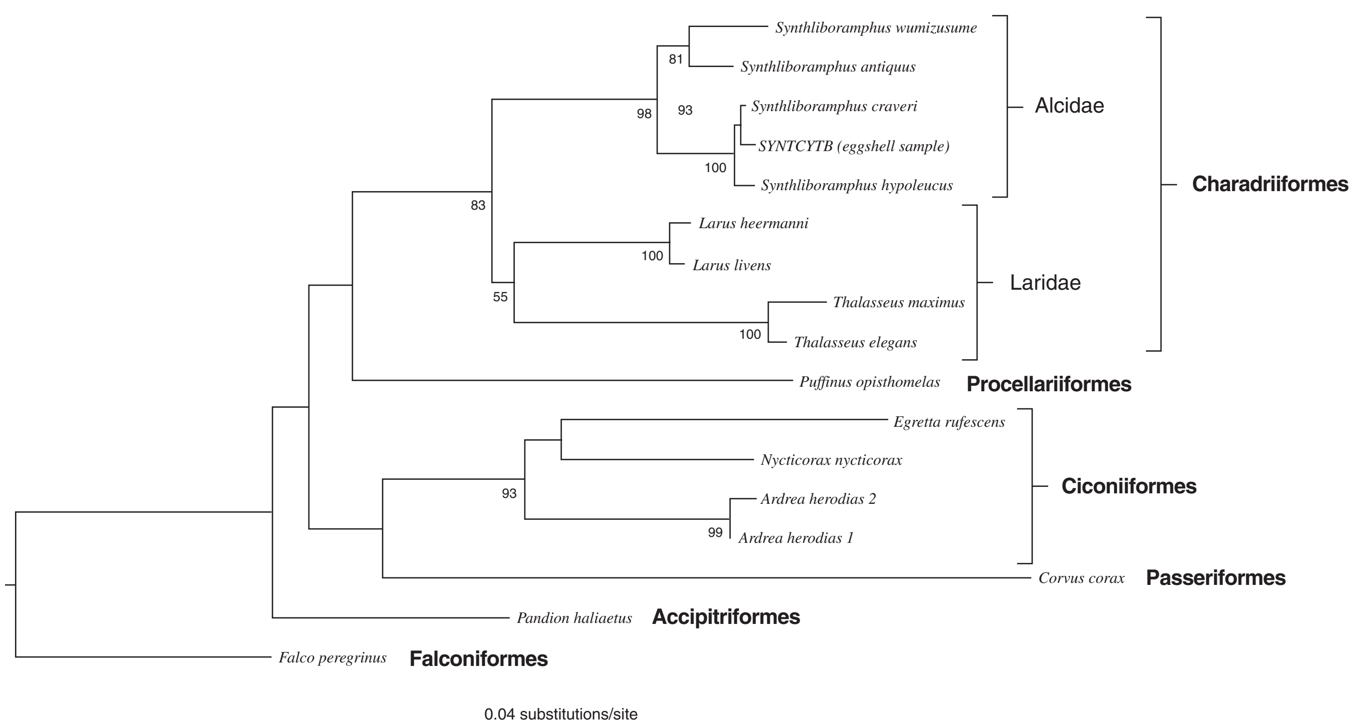

Fig. 1. Maximum likelihood tree based on 1143 bp of the mtDNA cytochrome b gene of nesting birds from Rasa Island plus other murrelets of the genus *Synthliboramphus*, using program PHYML v3.0. Bootstrap values greater than 50 are shown under nodes (or using arrows).

transversion ratio, were used in phylogenetic reconstruction. One thousand bootstrap pseudoreplicates were performed to assess node support. The extant avian species nesting on Isla Rasa, plus other murrelets of genus *Synthliboramphus* (and GenBank accession numbers) used in the phylogenetic analysis were: *Corvus corax* (AY527270), *Falco peregrinus* (U83307), *Pandion haliaetus* (AY987232), *Thalasseus elegans* (AY631302), *Thalasseus maximus* (FJ356187), *Puffinus opisthomelas* (AF076087), *Larus livens* (AF268501), *Larus heermanni* (AF268506), *Synthliboramphus hypoleucus* (U37305), *Synthliboramphus antiquus* (U37303), *Synthliboramphus wumizusume* (U37306), *Synthliboramphus craveri* (U37304), *Egretta rufescens* (U83153), *Nycticorax nycticorax* (AF193829), *Ardea herodias* (AF193821, U83150). The *Falco peregrinus* sequence was used as outgroup.

Our phylogenetic analysis of the cytochrome b sequences supports the following clades: Falconiformes, Procellariiformes, Passeriformes, Ciconiiformes, Accipitriformes and Charadriiformes (Figure 1). Despite the low support for basal clades, the phylogeny closely resembles other previously published avian phylogenetic reconstructions (Gillian *et al*. 2006, Pacheco *et al*. 2011). Within the Alcidae clade all the murrelets of genus *Synthliboramphus* group together and contain the sequence from our eggshell sample (SYNCYTB, Fig. 1). The eggshell sequence grouped with the Craveri's Murrelet cytochrome b sequence with high bootstrap support (93%). Xanthus's murrelet (*S. hypoleucus*) was sister to the Craveri's murrelet sequences. This result demonstrates that the eggshell was from a Craveri's Murrelet and proves the recent nesting of this species on Isla Rasa. Although further studies are needed to determine the number of breeding individuals that occur on Isla Rasa and whether these breeding events result in successful fledging, this confirmed record demonstrates the reoccupation of a former nesting island by the species, a fact that enhances the potential for recovery of this endangered species.

ACKNOWLEDGEMENTS

We want to thank the Dirección General de Vida Silverstre for the research, collection and exportation permits, and the Secretaría de Gobernación for the permit to stay and carry out research activities in Isla Rasa. We received valuable support from the Secretaría de Marina-Armada de México for the transportation of personnel, equipment and supplies to and from the island. We want to thank the personnel of the Comisión Nacional de Áreas Naturales Protegidas (CONANP) of the Sonora and Baja California regional offices for their valuable logistic support. We want to acknowledge funding provided by the Fondo para la Conservación del Golfo de California (provided jointly by Fondo Mexicano para la Conservación de la Naturaleza/Lindblad Expeditions/Packard Foundation), as well as by the UCMEXUS Program, and generous donations from Sue Adams and Ruth Applegarth. Sue Adams has also provided invaluable volunteer help during many field seasons, before, during and after the rodent eradication campaign.

REFERENCES

AMERICAN ORNITHOLOGISTS' UNION (AOU). 1957. Check-list of North American Birds. 5th Edition. Baltimore: American Ornithologists' Union.

AMERICAN ORNITHOLOGISTS' UNION (AOU). 1998. Check-list of North American Birds. 7th Edition. Washington, DC: American Ornithologists' Union.

ANDERSON, D.W. 1983. The seabirds. In: Case, T.J. & Cody, M.L. (Eds.) Island biogeography of the Sea of Cortez. Berkeley: University of California Press. pp. 246-264, 474-481.

ANDERSON, D.W. & PALACIOS, E. 2008. Birds and bird islands in the Bahia de los Angeles Region: status and conservation. In: Danemann, G. & Ezcurra, E. (Eds.) Bahía de Los Angeles: recursos naturales y comunidad, Linea base 2007. México: SEMARNAT/INE/Pronatura NW/San Diego Natural History Museum. pp 523-562.

BAHRE, C.J. & BOURILLÓN, L. 2002. Human impact in the Midriff Islands. In: Case, T.J., Cody, M.L. & Ezcurra, E. (Eds.). A new island biogeography of the Sea of Cortés. Oxford: Oxford University Press. pp. 383-406.

BANCROFT, G. 1927. Notes on the breeding coastal and insular birds of central Lower California. *The Condor* 29: 85-88.

BANKS, R.C. 1963. Birds of the Belvedere Expedition to the Gulf of California. *Transactions of the San Diego Natural History Society* 13: 49-60.

BENT, A.C. 1919. Life histories of North American diving birds. Washington, DC: Bulletin of the US National Museum.

BIRDLIFE INTERNATIONAL. 2000. Threatened birds of the world. Barcelona & Cambridge: Lynx Edicions & Birdlife International.

BIRDLIFE INTERNATIONAL. 2008. Species factsheet: *Synthliboramphus craveri*. Accessed on January 31, 2011. Available at: http://www.birdlife.org/datazone/species/index.html?action=SpcHTMDetails.asp&sid=3312&m=0

BREESE, D., TERSHY, B.R. & CRAIG, D.P. 1993. Craveri's Murrelet: Confirmed nesting and fledging age at San Pedro Martir Island, Gulf of California. *Colonial Waterbirds* 16: 92-94.

DANEMANN, G., EZCURRA, E. & VELARDE, E. 2008. Conservación ecológica. In: Danemann, G. & Ezcurra, E. (Eds.). Bahía de Los Angeles: recursos naturales y comunidad, Linea base 2007. México: SEMARNAT/INE/Pronatura NW/San Diego Natural History Museum. pp. 695-729.

DEWEESE, L.R. & ANDERSON, D.W. 1976. Distribution and breeding biology of Craveri's Murrelet. *Transactions of the San Diego Society of Natural History* 18: 155-168.

DIARIO OFICIAL DE LA FEDERACIÓN. 1964. Decreto que declara Zona de Reserva Natural y Refugio de Aves a la Isla Rasa, Estado de Baja California. Diario Oficial 30 de mayo, México, D.F.

DIARIO OFICIAL DE LA FEDERACIÓN. 2010. Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Jueves 30 de diciembre de 2010. pp. 1-77.

EGLOB, C., LABROSSE, A., HERBERT, C. & CRUMP. D. 2009. A nondestructive method for obtaining maternal DNA from avian eggshells and its application to embryonic viability determination in herring gulls (*Larus argentatus*). *Molecular Ecology Resources* 9: 19-27.

FRIESEN, V.L., BAKER, A.J. & PIATT J.F. 1996. Phylogenetic relationships within the Alcidae (Charadriiformes: Aves) inferred from total molecular evidence. *Molecular Biology and Evolution*. 13: 359-367.

GASTON, A.J. & JONES, I.L. 1998. The Auks: Alcidae (bird families of the world). Cambridge: Cambridge University Press.

GIBB, G.C., KARDAILSKY, O., KIMBALL, R T., BRAUN, E.L. & PENNY, D. 2006. Mitochondrial genomes and avian phylogeny: complex characters and resolvability without explosive radiations. *Molecular Biology and Evolution* 24: 269-280.

GUINDON, S., DUFAYARD, J.F., LEFORT, V., ANISIMOVA, M., HORDIJK, W. & GASCUEL O. 2010. New algorithms and methods to estimate maximum-likelihood phylogenies: assessing the performance of PhyML 3.0. *Systematic Biology* 59: 307-321.

GRINNELL, J. 1928. A distributional summary of the ornithology of Lower California. *University of California Publications in Zoology* 32: 1-300.

HARRISON, P. 1983. Seabirds, an identification guide. Boston: Houghton Mifflin Co.

HURLEY, E.K. & BLINICK, N.S. 2011. Fledging chronology of Craveri's Murrelet *Synthliboramphus craveri* on Isla Alcatraz, Gulf of California, Mexico. *Marine Ornithology* 39: 275-277.

JEHL, J.R. & BOND, S.I. 1975. Mophological variation and species limits in murrelets of the genus *Endomychura*. *Transactions of the San Diego Society of Natural History* 18: 9-23.

MANUWAL, D. 1984. Alcids. In: Haley, D.J. (Ed.) Seabirds of Eastern North Pacific and Arctic waters. Seattle: Pacific Search Press.

MELLINK, E. 2002. Invasive vertebrates on islands of the Sea of Cortés. In: Tellman, B. (Ed.) Invasive exotic species in the Sonoran region. Tucson: University of Arizona Press. pp. 112-125.

OSKAM, C.L., HAILE, J., MCLAY, E., RIGBY, P., ALLENTOFT, M.E., OLSEN, M.E., BENGTSSON, C., MILLER, G.H., SCHWENNINGER, J-L., JACOMB, C., WALTER, R., BAYNES, A., DORTCH, J., PARKER-PEARSON, M., GILBERT, M.T.P., HOLDAWAY, R.N., WILLERSLEV, E. & BUNCE, M. 2010. Fossil avian eggshell preserves ancient DNA. *Proceedings of the Royal Society B* 277: 1991-2000.

PACHECO, M.A., BATTISTUZZI, F.U., LENTINO, M., AGUILAR, R.F., KUMAR, S., & ESCALANTE, A.A. 2011. Evolution of modern birds revealed by mitogenomics: timing the radiation and origin of major orders. *Molecular Biology and Evolution* 28: 1927-1942.

POSADA, D. 2008. jModelTest: phylogenetic model averaging. *Molecular Biology and Evolution* 25: 1253-1256.

SCHMALTZ, G., SOMERS, C.M., SHARMA, P., & QUINN, J.S. 2006. Non-destructive sampling of maternal DNA from the external shell of bird eggs. *Conservation Genetics* 7: 543-549.

SIBLEY, D.A. 2003. The Sibley field guide to birds of western North America. New York: Knopf, Inc.

TAMURA, K. & NEI, M. 1993. Estimation of the number of nucleotide substitutions in the control region of mitochondrial DNA in humans and chimpanzees. *Molecular Biology and Evolution* 10: 512-526.

TERSHY, B. R. & BREESE, D. 1997. The birds of San Pedro Martir Island, Gulf of California. *Western Birds* 28: 96-107.

TERSHY, B. R., DONLAN, C. J., KEITT, B., CROLL, D., SÁNCHEZ, J.A., WOOD, B., HERMOSILLO, M.A., HOWALD, G. & BIAVASCHI, N. 2002. Island conservation in northwest Mexico: A conservation model integrating research, education and exotic mammal eradication. In: Veitch, C.R. & Clout, M.N. (Eds.). Turning the tide: the eradication of invasive species. Gland: IUCN SSC Invasive Species Specialist Group, IUCN. pp. 293-300.

VAN ROSSEM, A.J. 1926. The Craveri Murrelet in California. *Condor* 28: 80-83.

VAN ROSSEM, A.J. 1945. A distributional survey of the birds of Sonora, Mexico. *Museum of Zoology Louisiana State University Occasional Paper* No. 21.

VELARDE, E. 2000. Mérgulo de Craveri (*Synthliboramphus craveri*). In: Ceballos, G. & Márquez Valdelamar, L. (Eds.). Las Aves de México en Peligro de Extinción. México D.F.: Fondo de Cultura Económica/UNAM/CONABIO. pp. 169-171.

VELARDE, E. & ANDERSON, D.W. 1993. Conservation and management of seabird islands in the Gulf of California: setbacks and successes. In: Nettleship, D.N., Burger, J. & Gochfeld, M. (Eds.). Seabirds on islands: threats, case studies and action plans. Cambridge. International Council for Bird Preservation Technical Publications. pp. 721-767.

VELARDE G., E. & RODRIGUEZ A., E. 2000. Isla Rasa. In: Arizmendi, M.C. & Márquez, V.L. (Eds.) Áreas de Importancia para la Conservación de las Aves en México. México, D.F. CONABIO. pp. 178-179.

VELARDE, E., EZCURRA, E., CISNEROS, M.A. & LAVIN, M. 2007. Uso de las áreas naturales protegidas para recabar series de tiempo de largo plazo: el caso de las aves marinas para predecir la pesca comercial de la sardina Monterrey en el Golfo de California. In: Halffter, G., Guervara, S. & Melinc, A. (Eds.). Hacia una cultura de conservación de la diversidad biológica. M3M — Monografías Tercer Milenio, Vol. 6. Zaragoza, SEA, CONABIO, CONACYT, INECOL. UNESCO-MaB & Ministerio Medio Ambiente-Gobierno de España S.E.A. pp. 71-77.

WHEELER, W.C. & GLADSTEIN, D.S. 1994. MALIGN — A multiple sequence alignment program. *Journal of Heredity* 85: 417-418.