On the presence of N*asua* Storr (Carnivora, Procyonidae) in the Buenos Aires province in the late Holocene

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Abstract: The genus *Nasua* is represented by two species, *Nasua nasua* and *Nasua narica*. Its current distribution spans from the south of North America to the north of the Rio Negro in Uruguay. Both species of the genus inhabit a great number of forested habitats. In Argentina, the species *Nasua nasua* is found in Tucuman, Jujuy, Chaco, Formosa and the northeast of Santa Fe. In the present contribution we describe a lower canine of *Nasua nasua* from the late Holocene of the Arroyo Fredes archaeological site, in the Parana's Delta, Buenos Aires Province, Argentina, which is outside the current distribution of this species. We compared the canine with several specimens of *Nasua nasua* both males and females. Given the strong sexual dimorphism observed in the canines of this species, we recognized the specimen as a male. Two hypotheses can explain the presence of this specimen in the Parana's Delta of Buenos Aires: (1) Current and past climatic similarities between the southernmost record of the species and the Arroyo Fredes archeological site, and the corridor effect caused by the gallery forests. (2) Human transport by the guaranies.

Keywords: *Nasua*. Procyonidae. Parana's delta. Late Holocene.

Resumen: Sobre la presencia de *Nasua* Storr (Carnivora, Procyonidae) en la provincia de Buenos Aires en el Holoceno tardío. El género *Nasua* está compuesto por dos especies, *Nasua nasua* y *Nasua narica*. Se distribuye en la actualidad desde el sur de América del Norte hasta el norte del Río Negro en Uruguay. Ambas especies habitan un gran número de ambientes arbolados. En Argentina la especie *Nasua nasua* se encuentra en Tucuman, Jujuy, Chaco, Formosa y el Noreste de Santa Fe. En esta contribución describimos un canino inferior de *Nasua nasua* del Holoceno tardío del Sitio Arqueológico Arroyo Fredes en el Delta del Parana de la Provincia de Buenos Aires, Argentina, que se encuentra por fuera de la distribución actual de la especie. Comparamos el canino con

varios especímenes de *Nasua nasua,* tanto machos como hembras. Dado el fuerte dimorfismo sexual observado en los caninos, pudimos reconocer al espécimen como un macho. Dos hipótesis pueden explicar la presencia de este espécimen en el Delta del Paraná de Buenos Aires (1) Las similitudes entre las condiciones climáticas actuales y en el pasado entre la localidad actual más cercana y el sitio arqueológico Arroyo Fredes y el efecto corredor causado por los bosques en galería. (2) Transporte humano por los guaraníes.

Palabras clave: *Nasua*. Procyonidae. Delta del Parana. Holoceno tardío.

INTRODUCTION

The genus *Nasua* Storr is represented by two species, the white-nose coati (*Nasua narica* Linnaeus) and the South American Coatí (*Nasua nasua* Linnaeus) (Wilson & Mittermeier, 2009). *Nasua narica* is currently distributed in the south of North America, Mexico, Colombia, Peru and Ecuador, while *Nasua nasua* is found in South America from Colombia and Venezuela to Uruguay (Gompper, 1995; Gompper & Decker, 1998; Wilson & Mittermeier, 2009). In Argentina, it is found in Tucuman, Jujuy, Chaco, Formosa and the northeast of Santa Fe (Gompper & Decker, 1998; Pautasso, 2008, Wilson & Mittermeier, 2009; Barquez *et al*., 2006; Cannevari & Vaccaro, 2007).

The first appearances for the genus were recorded in North America in the Late Miocene of Florida (Baskin, 1988) and the Early Pliocene of Texas (Dalquest, 1978; Baskin, 1998). In South America its record is limited to one specimen from the Late Pleistocene of Minas Gerais, Brazil (Gervais & Ameghino, 1880) and one specimen, referred as cf. *Nasua* (Hoffstetter, 1963) from the Ensenadan of Tarija, Bolivia, with an unclear stratigraphic provenance (Marshall *et al.*, 1984; Hoffstetter, 1986).

In the present contribution, we describe the first record of *Nasua* and the species *N. nasua* from the Delta of the Parana River, Buenos Aires Province, Argentina. We provide alternative hypotheses explaining this finding outside the current distribution of the species.

MATERIALS AND METHODS

We compared the fossil specimen (INAPL-AF2, Instituto Nacional de Antropología y Pensamiento Latinoamericano) with 23 specimens of *Nasua nasua* deposited in the Division of Mastozoologia from the Museo Argentino de Ciencias Naturales “Bernardino

Rivadavia". We measured the 23 specimens of *Nasua nasua*, both male and females, and a specimen of *Nasua narica*, using a digital caliper of 0.01 mm. The measurements taken were the length (Lc1), width (Wc1) and height (Hc1) of the lower canine (Supplementary data 1). We plotted the measurements in a scatter plot graph to illustrate the determination of the sex of INAPL-AF2.

We compared the different bioclimatic conditions (supplementary data 2) obtained from the latest historical (not fossil) databases (Hijmans *et al*., 2005) for the southernmost location where *Nasua nasua* is recorded at the Rio Negro river, Uruguay, and the Arroyo Fredes archaeological site, Buenos Aires, Argentina. A similar analysis was made using the bioclimatic conditions suggested for the Last Glacial Maximum (LGM) (Collins *et al*., 2004).

RESULTS

SYSTEMATIC PALEONTOLOGY

Order CARNIVORA Bowdich, 1821

Family PROCYONIDAE Gray, 1825

Genus ***Nasua*** Storr, 1780

Type species. *Viverra nasua* Linnaeus, 1766.

Nasua nasua (Linnaeus, 1766)

Figure 2.A–D, 4.A–B

Studied material. An isolated left lower canine (INAPL-AF2) (Fig. 2.1–4).

Stratigraphic and geographic provenance. Arroyo Fredes Archaeological site (34° 13' 50,70" S 58° 23' 32,52" W), San Fernando, Buenos Aires Province, Argentina. (Figure 1)

The Arroyo Fredes archaeological site is located on a fluvial bank in the island sector of the San Fernando district, which belongs to Delta and Paraná Islands ecoregion (*sensu* Burkart *et al.*, 1999). The archaeological site was formed by Amazonian horticulturalist groups, historically known as g*uaraníes* (Loponte & Acosta, 2003-2005). The archaeological record includes pottery, lithic artifacts, faunal remains and primary human burials. All these materials were arranged in the 10-35cm thickness current soil horizon (horizon A). Underneath, the C horizon is composed by a substratum of fluvial sands and clays, which was the basis for the development of fluvial banks and is sterile in archaeological materials. Three radiocarbon dates show a temporal range from 690-370 ^{14}C years BP for this occupation (see Loponte *et al*., 2011 for details). INAPL-AF2 was recovered in the digging unit 6 (DU6). A capybara (*Hydrochaeris hydrochaeris)* bone fragment from DU6 was dated in 402 ± 40 ^{14}C years BP (δC^{13} -12 ‰) 1431-1525 years AD (AA 77309; calibrated according to Fairbanks *et al*., 2005; see Loponte *et al.*, 2011). INAPL-AF2 comes from an archaeofaunal context together with marsh deer (*Blastocerus dichotomus*), capybara (*H. hydrochaeris),* coypus (*Myocastor coypus*) and fishes (Characiformes and Siluriformes) (Acosta & Mucciolo, 2009; Musali, 2010; Loponte *et al.*, 2011). All these taxa are typical from the insular sector of Paraná Delta present in the area since 2500 years BP, suggesting an ecological situation similar to the current one (Loponte *et al.*, 2012).

FIGURE 1.

Description. The specimen is a complete left lower canine with a high degree of wear in its distal margin, which forms a strong vertical facet. The canine presents one cusp

and one root and it is subtriangular in cross-section. Its crown is high and narrow with two grooves on its labial and lingual sides. A shallow labial groove extends on the lower half of the canine. The lingual groove is deeper and extends to the tip of the tooth. The root also presents two shallow lateral grooves which run longitudinally on the lingual and labial sides. These lateral grooves are independent from the grooves of the crown. The enamel occupies half of the tooth length, except in the mesial side of the crown where it occupies less than the half of the tooth length.

FIGURE 2.

DISCUSSION

The morphology of INAPL-AF2 with its subtriangular outline and the labial and lingual lateral grooves is coincident with the features observed in the specimens of the genus *Nasua*. Among other procyonids, grooved canines were mentioned in the Potosinae (Ahrens, 2012; Decker & Wozencraft, 1991). In *Potos* and *Bassaricyon* both labial and lingual grooves can be observed (Ahrens, 2012). However both species are considerably smaller than *Nasua nasua*. Also, the canines of both species show a rounded cross-section. The canines of *Nasuella olivacea* are grooved as in the genus *Nasua* (Ahrens, 2012) but this species is characterized for being smaller than *Nasua* (Hollister, 1915). Other orders of carnivoran mammals have conical lower canines that are subelliptical in cross-section and the grooves on the crown, when present, are shallower than the grooves of *Nasua*. The crowns of the upper canines of *Nasua* are flat in cross-section and the base of the crown is wider than the tip which gives the element a triangular shape. Lower canines of *Nasua* are subtriangular in cross-section and the crown is mesially curved and distally straight. The

morphology of INAPL-AF2 is coincident with the morphology of the lower canines of *Nasua*. The size of the element is in the range of the size of the specimens of *Nasua nasua* here measured (Figure 3).

FIGURE 3.

Nasua nasua shows a strong sexual dimorphism with the females smaller than the males (Gompper & Decker, 1998). The anatomy of the lower canines differs between sexes: in the males it is tall with two distinct longitudinal grooves on the labial and lingual sides of the crown; while in the females, it is lower than in the males with a shallower labial groove. The specimen described here is coincident with the morphology observed in the males of *Nasua nasua*. The size of INAPL-AF2 is coincident with the size of the males of *Nasua nasua* (Figure 3).

The distinction between *Nasua nasua* and *Nausa narica* is based on characters of the pelage (white muzzle pelage in *Nasua narica* and brown of grey in *N. nasua*), palate (depressed along the midline in *Nasua narica* and flat in *N. nasua*) and the nasal bones (the sides of the nasal bones are parallel and not converge posteriorly in *Nasua narica* and converging posteriorly in *N. nasua*) (Gompper & Decker, 1998; Gompper, 1995). Both species are similar in size and the degree of sexual dimorphism (Gompper & Decker, 1998; Gompper, 1995). The morphology of the lower canine is similar in *Nasua nasua* and *Nasua narica* and we cannot discriminate both species on the basis of this element (Gompper, 1995). Considering that *Nasua narica* is restricted to Central and North America and the Northwestern part of South America (Colombia and Ecuador) (Gompper, 1995; Wilson &

171 Mittermeier, 2009) we suggest that INAPL-AF2 could tentatively correspond to *Nasua*
172 *nasua* given its current distribution (Gompper, 1995; Wilson & Mittermeier, 2009).

173 *Nasua nasua* inhabits a great number of forested habitats including rainforest, cloud
174 forest, xeric Chaco, dry scrub forest and gallery forest from Colombia and Venezuela,
175 reaching Uruguay, the south of Brazil, and the north part of Argentina (Gompper and
176 Decker, 1982; Pautasso, 2008; Wilson and Mittermeier, 2009). Its austral limit is the Rio
177 Negro River, Uruguay (González and Martínez-Lafranco). INAPL-AF2 was collected in
178 the zone of the Paraná River delta and it represents the first record of *Nasua nasua* in the
179 Buenos Aires province. The distance between the Arroyo Fredes archaeological site and the
180 southernmost record of the species in Argentina is ca. 1000 Km (Gompper and Decker,
181 1998; Pautasso, 2008; Wilson and Mittermeier, 2009; Barquez et al., 2006; Cannevari and
182 Vaccaro, 2007). However, this archaeological site is ca. 100 km from the southernmost
183 record of the species considering its current distribution, in the north of Rio Negro River in
184 Uruguay (González and Martínez-Lafranco, 2010).

185 Two hypotheses can explain the presence of *Nasua* in the Delta Region of Buenos
186 Aires: (1) climatic or (2) human causes. Similarities between current and past (at least for
187 the LGM) climatic conditions recorded in the joint of the Rio Negro and Uruguay rivers in
188 Uruguay and the Arroyos Fredes archaeological site (compared using the databases from
189 Hijmans *et al.*, 2005 and Collins *et al*., 2004; Supplementary data 2), the short distance
190 between both localities, and the effect of corridor caused by the gallery forests of the
191 Parana and Uruguay rivers (Fracassi *et al*., 2010; Bo *et al*., 2002) makes likely the presence
192 of *Nasua nasua* in the Paraná Delta. Contemporary ecological conditions in the Paraná
193 Delta were already established by 2300 years ago, according to the material recorded from

194 the non-ceramic level of Islas Lechiguanas archaeological site (Loponte *et al*., 2012).
195 Archaeofaunal record until the XVI century, including that from the Arroyo Fredes, does
196 not show different compositions which can sustain climate changes (Acosta, 2005;
197 Loponte, 2008; Arrizurieta *et al*., 2010; Loponte *et al*., 2011). However, during the Late
198 Holocene, in particular between 700-400 years BP, more humid conditions where
199 registered in the Pampean region and in South Eastern Uruguay, which was correlated with
200 the Medieval Warm Period (Tonni *et al*., 1999; Tonello & Prieto, 2010; Stutz *et al*., 2006;
201 Del Puerto *et al*., 2011). Warmer and more humid climatic conditions as a product of the
202 MWP could have favored the presence of Nasua in the Parana River delta.

203 On the other hand, the presence of *N. nasua* in Arroyo Fredes also can be explained
204 by anthropic activities. It is known that the Uruguay River was one of the main venues for
205 Amazonian horticultural groups, which peopled the Paraná Delta and the upper estuary of
206 the Río de la Plata (Loponte *et al*., 2011). The distribution of *N. nasua* greatly overlaps that
207 of the *guaraní* archaeological record, and therefore human transport could be a possible
208 factor to explain the presence of the tooth in the area under study. In addition, ethnographic
209 information indicated that the historic *guaraníes* captured and tamed coatis (Azara, 1802;
210 Remorini, 2009). Teeth handling is a behavior well documented in different hunter-gatherer
211 groups of the Low Paraná wetland (Acosta *et al*., 2013). However, the specimen under
212 study does not show macroscopic, intentional modifications. Analyzed under high
213 magnifications, the enamel of the canine has a particular microwear formed by narrow,
214 superficial and smooth striations disposed in a crossed multidirectional pattern (Figure 4).
215 Similar microwear was experimentally obtained in bone items simulating transport and
216 manipulation (*cf.* D'Errico, 1993). Faunal teeth and other anatomic units were recorded as

amulets in many hunter-gatherer contexts, being their meaning related to utilitarian and symbolic factors. Frequently, as can be the case under study, these items are not modified but set aside, conserved and transported among people (see Acosta *et al*., 2013 for a detailed discussion).

FIGURE 4.

CONCLUSIONS.

The specimen described here (INAPL-AF2) can be assigned to the genus *Nasua*. Given the current distribution of the species of *Nasua* (*Nasua narica* and *Nasua nasua*) we tentatively assigned the specimen to the species *Nasua nasua*. INAPL-AF2 represents the first record of *Nasua* in the Buenos Aires Province and the southernmost record of the genus. The current and past climatic similarities between the Rio Negro in Uruguay and the Arroyo Fredes archeological site, and the corridor effect caused by the gallery forests in the Paraná River delta can explain the presence of *Nasua* in the Buenos Aires province. On the other hand, its presence in the site can be explained by human transport by the *guaranies*. With the current evidence both hypotheses are equally likely and further evidence is needed to clarify this issue.

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Fig. 1. **A,** map showing the location of the Arroyo Fredes archaeological site. **B,** stratigraphic column of the Arroyo Fredes archaeological site.

Fig. 2. INAPL-AF2. **A,** lingual; **B,** labial; **C,** mesial and **D,** distal views. Scale bar equal 5 mm.

Fig. 3. Biplots of the linear measurements obtained from the specimens of *Nasua nasua, Nasua narica* and INAPL-AF2showing the distinction between males and females and the

363 position of the fossil among them. **A,** length of the canine (horizontal axis) vs. width of the
364 canine (vertical axis); **B,** height of the canine (horizontal axis) vs. width of the canine
365 (vertical axis).

366 Fig. 4. INAPL-AF2 Metallurgical microscope: narrow, superficial and smooth striations
367 disposed in crossed multidirectional pattern. Scale bars equal: 100 µ and 50 µ respectively.

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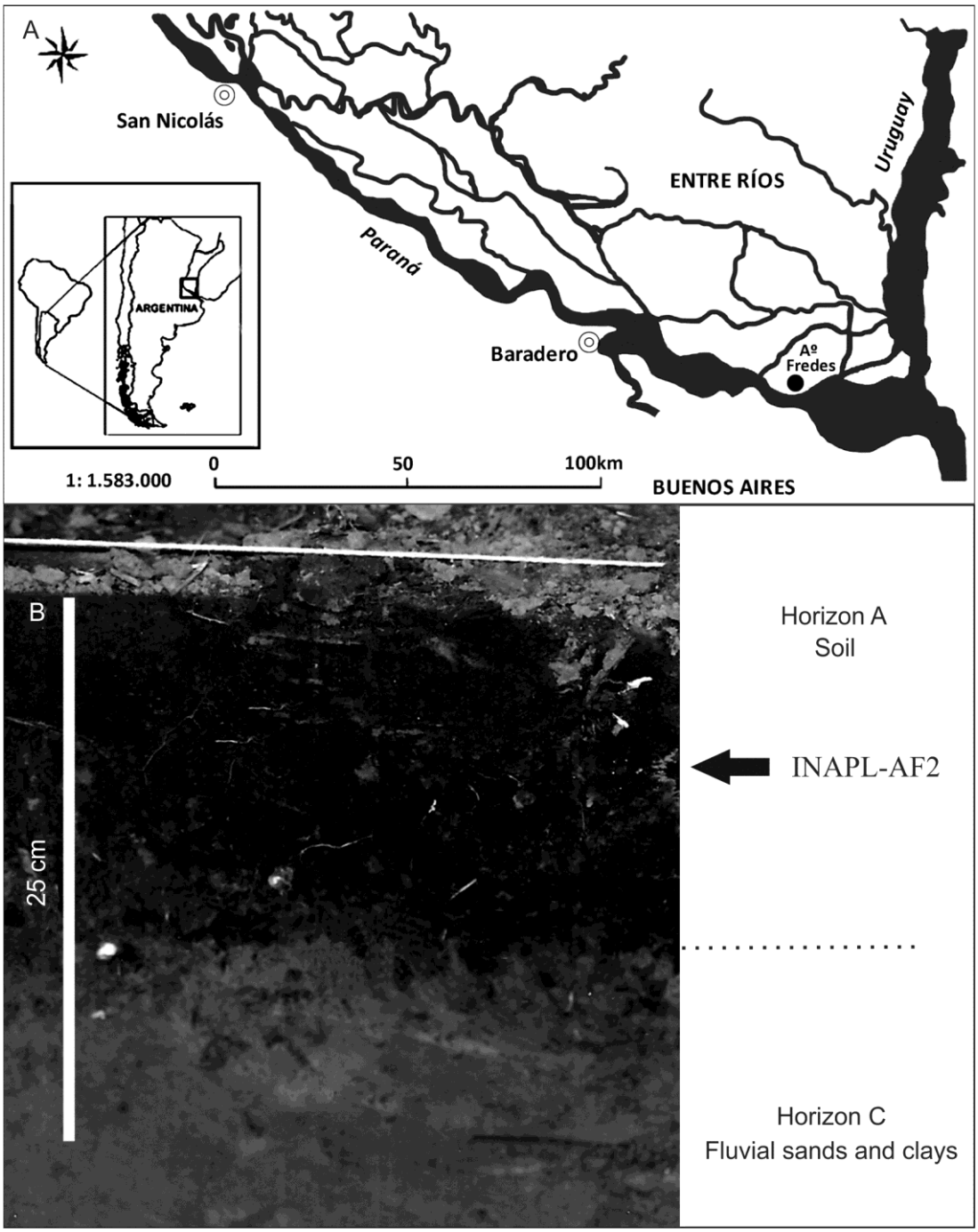
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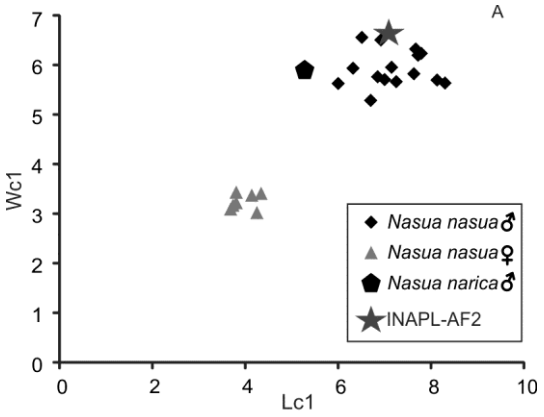
B
25 cm
Horizon A
Soil
INAPL-AF2
Horizon C
Fluvial sands and clays

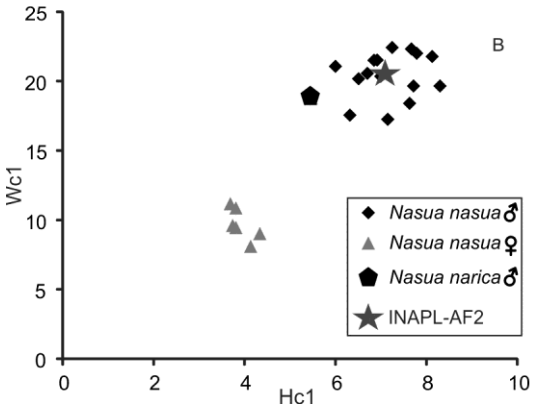
369

370


A
B
C
D

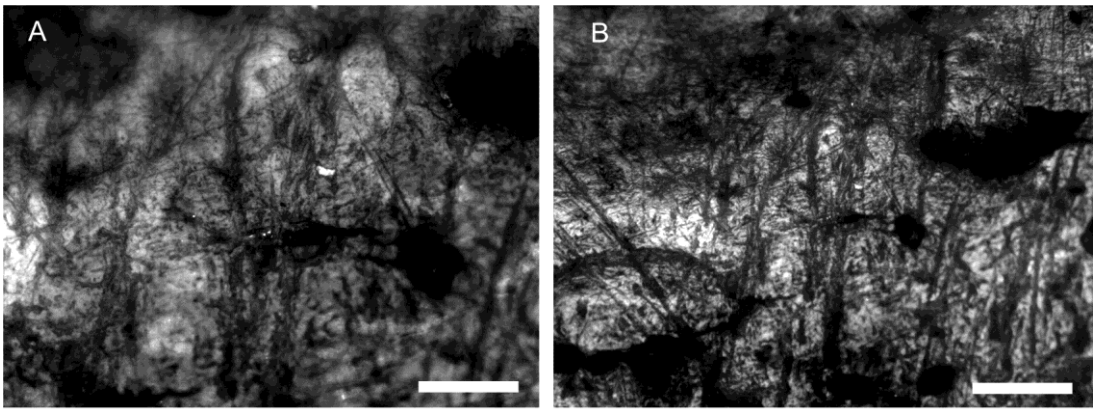
371


A
Wc1
Lc1
Nasua nasua♂
Nasua nasua♀
Nasua narica♂
INAPL-AF2


B
Wc1
Hc1
Nasua nasua♂
Nasua nasua♀
Nasua narica♂
INAPL-AF2

372

373


A
B