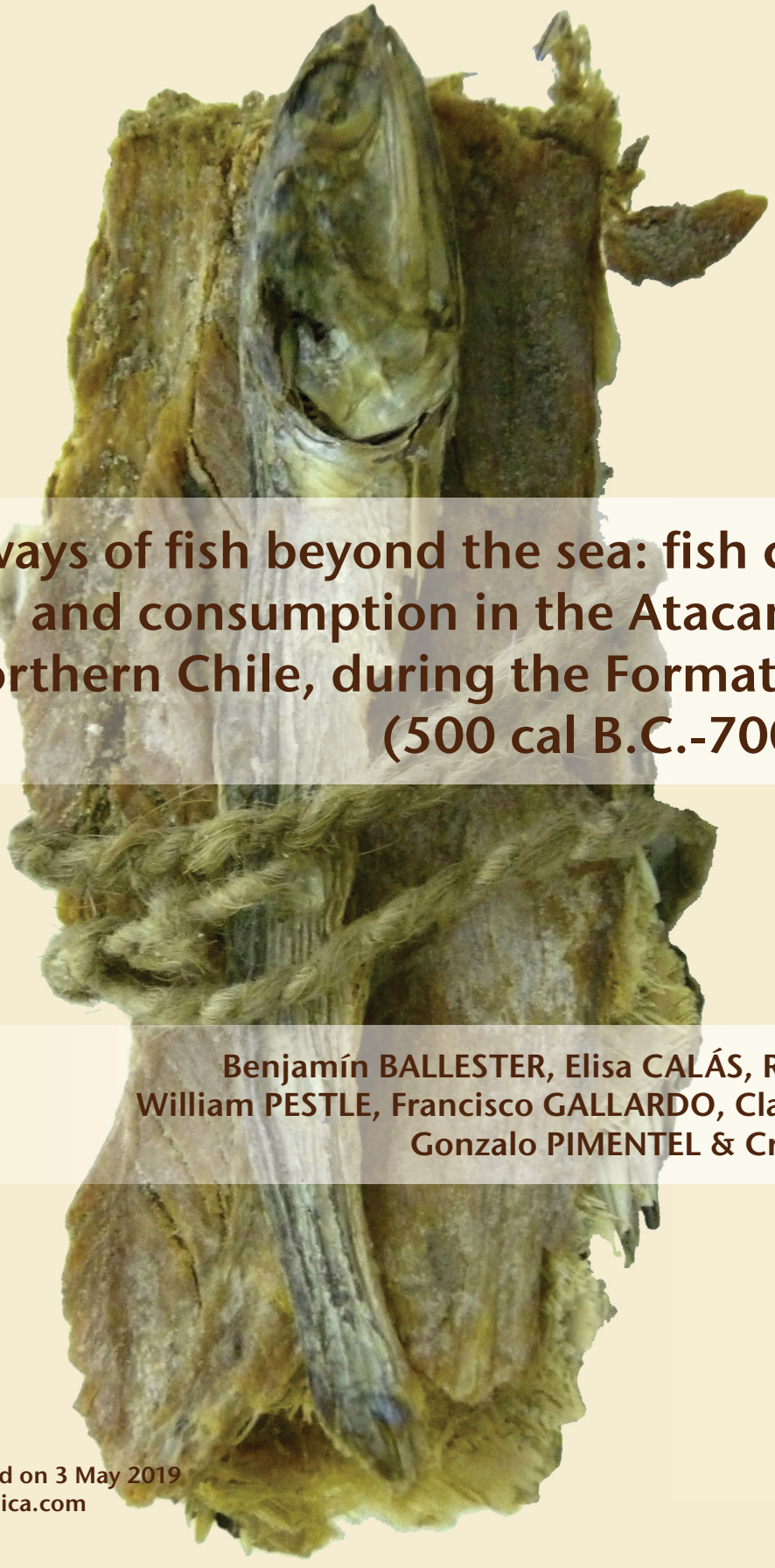
anthropozoologica

2019 • 54 • 6



The ways of fish beyond the sea: fish circulation and consumption in the Atacama desert, northern Chile, during the Formative period (500 cal B.C.-700 cal A.D.)

Benjamín BALLESTER, Elisa CALÁS, Rafael LABARCA, William PESTLE, Francisco GALLARDO, Claudia CASTILLO, Gonzalo PIMENTEL & Cristóbal OYARZO

art. 54 (6) — Published on 3 May 2019
www.anthropozoologica.com

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Aliment trouvé dans le cimetière Topater 01, composé de deux types de poissons attachés par une corde tressée : un anchois complet et un filet désossé d'un plus gros poisson. Photographie : F. Gallardo. / *Composite food found in Topater 01 cemetery, made of two kind of fishes tied together by a braided rope: a complete anchoveta and a boneless fillet of a bigger fish. Photograph: F. Gallardo*.

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Anthropozoologica est distribué en version électronique par / Anthropozoologica *is distributed electronically by:*

– BioOne® (http://www.bioone.org)

Anthropozoologica est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris, avec le soutien du CNRS.
Anthropozoologica *is a fast track journal published by the Museum Science Press, Paris, with the support of the CNRS.*
Les Publications scientifiques du Muséum publient aussi / *The Museum Science Press also publish:*
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diff.pub@mnhn.fr / http://sciencepress.mnhn.fr

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ISSN (imprimé / *print*) : 0761-3032 / ISSN (électronique / *electronic*) : 2107-08817

The ways of fish beyond the sea: fish circulation and consumption in the Atacama desert, northern Chile, during the Formative period (500 cal B.C.-700 cal A.D.)

Benjamín BALLESTER
UMR7041 Archéologies et Sciences de l'Antiquité (ArScAN), Équipe Ethnologie préhistorique, CNRS, Université Paris 1 Panthéon-Sorbonne, Université Paris Nanterre, Ministère de la Culture, 21, Allée de l'Université, F-92023 Nanterre Cedex (France)
benjaminballesterr@gmail.com

Elisa CALÁS
Programa de Doctorado en Arqueología Universidad de Buenos Aires, Puan 430, CABA, C1406CQJ (Argentina)
elisa.calas@gmail.com

Rafael LABARCA
Escuela de Arqueología, Universidad Austral de Chile, Sede Puerto Montt, Los Pinos s/n, Puerto Montt (Chile)
r.labarca.e@gmail.com

William PESTLE
Department of Anthropology, University of Miami, 5202 George E Merrick St, Coral Gables, FL-33146 (United States)
w.pestle@miami.edu

Francisco GALLARDO
Centro de Estudios Interculturales e Indígenas (CIIR), Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, Campus San Joaquín, Antropología UC, 2 do piso Macul, Santiago 7820436 (Chile)
fgallardo.ibanez@gmail.com

Claudia CASTILLO
Independent researcher claucasbat@gmail.com

Gonzalo PIMENTEL
Fundación Patrimonio Desierto de Atacama, Santa Victoria 45, Santiago de Chile (Chile)
gpimentel@desiertoatacama.com

Cristobal OYARZO
Independent researcher cristobaloyarzo@gmail.com

Submitted on 19 April 2018 | Accepted on 26 September 2018 | Published on 3 May 2019

Ballester B., Calás E., Labarca R., Pestle W., Gallardo F., Castillo C., Pimentel G. & Oyarzo C. 2019. — The ways of fish beyond the sea: fish circulation and consumption in the Atacama desert, northern Chile, during the Formative period (500 cal B.C.-700 cal A.D.). *Anthropozoologica* 54 (6): 55-76. https://doi.org/10.5252/anthropozoologica2019v54a6. http://anthropozoologica.com/54/6

ABSTRACT
Along the Atacama Desert coast, fish has always been a staple food and by the Formative period (500 cal B.C.-700 cal A.D.) it had become a product in high demand by the inhabitants of the inland valleys, oases and ravines of the desert. In this paper we explore the technologies used in coastal fishing activities, the diverse species caught, and fish processing and preserving techniques. We further examine the circulation routes of the product through the desert and associated strategies, the agents involved in transporting it and consumption levels in inland villages. Our study employs a multivariate analysis that includes evidence from zooarchaeology, stable isotope analysis of deceased individuals, and the composition of human coprolites, all of which were recovered from domestic waste, funerary contexts, and rest stops associated with the circulation routes running between the coast and the inland desert regions. Our results suggest that in this ancient social context, food was not only used to quell hunger, but through its associated economic cycles of production, circulation and consumption, was part of a complex and extended web of social relations. Within that network, food functioned as material culture, and as such enabled social distinctions to emerge within local groups and cultural negotiations to be conducted among different localities. Fish circulation and consumption played an active role in the reproduction of a social structure characterized by close and firm ties between marine hunter-fisher-gatherers and agropastoral communities, despite their long distance from each other.

KEY WORDS
Dried fish,
exchange,
culinary,
stable isotopes,
ichthyology,
Formative period.

RÉSUMÉ
La route du poisson au-delà de la mer : circulation et consommation de poisson dans le désert d'Atacama, au nord du Chili, durant la période Formative (500 av. J.-C.-700 apr. J.-C.).
Le long de la côte du désert d'Atacama, le poisson a toujours été un aliment de base et dès la période Formative (500 av. J.-C.-700 apr. J.-C.), il devint un produit très convoité par les habitants des vallées, oasis et ravins des terres intérieures du désert. Dans cet article, nous explorons les technologies employées dans la pêche côtière, la diversité des espèces capturées et les techniques de traitement et de conservation du poisson. Nous examinons ensuite les voies de circulation de ce produit à travers le désert, ainsi que les stratégies et les agents associés dans son transport. Enfin, nous évaluons sa consommation dans les villages intérieurs. Notre étude utilise une analyse multivariée incluant des éléments issus de la zooarchéologie, l'analyse isotopique stable d'individus décédés et la composition des coprolithes humains, provenant tous de sites domestiques et funéraires, ainsi que de sites de repos temporaires associés aux voies de circulation entre la côte et l'intérieur du désert. Nos résultats suggèrent que, dans ce vaste contexte social et historique, les aliments ont non seulement été employés pour apaiser la faim, mais qu'à travers les différents cycles économiques de production, circulation et consommation qui leur sont liés, ils ont également intégré un réseau complexe de rapports sociaux. Dans ce cadre, les aliments auraient fonctionné comme une culture matérielle et, en tant que telle, auraient contribué à l'émergence de distinctions sociales et à l'établissement de négociations culturelles entre les différentes populations locales. La circulation et la consommation de poisson jouaient ainsi un rôle actif dans la reproduction d'une structure sociale caractérisée par des liens étroits et fermes entre les collectifs de chasseurs-pêcheurs-cueilleurs du littoral et les communautés agropastorales du désert intérieur, malgré leur éloignement géographique.

MOTS CLÉS
Poisson séché,
échange,
culinaire,
isotopes stables,
ichtyologie,
période Formative.

INTRODUCTION

According to the *Glosario de la lengua atacameña* compiled by Emilio Vaïsse *et al.* (1896: 16), among the people of the Atacama Desert valleys and oases the word "ckackchi" was used interchangeably to refer both to "fish" and as a descriptor for any food that was "good, pleasant, and tasty to the palate". More than a linguistic coincidence, the double meaning of the word "ckackchi" shows clearly the level of respect and affinity that groups of the Atacama interior had for this foreign product.

However, the history of such dietary predilections can be difficult to reconstruct with any scientific certainty by archaeological means alone, as it requires discerning subtle aspects of personal and group appreciation that do not leave material traces. What archaeologists can hope to elucidate instead are aspects of the production, circulation, and consumption of these highly valued foods. In the present case, evidence attesting to these processes includes the preserved traces of exchange routes, the waste middens of habitation sites, human coprolites, funerary food offerings, and the stable isotope composition of human osseous remains.

The earliest evidence of fish consumption in the archaeological record of the Atacama interior indicates that this product was being consumed, in small quantities at first, between 4000-2000 cal B.C. in some inland valley and oasis sites, including Chiuchiu, San Pedro de Atacama, and Tarapacá

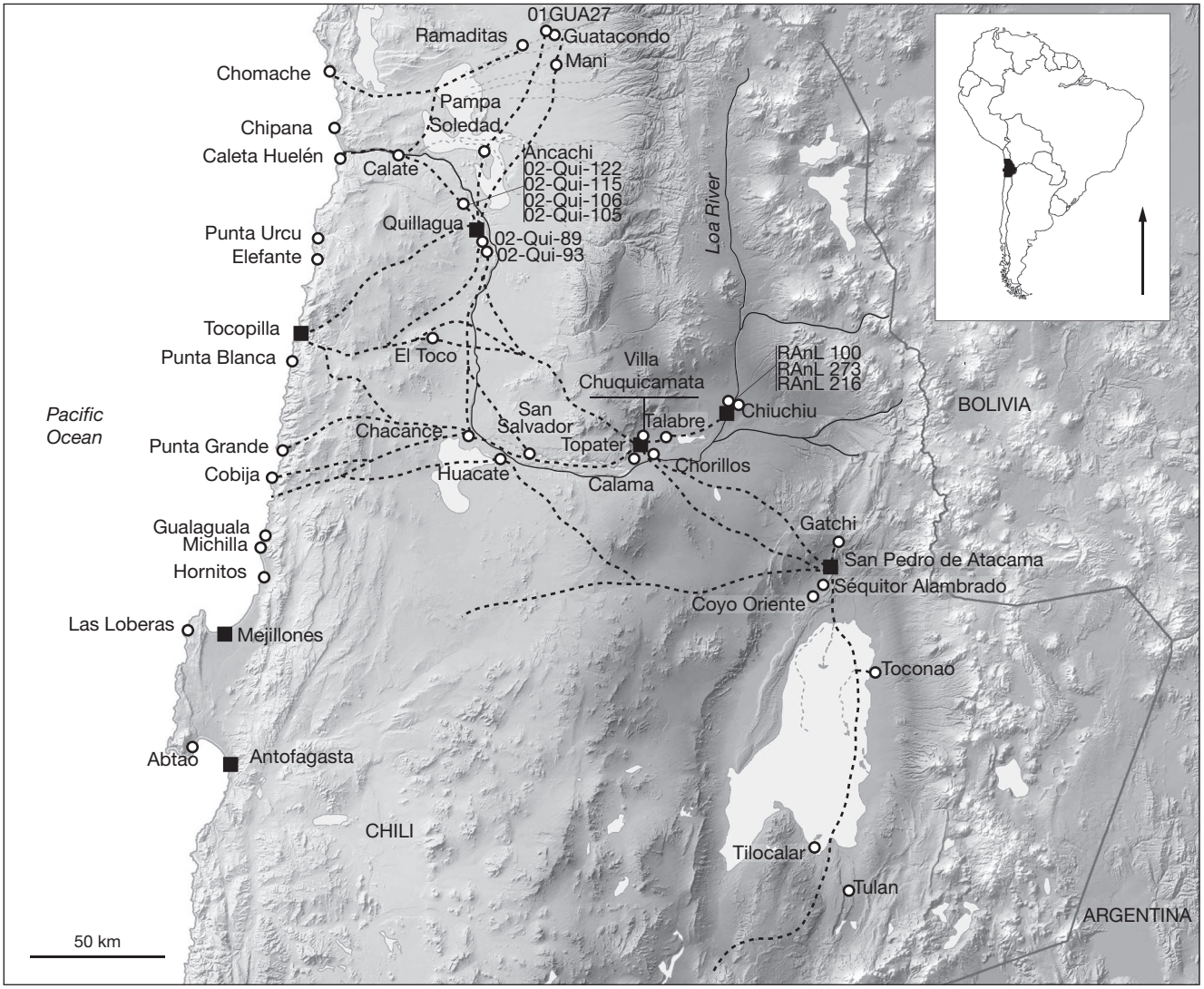

FIG. 1. — Atacama Desert (Chile) map with the localities (■, current cities and towns; ○, archaeological localities and sites) and circulation routes (dotted lines) mentioned.

(Druss 1978; Casteel 1980; Benavente 1988-1989; Cartajena 1994; Agüero & Uribe 2011; Fig. 1). During the coastal Formative period (500 cal B.C.-700 cal A.D.), however, the inland circulation and consumption of fish intensified, evincing a burgeoning system of regional exchange (Casteel 1980; Follet 1980; Scott *et al.* 2005; Castillo 2011, 2015; Santana *et al.* 2012; Torres-Rouff *et al.* 2012a; Pestle *et al.* 2015a, b; Castillo *et al.* 2017; Pestle 2017).

In this article, we offer a preliminary model of fish consumption in the Atacama desert interior during the Formative period (500 cal B.C.-700 cal A.D.) employing zooarcheological, bioanthropological, and paleofecal information (both published and unpublished). In particular, we focus on such aspects as the richness and relative frequency of the fish species consumed, the techniques required to preserve them for exchange, and the relationship between distance from the coast and fish consumption. These three aspects shed light upon the human agents involved in the circulation and exchange, the technologies and strategies they employed, and the different social contexts in which this food was consumed in the interior valleys and oases of the Atacama desert. In this perspective, we consider fish to be not simply a food but a good, an element of material culture (Van der Veen 2003) whose value goes beyond its merely nutritive value, as it plays an active role in more complex and diverse aspects of the social, cultural, political and economic spheres (Hastorf 2012).

ATACAMA DURING THE FORMATIVE PERIOD

The Atacama Desert is one of the most arid regions on the planet, with very low precipitation and much lower than average primary productivity in general; however, due to a pronounced east-west altitudinal gradient (Fig. 2), the region actually comprises a diverse range of ecological niches with characteristic biota and different degrees of primary

productivity (Weischet 1975; Ortlieb 1995; Marquet *et al.* 1998; McKay *et al.* 2003; Clarke 2006). In the pre-Hispanic period, that uneven distribution of resources forged a human geography in which the inhabitants tended to be much more concentrated in areas where resources and freshwater were more readily available (Fig. 1). Thus, in one of the driest and harshest deserts of the globe, valleys and oases watered by Andean runoff and scattered freshwater springs on the Pacific coast became the primary focus for habitation (Núñez & Dillehay 1979; Llagostera 2013), and the intermediate spaces between those focal points remained uninhabited, even to this day in most cases (Pimentel 2012).

Those habitable locations were usually far from one another, obliging their inhabitants to travel tens and even hundreds of kilometers across difficult terrain to reach a neighboring settlement, where they could build or strengthen economic, political, and social ties, all indispensable for social reproduction (Núñez & Dillehay 1979; Berenguer & Pimentel 2010; Souza *et al.* 2010; Ballester & Gallardo 2011; Pimentel 2012; Torres-Rouff *et al.* 2012a; Pimentel *et al.* 2017). The material remains of this process include: the ancient routes and travel-related structures that connected archaeological localities; the remains of individuals who died in transit; the large quantity and wide range of foreign goods found at residential sites and cemeteries; and the clear similarities in aspects of culture, style, representation, and design among distant settlements, marking the flow not only of people and goods, but also of social information (Núñez 1985; Agüero *et al.* 2006; Cases *et al.* 2008; Pimentel *et al.* 2010, 2011; Pimentel 2012; Torres-Rouff *et al.* 2012b; Gallardo & Cabello 2015; Carrasco *et al.* 2015; Labarca *et al.* 2015; Gallardo *et al.* 2017a).

During the Formative period, major social changes occurred in the Atacama Desert that were accompanied by similarly significant shifts in the economic and political structures (Castro *et al.* 2016). Sedentism, surplus production, and inter-community linkages became central to the societies of the region and, although those changes occurred across the region, each locality experienced them in its own particular way. In the valleys and oases of the interior, differences abounded in the scale of food gathering versus agricultural development, the consolidation of pastoralist practices, the architecture employed in building village complexes, the use of new hunting technologies, and the scale and scope of handicraft manufacturing (Gallardo 1993; Ayala 2001; Souza 2004; Agüero & Cases 2004; Rees & Souza 2004; Uribe & Ayala 2004; Gallardo & Yacobaccio 2005; Núñez *et al.* 2005, 2006; Agüero *et al.* 2006; Cartajena *et al.* 2007; Gallardo & Souza 2008; Uribe 2009; Uribe & Vidal 2012; Adán *et al.* 2013).

On the Pacific coast, communities maintained their way of life based on hunting, fishing, and gathering marine resources. But they also began to intensify production, developing innovative hunting and fishing techniques to increase their catches, using the surpluses to enable them to take a leading role in the exchange networks that would eventually cross the Atacama Desert (Latcham 1909; Llagostera 1989, 1990; Castelleti 2007; Ballester & Clarot 2014; Gallardo *et al.* 2017a). During this period, these marine hunter-fisher-gatherers lived in stable residential settlements and used a logistical mobility strategy in which they moved back and forth along the coast in seagoing vessels and traveled on foot into the desert interior, building an extensive territory that incorporated the waters of the Pacific, the shoreline, and the inland pampa (Cases *et al.* 2008; Blanco *et al.* 2010; Pimentel *et al.* 2010, 2011; Ballester & Gallardo 2011; Ballester & Clarot 2014; Ballester & Crisóstomo 2017; Pimentel & Ugarte 2017; Gallardo *et al.* 2017a).

Along with their residences, they built monumental cemeteries – fields that could reach up to 300 tumuli built of soil and rock of 1.5 m in height and 7 m in diameter average dimensions, most containing the remains of one individual accompanied by a set of rich grave goods – that represent a huge investment of collective labor (Latcham 1910; Capdeville 1928; Mostny 1964b; Spahni 1967; Núñez 1971; Moragas 1982; Ballester & Clarot 2014; Gallardo *et al.* 2017a). Within these graves were everyday objects for obtaining marine resources such as harpoons, copper and cactus spine hooks, bone tools for extracting mollusks, and nets for fishing, among many other items. Foreign goods from the valleys and oases of the interior were also common among these grave goods and included ceramic vessels, gold and copper adornments, textiles, snuff trays, terrestrial shells used as pigment containers, foreign animals and plant-fiber baskets. All of these would have been obtained through the exchange network for surplus dried fish and shell artifacts (Latcham 1909; Mostny 1964b; Ballester & Clarot 2014; Labarca *et al.* 2015; Gallardo 2017; Carrasco *et al.* 2017; Gallardo *et al.* 2017a, b).

Archeological investigation has revealed that during the Formative period, the circulation of goods between the coast and interior was in the hands of agents from both the coast and from inland valleys and oases. The former traveled inland on foot for a variety of economic and productive purposes, one of the most important being exchange (Pimentel *et al.* 2010, 2011; Ballester & Gallardo 2011; Ballester & Crisóstomo 2017; Pimentel & Ugarte 2017; Blanco *et al.* 2017). At the same time, but with increasing intensity from the Formative and following periods, certain individuals would have come from the interior valleys and oases toward the coast for the same purpose – to exchange goods and stablish social interactions – but most of them would have used camelid caravans for this purpose (Núñez & Dillehay 1979; Núñez 1985; Pimentel *et al.* 2010, 2011, 2017; Torres-Rouff *et al.* 2012b).

METHODOLOGY

The study of fish consumption in the Atacama interior relied heavily upon stable isotope analyses to determine diet (Santana 2011; Santana *et al.* 2012, 2015; Pestle *et al.* 2015a, b; Pestle 2017), although in general the information obtained has remained in the specialized realm, uncoupled from other sources of information. Our approach, in contrast, seeks to

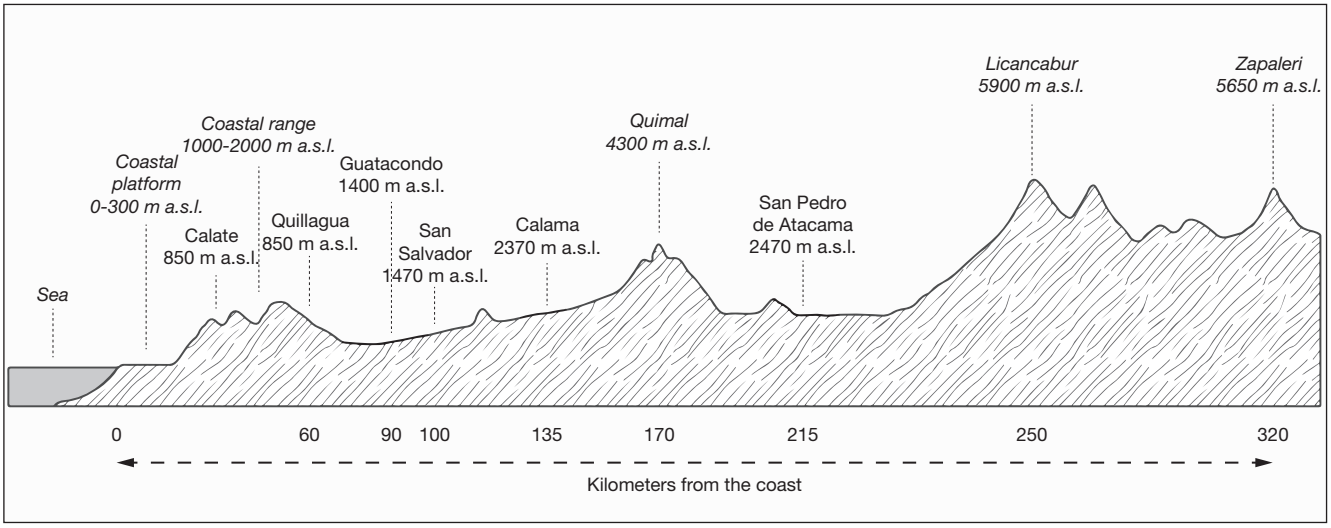

Fig. 2. — Altitudinal profile of the region with the position from the different localities mentioned in the article. Sites in italics: main geographical landmarks. Abbreviation: **m a.s.l.**, meters above sea level.

link up different materialities, archeological contexts, and analytical perspectives by integrating zooarcheological and paleofecal evidence with bioanthropological data, as well as taking into account domestic, logistic and route waste, but also funerary contexts.

As a first step, we identified all archeological sites in the Atacama interior that showed evidence of fish consumption and had been dated to the Formative period (N=32)[1]. Eleven of these sites (34.38%) were associated with transit routes and 21 (65.63%) were in an inland valley or oasis. Our team conducted the analysis for 20 of those 32 sites (62.5%) – most of them on transit routes (N=11) or in the localities of Quillagua (N=6), Guatacondo (N=2) and the middle Loa (N=1) – while the rest (N=12) were obtained from the literature. Aware of the difficulty of comparing results generated through different sampling strategies and/or interventional intensities, especially in quantitative terms, our comparisons were made on the basis of taxonomic richness (NTAXA).

Taxonomic identification for the contexts we analyzed employed both reference skeletons and osteological guides (e.g. Falabella *et al.* 1995), while quantification was based on the minimum number of elements (MNE) and skeletal frequency was based on the percentage of the minimum number of animal units (%MAU) (Binford 1978; Grayson 1984). For analytical purposes, fish skeletons were divided into two sections: cranial, including facial and neurocranial bones; and postcranial, which included only the vertebral column (first vertebra included), appendicular skeleton (pectoral and pelvic girdles), and tail (Hoffman *et al.* 2000). Other minor bones such as spines, ribs, and pterygiophores were not considered. For stable isotopes and coprolites, data from previously published studies were used.

1. Regrettably, the faunal studies in the region are scarce, and it is very difficult to ensure the number of archaeological site that surely do not have fish remains to compare.

THE CYCLE OF FISH: PRODUCTION, DISTRIBUTION, AND CONSUMPTION

Fishing technologies during the Formative period

Atacama coastal groups had been practicing hook-and-line fishing for at least 4000 years before the Formative period (Mostny 1964a; Bittmann 1978, 1984; Llagostera 1989; Contreras *et al.* 2011; Flores *et al.* 2016), but that period witnessed the replacement of the shell and compound hooks used up to the end of the Late Archaic (4000-2000 cal B.C.) with hooks made of cactus needles and, beginning in 500 cal B.C., hooks made of hammered copper. These two later technologies continued to be used up until the moment of European contact (Fig. 3F-J; Mostny 1942, 1964b; Bird 1943; Spahni 1967; Boisset *et al.* 1969; Bravo 1981; Llagostera 1989, 1990; Castelletti 2007; Salazar *et al.* 2010; Ballester & Clarot 2014; Latorre 2017). In addition to hooks, the act of fishing required at least two more artefactual components – fishing line (in this case of cotton) and line weights. The earliest cotton fishing line dates to a few centuries before 4000 cal B.C., attesting to the use of such technology throughout the later coastal occupation sequence (Fig. 3K; Bird 1946; Boisset *et al.* 1969; Ballester & Clarot 2014). For their part, line weights varied in form, size, and raw material used. The earliest examples, dating to around 5000-4000 cal B.C., were composed of rock, bone, or *Choromytilus chorus* (Molina, 1782) shells (Mostny 1964b; Silva & Bahamondes 1968; Boisset *et al.* 1969; Núñez *et al.* 1974; Contreras *et al.* 2011; Flores *et al.* 2016), while those attributed to the Formative period were of stone and often cigar-shaped (Fig. 3B-E; Mostny 1964b; Spahni 1967; Ballester & Clarot 2014).

Another fishing instrument employed during this period was the gaff or "potera", a device used to catch cephalopods and for capturing fish in large shoals (Fig. 3A; Jiménez 1943; Silva & Bahamondes 1968; Van Kessel 1988; Ballester 2017; Labarca *et al.* 2017). The device can be recognized by certain

features, particularly the grooved spherical weights and the lateral bone barbs that aided in penetrating and securing the prey (Bird 1943, 1946; Ballester & Clarot 2014; Labarca *et al.* 2017). The earliest evidence for this technology comes from Late Archaic funerary contexts at Caleta Huelen 42 and Taltal (Mostny 1964b; Zlatar 1975), although it appears much more frequently in the Formative archeological contexts. Fish were also captured using harpoons, which allowed individual fish to be caught without the need for bait (Fig. 3L-N; Mostny 1964b; Llagostera 1989; Ballester 2018).

Nets are one of the least-studied fishing artifacts of the northern Chilean coast, in part owing to the very small number of surviving archaeological examples. The earliest published examples come from the site of Abato 1 (4454-3369 cal B.C.), where three distinct types (single link, double link, and knotted) have been identified (Boisset *et al.* 1969). Net-like textiles are often found in Formative period settlement sites, while complete bags and larger fragments have been recovered from some funerary contexts (Fig. 3O; Spahni 1967; Ballester & Clarot 2014).

Overall, these finds give a picture of a fishing toolkit that satisfied many distinct needs (Ballester 2017). Each type and size of hook, when paired with a different kind of weight, targeted a certain kind of fish and could be customized according to fish habitat, size, and water depth. The gaff, thanks to its lateral barbs, could catch more than one fish at a time and was used against large shoals of fish, ensuring high efficiency but low selectivity. The harpoon could be used to catch fish cruising close to the surface, as it required the hunter to keep the prey in view to hit it with the small head, for example, thereby permitting more targeted, selective approach, but only for certain species. Nets, for their part, produced a mass of fish limited only by the size of holes in the net, its overall size, and the quantity of fish in the water, giving the fisherman an abundant catch but little selectivity.

The productiveness of these artifacts can only be measured as a function of the strategy used and how it was implemented, both of which are difficult to ascertain from the archaeological record. We do know that after European contact, long fishing lines with more than 700-800 hooks, called "palangres" or "espineles", could produce a 300-400 fish catch only in one night (Matte 1981). A catch of this size ought not to be surprising when we consider historical references such as that describing the visit of French explorer Louis Feuillée to Cobija in 1710. According to the record, Feuillée (1714) purchased between 225-275 kg of dried fish from local fisherman. Just as an approximate and theoretical exercise, if we consider that drying of fish reduces its weight by roughly 80% (as a consequence of gutting and dehydration; Burgess *et al.* 1971), the initial catch weight that Feuillée's purchase represented would likely have been at least five times greater than the dry weight he reported, between 1130-1360 kg. If we use the jack mackerel (*Trachurus murphyi* Nichols, 1920) as a tentative fish example – one of the most popular and common fish captured in this coast –, it would correspond to 735-906 complete adult individuals (Yañez 1955; Rosario 1970; Vargas *et al.* 1993).

For determining the species consumed, coastal refuse middens provide the best evidence[2]. The domestic midden at Abtao 5[3], for example, yielded no fewer than 20 fish species, 49.2% of which were from pelagic habitats and 50.8% from benthic-demersal settings (Bravo 1981, 1985; Llagostera 1990). Similarly, in Taltal, in a grouping of eleven sites attributed to the Formative period, fourteen fish species were identified (Castelleti 2007; Castelleti & Maltrain 2010). The diversity of these assemblages exemplifies the multiplicity of strategies and technologies used to catch fish and the wide variety of species preferred by these coastal groups.

Fish along circulation routes

No fewer than five Formative period routes connecting the coast with the Atacama Desert interior have been documented in our study area, linking Quillagua, the middle Loa, and Guatacondo (Figs 1; 2; 4). Eleven sites associated with the routes passing through Calate, El Toco and Talabre have been studied from a zooarchaeological perspective (Table 1). These sites appear to be transit stops, composed of a variable number of circular dry-stone structures and featuring a low density of material culture. These sites possess limited faunal assemblages, with notably more fish than other common taxa such as camelids or rodents (Table 1). Generally, we observed the presence of a varied fish species list, although the majority of these were represented by just a few bony elements. The exceptions included the jack mackerel, corvina drum (*Cilus gilberti* (Abbott, 1899)), anchovy (*Engraulis ringens* Jenyns, 1842) and menhaden (*Ethmidium maculatum* (Valenciennes, 1847)), which were found in the greatest abundance and/or in the majority of sites (Table 1).

Archeological investigation of sites associated with pre-Hispanic transit routes in the area have shown that coastal groups participated actively in circulating their surplus of fish in the desert interior (Cases *et al.* 2008; Pimentel *et al.* 2010, 2011, 2017). On their travels, these individuals preferentially consumed fish instead of the resources they would have eventually obtained via exchange with inhabitants of the inland oases. A study of the stomach contents of a coastal individual who died on the El Toco route found fish remains exclusively and the isotopic history of this individual suggested a diet rich in marine resources (Fig. 5); even more, a little textile bag founded in direct association to the individual contained a cactus spine fishhook, another prove of his littoral origin (Cases *et al.* 2008; Knudson *et al.* 2012; Pestle *et al.* 2015b). Equally, in one of the many tombs associated with the ancient route that connected the Loa River mouth with the locality of Calate (25 km from the coast) (Figs 1; 2), a 4-6 year old child was found with a rich array of offerings that included at least three large dried, gutted, headless, skinned fish with caudal fins and vertebrae attached, along with a large number

2. Unfortunately, there are very few systematically excavated and chronologically controlled Formative sites, and as a consequence we can only make a general, preliminary assessment of the diversity of species consumed.

3. Even though this is one of the best-documented coastal sites, it still suffers from a lack of chronological control, making it very difficult to separate the distinct occupational and cultural layers and events. The only date obtained thus far, from the lower strata, is 398-190 cal B.C. (Bravo 1981, 1985; Llagostera 1990).

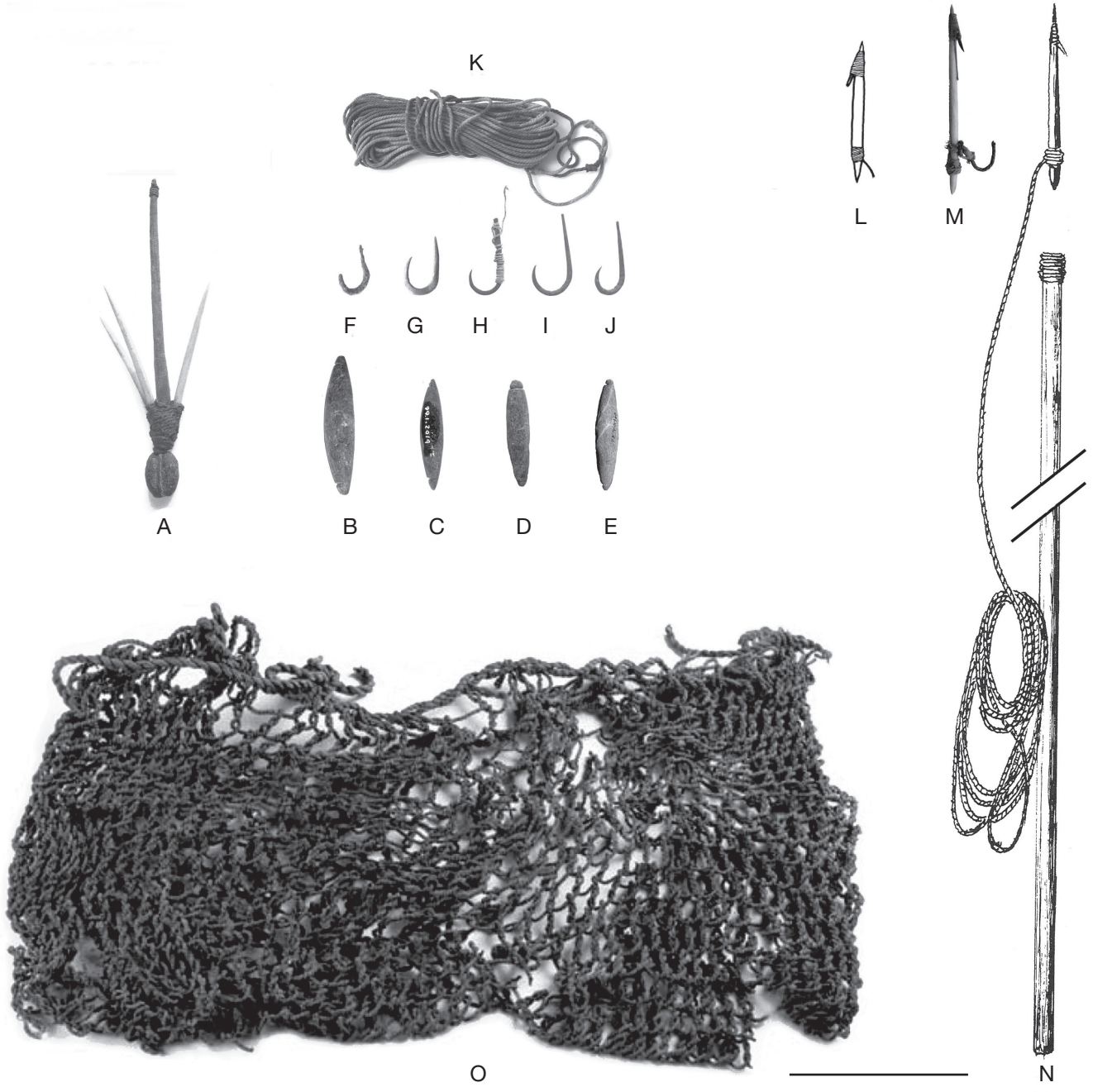

Fig. 3. — Coastal fishing toolkit: **A**, gaff or "garabato" (uncertain chronology; Berenguer 2008: 25); **B**, **C**, stone line-weights from Caleta Huelén 20; **D**, stone line-weight from Hornitos 01; **E**, stone line-weight from Punta Blanca 01 (the four from the Formative Period; Ballester & Clarot 2014: 58); **F**, copper hook from Punta Grande 02; **G**, bone hook from Michilla 11; **H**-**J**, spine cactus hooks from Las Loberas (the five from the Formative Period; Ballester & Clarot 2014: 58); **K**, braided cotton line from Las Loberas (Formative Period; Ballester & Clarot 2014: 58); **L**, harpoon head made by a bone stem and cactus spine barbs from Caleta Huelén 31 (Formative Period; Spahni 1967: Pl. V, 17); **M**, harpoon head made by a bone stem and cactus spine barbs from Las Loberas (Formative Period; Ballester & Clarot 2014: 60); **N**, complete harpoon device scheme (Llagostera 1989: 62, fig. 2); **O**, complete fishing net from Las Loberas (Formative Period; Sinclaire 2008: 82). Scale bar: 10 cm.

of small unprocessed anchovies (Fig. 6; Torres-Rouff *et al.* 2012b; Pimentel & Ugarte 2017; Pimentel *et al.* 2017). This context has been dated to the late Formative period (Fig. 4), and the child's elevated δ15N values indicate a diet based on marine resources (Fig. 5; Torres-Rouff *et al.* 2012b; Pestle *et al.* 2015a, b; Pimentel & Ugarte 2017; Pimentel *et al.* 2017).

Quillagua, a meeting place between the coast and the desert

The oasis of Quillagua, 60 km from the Pacific coast, was one of the main points of entry for fish into the interior (Figs 1; 2). During the Formative period the locality was inhabited by both locally-derived groups and others strongly linked to the

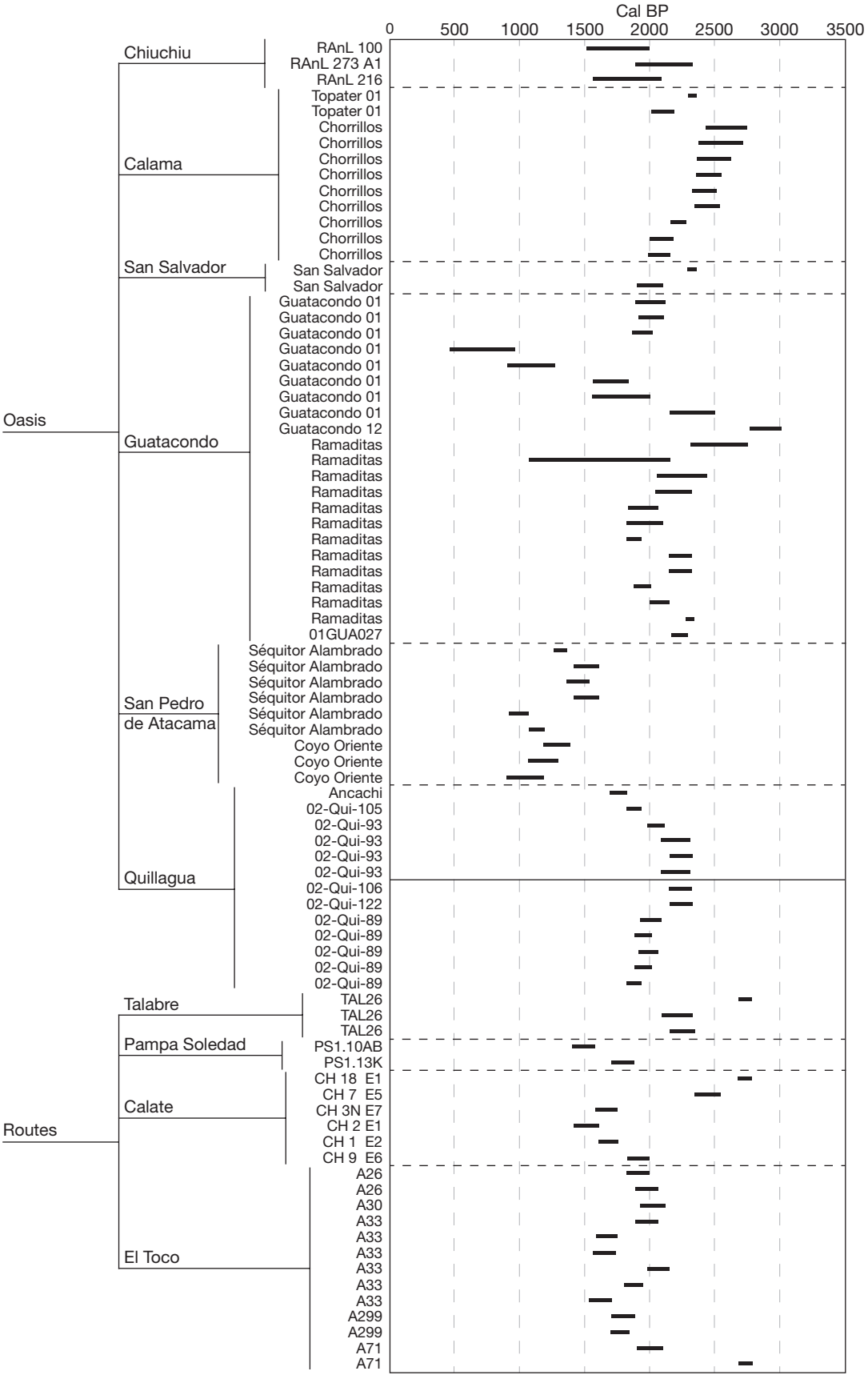

Fig. 4. — Radiocarbon datations from the Formative sites of the Atacama Desert considered in this study. Marine and human material samples were excluded. Calibration made by SHCAL13 curve (Hogg *et al.* 2013) using Calib 704 (Stuiver *et al.* 2005).

TABLE 1. — Fish remains (NISP) from route sites of the Atacama Desert. All sites are referenced in this article, except the funerary site Toco A299, referenced in Cases *et al*. 2008. Abbreviations: **C**, cranial; **D**, domestic; **F**, funerary; **P**, postcranial; **R**, route.

		Locality, site and context											
		Ch-Calate						El Toco				Talabre	
		Ch 01	Ch 02	Ch 03	Ch 07	Ch 09	Ch 18	Toco A26	Toco A33	Toco A71	Toco A299	Tal-26	
Order/Species	**Skeletal part**	R	R	R-F	R	R	R	R	R	R	F	R	**Total**
Perciformes													
Acanthistius pictus (Tschudi, 1846)	C	–	–	–	1	–	–	–	–	–	–	–	1
	P	–	–	–	–	–	–	–	–	–	–	–	0
Aplodactylus punctatus Valenciennes, 1832	C	–	–	–	–	1	–	–	–	–	–	–	1
	P	–	–	–	–	–	–	–	–	–	–	–	0
Auchenionchus sp.	C	–	–	–	–	1	–	–	–	–	–	–	1
	P	–	–	–	–	–	–	–	–	–	–	–	0
Cheilodactylus variegatus Valenciennes, 1833	C	–	–	–	–	–	–	–	–	–	–	–	0
	P	–	1	3	–	–	–	–	4	–	–	1	9
Cilus gilberti (Abbott, 1899)	C	–	7	2	–	–	–	–	–	–	–	–	9
	P	–	11	25	–	2	–	–	–	–	–	2	40
Graus nigra Philippi, 1887	C	–	1	–	–	–	–	–	–	–	–	–	1
	P	–	2	2	–	–	–	1	–	–	–	3	8
Hemilutjanus macrophthalmos (Tschudi, 1846)	C	–	–	–	–	–	–	–	–	–	–	–	0
	P	–	7	–	–	–	–	–	–	–	–	–	7
Isacia conceptionis (Cuvier, 1830)	C	–	–	1	–	–	–	–	–	–	–	–	1
	P	–	–	–	–	–	–	–	–	–	–	–	0
Labrisomidae	C	–	1	1	–	–	–	–	–	–	3	–	5
	P	–	–	–	–	–	–	–	1	–	32	–	33
Pinguipes chilensis Valenciennes, 1833	C	–	–	1	–	–	–	–	–	–	–	–	1
	P	–	–	2	–	–	–	–	–	–	–	–	2
Prolatilus jugularis Valenciennes, 1833	C	–	–	–	–	–	–	–	–	–	–	–	0
	P	–	–	–	–	–	–	–	1	–	–	–	1
Sarda chiliensis (Cuvier, 1832)	C	–	–	–	–	–	–	–	–	–	–	–	0
	P	–	25	2	–	–	–	–	–	–	–	–	27
Semicossyphus darwini (Jenyns, 1842)	C	–	2	4	–	–	–	–	–	–	–	–	6
	P	–	3	5	–	–	–	–	–	–	–	1	9
Trachurus murphyi Nichols, 1920	C	–	3	4	–	–	–	1	–	–	–	–	8
	P	1	64	124	7	65	–	8	9	3	–	10	291
Chimaeriformes													
Callorhinchus callorynchus (Linnaeus, 1758)	C	–	–	–	–	–	–	–	–	–	–	–	0
	P	–	–	1	–	–	–	–	–	–	–	–	1
Clupeiformes													
Engraulis ringens (Jenyns, 1842)	C	–	–	60	–	–	–	–	–	–	–	–	60
	P	–	–	199	–	–	–	–	–	–	–	–	199
Ethmidium maculatum (Valenciennes, 1847)	C	–	–	–	–	–	–	–	–	–	–	–	0
	P	–	74	17	–	20	–	–	2	–	–	–	113
Pleuronectiformes													
Paralichthys microps (Günther, 1881)	C	–	3	1	–	1	–	–	–	–	–	–	5
	P	–	11	6	–	–	–	–	–	–	–	8	25
Scorpaeniformes													
Sebastes oculatus Valenciennes, 1833	C	2	1	–	–	–	–	–	–	–	–	–	3
	P	–	2	–	–	–	–	–	2	–	–	–	4
Actinopterygii indeterminate	C	–	22	132	–	–	1	–	9	–	–	1	165
	P	4	650	533	9	166	80	13	103	28	–	110	1696
Total		7	890	1125	17	256	81	23	131	31	35	136	2732

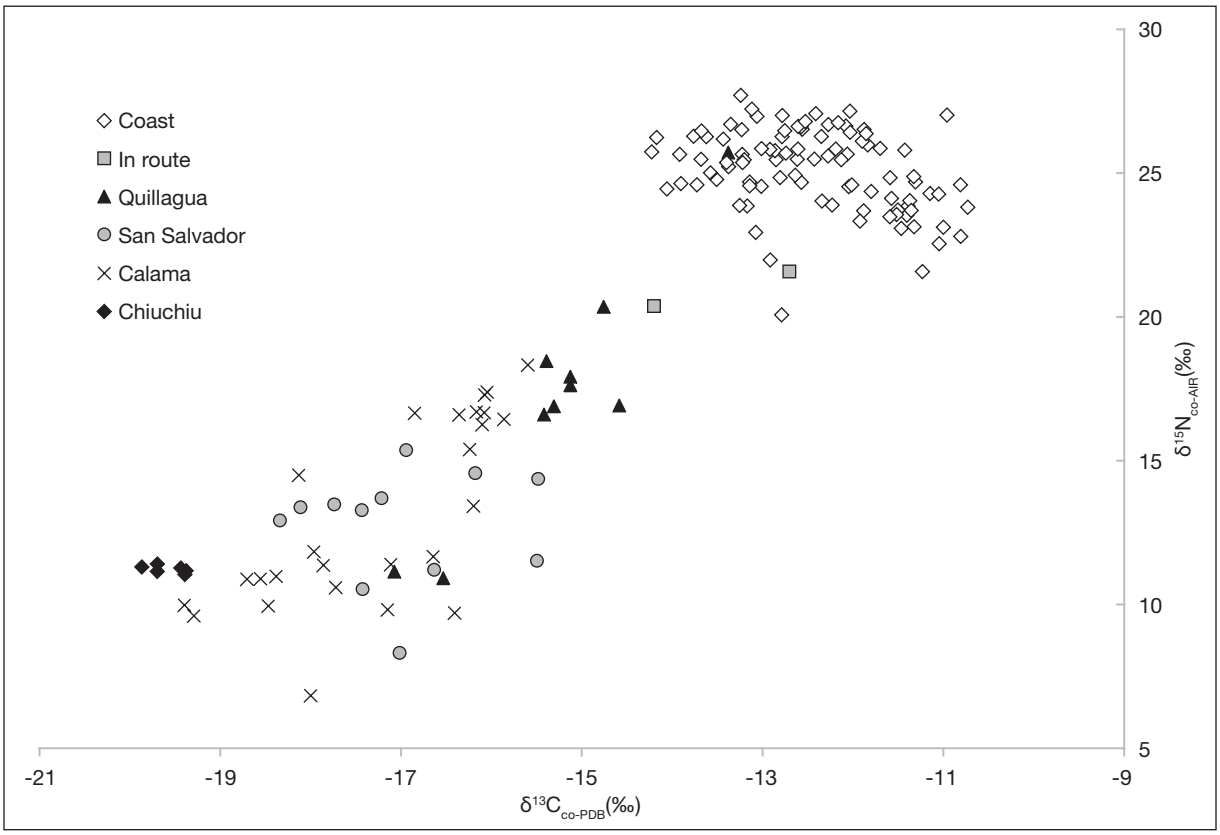

FIG. 5. — Human isotope values from the different cemeteries mentioned, separated by localities (Knudson *et al.* 2012; Torres-Rouff *et al.* 2012a; Ballester & Clarot 2014; Pestle *et al.* 2015a, b; Pestle 2017).

FIG. 6. — Headless dried fish offered to a 4-6 years old infant in the route of Calate-Loa River mouth.

coastal world, and as such everyday life would have been shared by people who were geographically and culturally distinct (Gallardo *et al.* 2017a). The presence of a non-local contingent in Quillagua has been inferred, in part, from the δ15N signatures of individuals interred in the cemetery of Ancachi (02-Qui-75), situated 6 km downriver from Quillagua proper (Latcham 1938; Gallardo *et al.* 1993a, b; Pestle 2017). These signatures correspond to a diet rich in marine protein, in some cases with values equivalent to those seen in coastal peoples (Fig. 5; Pestle *et al.* 2015a; Pestle 2017). This cemetery, along with two others located upriver, follow the same architectural and funerary patterns than coastal cemeteries – as tumuli fields. These findings attest to an intimate connection and close cultural linkage between at least some of the inhabitants of Quillagua and the coastal world (Latcham 1938; Spahni 1967; Núñez 1971; Ballester & Clarot 2014; Gallardo *et al.* 2017a). Data from residential middens in Ancachi confirm the conclusions derived from stable isotope analysis.

Also in the Ancachi area (Fig. 1), the excavation of three large Formative period residential camps (02-Qui-122, 02-Qui-115 & 02-Qui-106) yielded a great quantity of cranial and postcranial bones from diverse marine fish species (Table 2; Gallardo *et al.* 1993a, b, 2017a). This zooarchaeological evidence reinforce the interpretation of a high marine consumption in the neighbour cemetery. Upriver and near the actual town of Quillagua, in 02-Qui-89 (Agüero *et al.* 2001, 2006), an artificial mound associated with a cluster of circular structures with central patios dated to the Formative period (Fig. 4), the bones, skin, and scales of Pacific fish have been recently recovered and identified (Table 2). Excavations performed at the site also yielded human coprolites containing fish vertebrae, demonstrating the human consumption of this resource. Additionally, excavations at a similar residential settlement called 02-Qui-93 yielded more than 770 fish bones representing at least 10 different species (Table 2).

TABLE 2. — Fish remains (number of identified specimens) from Quillagua sites.

		Locality, site and context						
		Quillagua 02-Qui-89	Quillagua 02-Qui-93	Quillagua 02-Qui-105	Quillagua 02-Qui-122	Quillagua 02-Qui-115	Quillagua 02-Qui-106	
Order/Species	**Skeletal part**	Domestic	Domestic	Funerary	Domestic	Domestic	Domestic	**Total**
Perciformes								
Acanthistius pictus (Tschudi, 1846)	Cranial	–	–	–	–	–	1	1
	Postcranial	–	–	–	–	3	–	3
Cheilodactylus variegatus Valenciennes, 1833	Cranial	–	–	–	–	1	–	1
	Postcranial	28	64	–	–	1	3	96
Cilus gilberti (Abbott, 1899)	Cranial	–	–	–	1	1	–	2
	Postcranial	10	28	–	1	1	3	43
Graus nigra Philippi, 1887	Cranial	–	–	–	1	–	–	1
	Postcranial	–	1	–	–	–	–	1
Hemilutjanus macrophthalmos (Tschudi, 1846)	Cranial	–	–	–	–	–	–	0
	Postcranial	–	2	–	–	–	–	2
Paralabrax humeralis (Valenciennes, 1828)	Cranial	–	–	–	–	–	–	0
	Postcranial	2	1	–	–	19	–	22
Pinguipedidae	Cranial	–	–	–	–	–	–	0
	Postcranial	–	10	–	–	–	–	10
Sarda chiliensis (Cuvier, 1832)	Cranial	–	–	–	–	–	–	0
	Postcranial	2	26	–	9	13	1	51
Sciaena deliciosa (Tschudi, 1846)	Cranial	–	–	–	–	–	1	1
	Postcranial	–	–	–	–	4	–	4
Semicossyphus darwini (Jenyns, 1842)	Cranial	–	–	–	4	7	–	11
	Postcranial	–	3	–	–	–	–	3
Seriolella violacea Guichenot, 1848	Cranial	–	–	–	–	–	–	0
	Postcranial	–	–	–	–	2	2	4
Trachurus murphyi Nichols, 1920	Cranial	–	–	–	–	1	–	1
	Postcranial	96	72	–	1	42	7	218
Xiphias gladius Linnaeus, 1758	Cranial	–	–	–	–	–	–	0
	Postcranial	1	–	–	–	–	–	1
Pleuronectiformes								
Paralichthys microps (Günther, 1881)	Cranial	–	1	1	1	–	1	4
	Postcranial	–	–	–	–	1	–	1
Paralichthyidae indet.	Cranial	–	–	–	–	–	–	0
	Postcranial	11	155	–	9	18	13	206
Ophidiiformes								
Genypterus sp.	Cranial	–	–	–	1	–	–	1
	Postcranial	–	–	–	–	–	–	0
Scorpaeniformes								
Sebastes oculatus Valenciennes, 1833	Cranial	–	–	–	–	–	–	0
	Postcranial	3	–	–	–	–	–	3
Clupleiformes								
Clupeiforme indet.	Cranial	–	–	–	–	–	–	0
	Postcranial	5	–	–	–	–	–	5
Lamniformes								
Isurus oxyrinchus Rafinesque, 1810	Cranial	–	–	–	–	1	–	1
	Postcranial	–	–	–	–	–	–	0
Squalimorpha indet.	Cranial	–	–	–	–	1	–	1
	Postcranial	–	–	–	–	1	–	1
Actinopterygii indet.	Cranial	–	–	–	1	6	6	13
	Postcranial	81	408	–	54	89	64	696
Total		239	771	1	83	212	102	1408

Direct routes between Quillagua and the coast were used intensively during the Formative, both those stretching to Tocopilla and those that paralleled the Loa River down to the sea (Fig. 1). The latter passed through the area of Calate, where fish remains have commonly been found both at rest stops and in the tombs of deceased travelers (Table 1; Torres-Rouff *et al.* 2012b; Pimentel & Ugarte 2017; Pimentel *et al.* 2017).

The traditions of shared occupation of the valley and frequent consumption of products from the Pacific coast were maintained in the centuries following the Formative period, establishing greater historical continuity and strengthening social bonds between Quillagua's inhabitants and those living by the sea (Santana 2011; Santana *et al.* 2015). Without a doubt, the richness of the ecosystem of the valley and the relative proximity of the coast (compared to the remoteness of other oases) helped transform the area into a space of encounter and a hub for people living along the Pacific coast, and this strengthened both economic relations and cultural ties.

The consumption of fish in Guatacondo, the Middle Loa and the Atacama Salt Flat

During the Formative period, fish circulated far inland to major population centers, including the oases of Calama and Chiuchiu (*c.* 140 and 160 km from the coast, respectively), the ravine confluences of the Pampa del Tamarugal, such as Guatacondo and Mani (*c.* 90 km from the coast), and the oases around the Salar de Atacama, such as San Pedro (*c.* 210 km from the coast) and Toconao (*c.* 240 km from the coast) (Figs 1; 2; Pollard 1971; Benavente 1978, 1981, 1998; Follet 1980; Orellana 1991; Cartajena 1994; Thomas *et al.* 1994; Rivera *et al.* 1996; González & Westfall 2010; Agüero & Uribe 2011).

At the Guatacondo ravine, the Ramaditas and Guatacondo 01 villages were probably the main residential hubs during the Formative period (Fig. 4; Mostny & Niemeyer 1963; Mostny 1970a, b; Meighan & True 1980; Rivera *et al.* 1996; Rivera 2002; Urbina *et al.* 2012; Adán *et al.* 2013). Notable among the mass of domestic refuse recovered from the excavations of these occupied areas was the presence of vertebral bones from at least seven fish species, whereas fish cranial bones were entirely absent (Table 3). Recent excavations of a waste mound in the village of Ramaditas corroborated the above findings (Table 3) and provided a wider variety of species than previously recorded (Follet 1980; Rivera *et al.* 1996). Not far from the main Guatacondo 01 site, in the Formative residential complex of 01GUA027 (Fig. 4), the remains of at least nine different fish species were recovered, all from them postcranial skeleton (Table 3).

Human coprolites recovered from the residential areas of Guatacondo 01 and Ramaditas have also confirmed the local consumption of fish. At Guatacondo 01, fish vertebrae were identified in one of the sixteen human feces collected as sample (Williams 1980), while at Ramaditas fish consumption can be inferred from the results of two related findings. One came from the analysis of protein residues using antiserum, which yielded a positive result for the presence of anchoveta (Scott *et al.* 2005); while the other was the presence of roughly 200 eggs of the parasite *Diphyllobothrium* spp. in four fecal samples from Area 1 of the village (Rivera 2002). This parasite, very common among the coastal people of northern Chile and southern Peru, uses fish as its host during maturation and is transmitted to humans as a result of the consumption of raw, dried, smoked, or poorly cooked fish (Callen & Cameron 1960; Ferreira *et al.* 1984; Reinhard 1992; Arriaza 1995; Reinhard & Urban 2003; Carvalho *et al.* 2003; Santoro *et al.* 2003; Araújo *et al.* 2011).

The middle course of the Loa River contains a series of stable residential sites and dense cemeteries dating to the Formative period (Fig. 4). Some 80 km from the coast and 40 km west of Calama (Figs 1; 2), on the south bank of the San Salvador river, a village has been found, consisting of 10 to 15 semi-subterranean structures now filled in with aeolian soil. These residences are associated with a looted cemetery of between 20 and 25 graves, and calibrated radiocarbon dates obtained for both residential and mortuary contexts situates them in the Middle Formative period (Fig. 4; Torres-Rouff *et al.* 2012a). Excavation of one residential precinct yielded a considerable volume of food remains, almost all of which consisted of algarrobo (*Prosopis* sp.) fruit and fish vertebrae. More than 2000 fish bone fragments were recovered, all vertebral bodies, spines, and arches with not a single cranial fragment among them (Table 3). As the absence of cranial fragments hindered taxonomic identification, four species could be identified from the large assemblage recovered (Table 3; Castillo 2011, 2015; Castillo *et al.* 2017).

This appreciable volume of fish remains so far from the sea makes sense when one takes into account the δ15N values of individuals from the cemetery of the site. Of the 15 sampled individuals from San Salvador, at least 12 showed evidence of marine product consumption, averaging approximately between 8% to 25% of their overall protein diet (Fig. 5; Torres-Rouff *et al.* 2012a; Pestle *et al.* 2015a, b; Pestle 2017).

In the present-day oasis of Calama, the best evidence for Formative fish consumption comes from funerary contexts. In the Regimiento Chorrillos and Topater 01 (Fig. 4) cemeteries coastal goods were frequently provided as funerary offerings, and fish remains were no exception (Table 3; Latcham 1938; Thomas *et al.* 1994; González & Westfall 2010). One such offering found at Topater 01 is particularly noteworthy. The item (Fig. 7) is a composite food, a single morsel that included a piece of dried fish filet along with a complete dried anchovy tied together with three rounds of string knotted at the ends. It is a sophisticated serving to be sure, one that combines in a single mouthful, two distinct species of fish and two distinct preparations – one butchered and dressed, the other entire –, transforming the whole into more than simply the sum of its parts to offer much more than simple nutritional value.

Additionally, eggs (40 in total) of the parasite *Diphyllobothrium* spp. were identified among an assemblage of 179 human fecal samples obtained from six funerary contexts in the Regimiento Chorrillos cemetery, demonstrating that at least some fraction of the deceased people buried in that cemetery had consumed incompletely cooked, raw, or dried fish (Castells *et al.* 2010).

The δ15N values of individuals from the Villa Chuquicamata cemetery, in the same oasis of Calama (Fig. 5), further demonstrates that the ingestion of marine resources was far more than an occasional or sporadic event; all individuals interred therein display some level of consumption of these products and for certain individuals these products accounted for up to 50% of their diet (Pestle *et al.* 2015a, b; Pestle 2017). Additionally, the analysis of individuals from the Regimiento Chorrillos and Topater 01 cemeteries (two and 12, respectively) show that one individual from each had δ15N isotopic values consistent with a diet that included marine resources (Fig. 5; Pestle *et al.* 2015a, b; Pestle 2017).

Upriver, at the Chiuchiu oasis, is a complex of domestic settlements and at least one cemetery attributable to the Formative period (Figs 1; 2; 4). At three of the most important residential settlements there – Chiuchiu 200, Chiuchiu Cemetery, and RAnL 100 (Fig. 4) – the frequency of fish remains in waste deposits was low, although no quantitative data or species identification are available for those sites (Pollard 1971; Benavente 1978,

TABLE 3. — Fish remains (NISP) from interior valley, oases and ravines sites of the Atacama Desert. ×, presence of fish remains without possibility of estimating the number of individuals. Abbreviations: **D**, domestic; **F**, funerary; **Or**., Oriente.

		Locality, site, context and reference															
		San Salvador	Guatacondo				Calama		Chiuchiu				San Pedro de Atacama				
		Aldea San Salvador D	Guatacondo 01 D	01GUA027 D	Ramaditas Aldea D	Ramaditas Montículo D	Regimiento Chorillos F	Topater 01 F	Chiuchiu cem. D	Chiuchiu 200 D	RAnL 273 F	RAnL 100 D	Gatchi 2C D	Sequitor Alambrado Or. F	Coyo Oriente F	Toconao Oriente F	
Order/Species	**Skeletal part**	Castillo 2015	Follet 1980	This study	Rivera *et al.* 1996	This study	Gonzalez & Westfall 2010	Thomas *et al.* 1994	Cartajena 1994	Benavente 1978, 1981 Benavente 1998; Pollard 1971		Pollard 1971	Agüero & Uribe 2011	Le Paige 1977	Le Paige 1977	Orellana 1991	**Total**
Perciformes																	
Cilus gilberti (Abbott, 1899)	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	55	3	2	–	1	×	–	–	–	–	–	–	–	–	–	61
Cheilodactylus variegatus Valenciennes, 1833	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	–	–	2	–	4	–	–	–	–	–	–	–	–	–	–	6
Graus nigra Philippi, 1887	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
Hemilutjanus macrophthalmos (Tschudi, 1846)	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
Sarda chiliensis (Cuvier, 1832)	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	–	13	–	–	–	–	–	–	–	–	–	–	–	–	–	13
Semicossyphus darwini (Jenyns, 1842)	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	3
Seriolella violacea Guichenot, 1848	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	–	–	7	–	2	–	–	–	–	–	–	–	–	–	–	9
Trachurus murphyi Nichols, 1920	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	244	6	1	–	–	–	–	–	–	–	–	–	–	–	–	251
Clupeiformes																	
Engraulis ringens Jenyns, 1842	Cranial	–	–	–	–	–	–	×	–	–	–	–	–	–	–	–	0
	Postcranial	–	–	–	–	–	–	×	–	–	–	–	–	–	–	–	0
Clupeiformes indet.	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	–	–	12	–	–	–	–	–	–	–	–	–	–	–	–	12
Ophidiiformes																	
Genypterus sp.	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Paralichthyidae indet.	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	–	10	30	–	9	–	–	–	–	–	–	–	–	–	–	49
Scorpaeniformes																	
Sebastes oculatus Valenciennes, 1833	Cranial	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	Postcranial	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	2
Indeterminate																	
Actinopterygii indet.	Cranial	–	–	1	–	–	–	×	–	–	–	–	–	–	–	–	1
	Postcranial	1556	–	64	17	36	×	×	×	×	2	4	×	1	10	1	1691
Total		1879	34	123	17	52	×	×	×	×	2	4	×	1	10	1	2123

1981; Cartajena 1994). Only two fish vertebrae were reported from the cemetery of Chiuchiu 273 (Benavente 1998), and the six human samples analyzed by stable isotopes technique from this cemetery does not show clear evidence of marine proteins consumption (Pestle *et al.* 2015a, b; Pestle 2017).

Further south, around the Atacama Salt Flat, the frequency of fish remains decreases significantly, but however low that rate is, the mere presence of such remains demonstrates that they were in some degree obtained and consumed. Fish vertebrae have been recovered from both Late Archaic and Formative layers from the Ghatchi 2C village near the Vilama River (Agüero & Uribe 2011) and fish have been identified among the funerary offerings of three individuals, each buried in a different cemetery – Séquitor Alambrado, Coyo Oriente, and Toconao Oriente (Table 3; Le Paige 1977; Orellana 1991).

Fig. 7. — Composite food made of two kind of fishes tied together by a braided rope: a complete anchoveta and a boneless fillet of a bigger fish. Topater 01 cemetery (Gallardo 2017: fig. 2). Scale bar: 5 cm.

THE WAYS OF FISH BEYOND THE SEA

The zooarchaeological, isotopic, and paleofecal evidence shows clearly that people living in the valleys, oases, and ravines of the interior Atacama Desert during the Formative period augmented their diets, to differing degrees, with fish products obtained through exchange from the Pacific Ocean coast (Williams 1980; Rivera 2002; Scott *et al.* 2005; Castillo 2011, 2015; Santana *et al.* 2012; Torres-Rouff *et al.* 2012a; Pestle *et al.* 2015a, b; Pestle 2017). These products were transported by both coastal and inland agents who traversed great expanses of desert, sustaining themselves by consuming the selfsame fish, the remains of which have been found alongside the routes they traveled (Cases *et al.* 2008; Pimentel *et al.* 2010, 2011; Pimentel 2012; Knudson *et al.* 2012; Torres-Rouff *et al.* 2012b; Pimentel & Ugarte 2017).

While residential sites on the coast provide evidence of the intensive consumption of a wide range of marine fish species (n=30) (Bravo 1981, 1985; Llagostera 1990; Castelleti 2007; Castelleti & Maltrain 2010), along the trade routes and in the interior the intensity of fish consumption decreased as a function of distance from the coast and the variety of species consumed also diminished (n=19 in trade routes, n=19 in Quillagua oasis, n=11 in Guatacondo, and n=12 in Loa River Middle and Atacama Salt Flat) (Fig. 8; Table 4). The δ15N isotopic values from the coast and the interior localities decrease in the same degree, in an inverse relation to the distance, from a very high consumption of marine proteins along the littoral settlements through an almost nil in Chiuchiu and the Atacama Salt Flat populations (see Pestle *et al.* 2015a, b; Fig. 3). Probably, in the last places – and more distant from the coast – fish arrived only occasionally and operated primarily as an exotic and scarce good; while in intermediary valleys, as Calama, San Salvador and Guatacondo, fish has functioned at the same time as food and as an exotic good. Indeed, in Quillagua and some coastal desert trails, fish was principally a food resource, just like in the coastal settlements.

Acknowledging the limitations of our analysis and the general lack of in-depth research, it should be noted that the fish species in circulation in the desert interior were, in general, the same ones that were most frequently caught and consumed on the coast (Table 4), although the methods used to catch them included alternately hooks, gaffs, harpoons and nets, performed by costal people.

Among those species, anchovies had to be captured using nets with small openings or may have occasionally been harvested from beachings of large schools. Tracking and catching of anchovies would also have facilitated access to a number of larger fish species, all of which would have been transported after capture. This "cascade" greatly increased the importance of the humble anchovy, even if they were less captured and consumed, probably endowing it with special value in the ichthyological pantheon of the coastal world. Thus, this species was not only an important local food source; it was also (at least partly) responsible for offshore seasonal productivity and thus with the coastal-interior product/commodity exchange network. For example, schooling pelagic species such as the jack mackerel and bonito (*Sarda chiliensis chiliensis* (Cuvier, 1832)), frequent the coast in great numbers in spring and summer, where they feed on smaller fish such as the anchovy and thereby increase their value as a human food source (Yañez 1955; Rosario 1970; Medina & Arancibia 2002). A similar situation holds with the flounder (Paralichthyidae), which consumes mainly anchovies and some crustaceans while inhabiting a more circumscribed range of marine environments including sandy, soft-bottomed areas (Silva & Oliva 2010). In this sense, the anchovy's value was probably not completely lied just to the nutritional importance to humans, but also into its capability to attract and bring to the coast the other fish species.

Another group of fish frequently sought by coastal people, albeit one that does not live in large schools, includes the cusk eel (*Genypterus* sp.), sea chub (*Graus nigra* Philippi, 1887), and Peruvian morwong (*Cheilodactylus variegatus* Valenciennes, 1833), all of which inhabit the rocky and craggy seabottom where they consume mollusks, echinoderms, and crustaceans (Yañez 1955; Fuentes 1981a, b, 1982; Flores & Rendic 2011). The capture of these species relied heavily on the use of harpoons and hand lines, resulting in the selective capture of single individuals. These species were also transported to the interior where they were consumed by desert residents.

The fish species that we have identified in the interior settlements studied inhabit different ocean zones, including the neritic, oceanic, pelagic, and benthic. The defining characteristic of the overall fish assemblage is the high

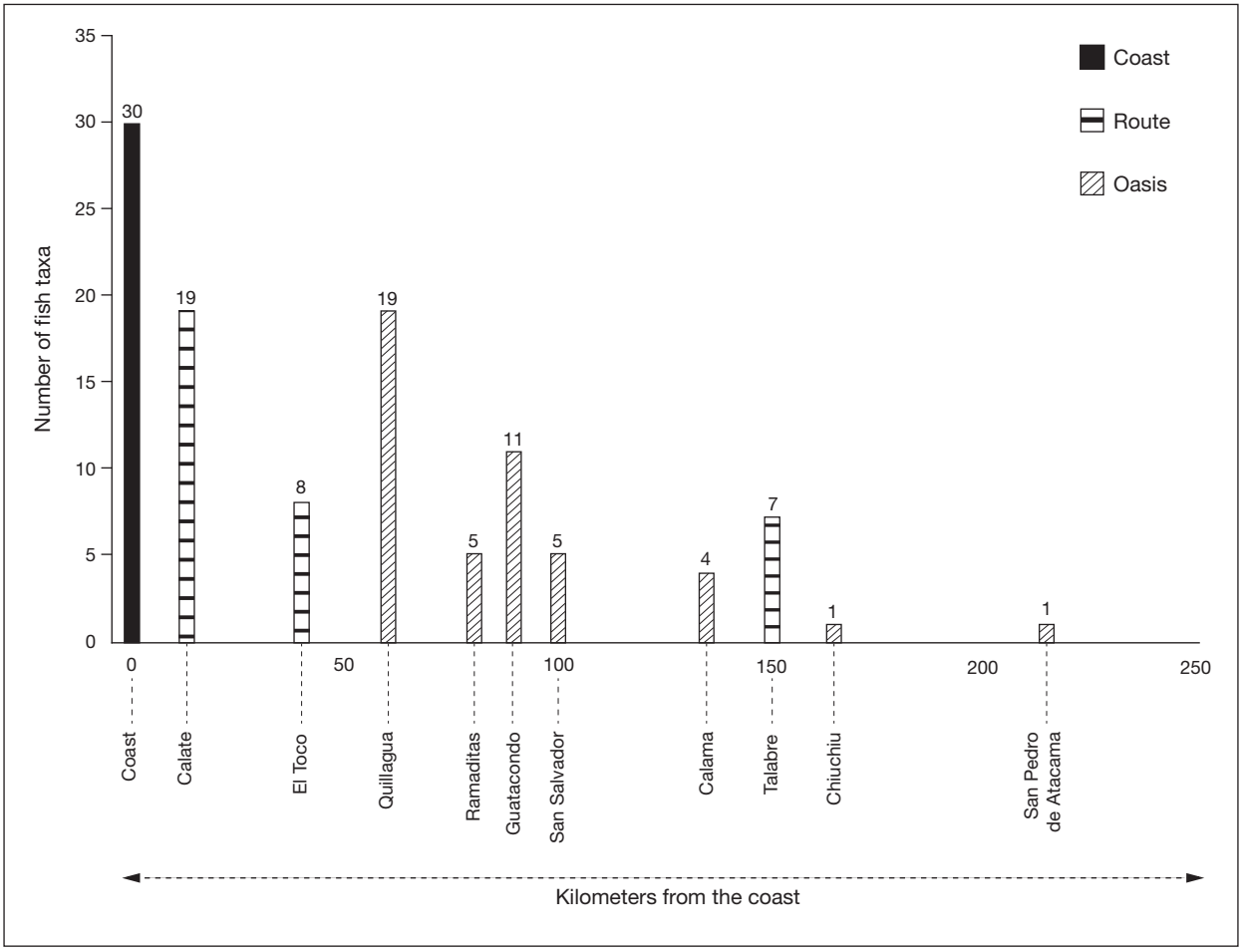

Fig. 8. — Graphic showing the taxonomic richness of the different localities from the Atacama Desert. It has been distinguished between coast, oasis and routes. For coastal sites column, we have employed the information available in publications about Formative period archaeological sites from Antofagasta region (Bravo 1981, 1985; Llagostera 1990; Castelleti 2007; Castelleti & Maltraín 2010).

proportion of postcranial compared to cranial elements, which indicates that the fish were butchered or reduced prior to being transported to the interior oases. Head removal is understandable, given its low meat content and the decreased weight of the final transportable product, particularly for large fish[4], where it appears to have been commonplace; it does not, however, appear to have been common for smaller species such as anchovy, which are found complete in interior sites (Gallardo 2017). From a taphonomic point of view, the low frequency of cranial and facial elements certainly cannot be ascribed to differential preservation, as these osteological elements are particularly dense (Falabella *et al.* 1994).

Regarding fish processing prior to transport, at least two distinct strategies can be identified: the transport of whole fish and that of butchered/headless fish. Both strategies were used in the Formative period to transport fish to the interior, with the choice of which depending on the species in question and distance to be traveled. While in Quillagua and other coastal outposts in the desert such as Calate and El Toco, we confirmed the presence of complete specimens of different species (including cranial bones, but in low quantity), in places farther away from the coast such as Calama, Chiuchiu, San Pedro de Atacama, Guatacondo and San Salvador, all specimens except the anchovy appear butchered and headless (Fig. 9). The anchovy's special treatment is largely a result of its small size, as butchering and/or head removal would not only have resulted in the loss of much of the edible portion and therefore of much of its economic value, but would also have been an extremely labor-intensive task to process the large volume of fish captured by a system of nets. Even so, we cannot rule out the possibility that the differential treatment of the anchovy was not just a practical decision, but also a reflection of this species enormous (dual) social significance, as discussed above.

As in colonial and republican times (Feuillée 1714; Pernoud 1990; Ballester *et al.* 2010; Álvarez 2013), drying was no doubt the most common method of preserving fish after capture. Not only is drying a technique that would have required no additional investment (e.g. salt or wood), the Atacama Desert environment naturally favored the desiccation and

4. Regrettably we do not have estimation size analyses for the all archaeological sites, but Castillo (2011, 2015) presents this information at least for the San Salvador village.

TABLE 4. — Fish species presences in the coast, routes and interior archaeological sites. For coastal sites column we had employ the information available in publications about Formative period archaeological sites from Antofagasta region (Bravo 1981, 1985; Llagostera 1990; Castelleti 2007; Castelleti & Maltraín 2010).

Order/Family	Scientific name	Common name	Coast	Route	Quillagua	Valleys, oases and ravines
Perciformes						
Aplodactylidae	*Aplodactylus punctatus* Valenciennes, 1832	Marblefish	×	×	–	–
Carangidae	*Trachurus murphyi* Nichols, 1920	Jack mackerel	×	×	×	×
Centrolophidae	*Seriolella violacea* Guichenot, 1848	Palm ruff	×	–	×	×
Cheilodatylidae	*Cheilodactylus variegatus* Valenciennes, 1833	Peruvian morwong	×	×	×	×
Haemulidae	*Anisotremus scapularis* (Tschudi, 1846)	Peruvian grunt	×	–	–	–
	Isacia conceptionis (Cuvier, 1830)	Cabinza grunt	×	×	–	–
Gempylidae	*Thyrsites atun* (Euphrasen, 1791)	Snoek	×	–	–	–
Kyphosidae	*Girella laevifrons* (Tschudi, 1846)	Sea chub	×	–	–	–
	Graus nigra Philippi, 1887	Sea chub	×	×	×	×
Labridae	*Semicossyphus darwini* (Jenyns, 1842)	Sheephead wrasse	×	×	×	×
Labrisomidae	*Auchenionchus* sp.	Chalaco	–	×	–	–
	Labrisomus philippii (Steindachner, 1866)	Chalapo clinid	×	×	–	–
Oplegnathidae	*Oplegnathus insignis* (Kner, 1867)	Pacific beakfish	×	–	–	–
Pinguipedidae	*Pinguipes chilensis* Valenciennes, 1833	Chilean sandperch	×	×	×	–
	Prolatilus jugularis (Valenciennes, 1833)	Pacific sandperch	–	×	–	–
Pomacentridae	*Chromis crusma* (Valenciennes, 1833)	Damselfish	×	–	–	–
Scombridae	*Sarda chiliensis* (Cuvier, 1832)	Bonito	×	×	×	×
Serranidae	*Acanthistius pictus* (Tschudi, 1846)	Brick seabass	×	×	×	–
	Paralabrax humeralis (Valenciennes, 1828)	Peruvian rock seabass	×	–	×	–
	Hemilutjanus macrophthalmos (Tschudi, 1846)	Grape-eye seabass	×	×	×	×
Sciaenidae	*Cilus gilberti* (Abbott, 1899)	Corvina drum	×	×	×	×
	Cynoscion analis (Jenyns, 1842)	Peruvian weakfish	×	–	–	–
	Sciaena deliciosa (Tschudi, 1846)	Lorna drum	×	–	×	–
	Sciaena sp.	Sargo jote	×	–	–	–
Xiphiidae	*Xiphias gladius* Linnaeus, 1758	Swordfish	×	–	×	–
Chimaeriformes						
Callorhinchidae	*Callorhinchus callorynchus* (Linnaeus, 1758)	Plownose chimaeras	–	×	–	–
Clupeiformes						
Engraulidae	*Engraulis ringens* Jenyns, 1842	Anchovy	×	×	×	×
Clupeidae	*Ethmidium maculatum* (Valenciennes, 1847)	Pacific Menhaden	×	×	–	–
Ophidiiformes						
Ophidiidae	*Genypterus* sp.	Cusk-eel	×	–	×	×
Gobiesociformes						
Gobiesocidae	*Gobiesox marmoratus* Jenyns, 1842	Clingfish	×	–	–	–
Pleuronectiformes						
Paralichtyidae	*Paralichthys microps* (Günther, 1881)	Flounder	×	×	×	×
Scorpaeniformes						
Sebastidae	*Sebastes oculatus* Valenciennes, 1833	Patagonian redfish	×	×	×	×
Lamniformes						
Lamnidae	*Isurus oxyrinchus* Rafinesque, 1810	Shortfin mako shark	–	–	×	–
Indeterminate						
Indeterminate	Squalimorpha indet.	Shark indet.	–	–	×	–
	Chondrichthyes indet.	–	×	–	–	–
Total			30	19	19	12

dehydration of organic matter, making the drying of fish a simple task (Castillo 2011, 2015). This food preparation process required a greater labor investment to preserve and transport the product, and as such it represented an economic goal that went beyond *immediate consumption* to include long term planning for *deferred consumption* (Woodburn 1982), whether by the fishermens' communities themselves or by other groups that ultimately obtained and consumed those fish. Coastal groups intentionally became part of extra-local exchange networks, assuming a leading role in the production (exploitation-processing) and distribution of dried fish to become active agents in the economy of the Atacama Desert region during the Formative period.

CONCLUSIONS

The Formative period was an era of profound social transformation throughout the Atacama Desert, and those changes manifested themselves differently according to distinct regional and local histories, processes, and experiences. Perhaps the most definitive feature of this period – in social terms – is the expansion of spheres of interaction and the strengthening of ties among geographically distant communities (Agüero *et al.* 2006; Núñez *et al.* 2006; Uribe 2009; Castro *et al.* 2016; Gallardo *et al.* 2017a). This new framework of relations transformed local and traditional identities by exposing them to a new cosmopolitan reality through a constantly

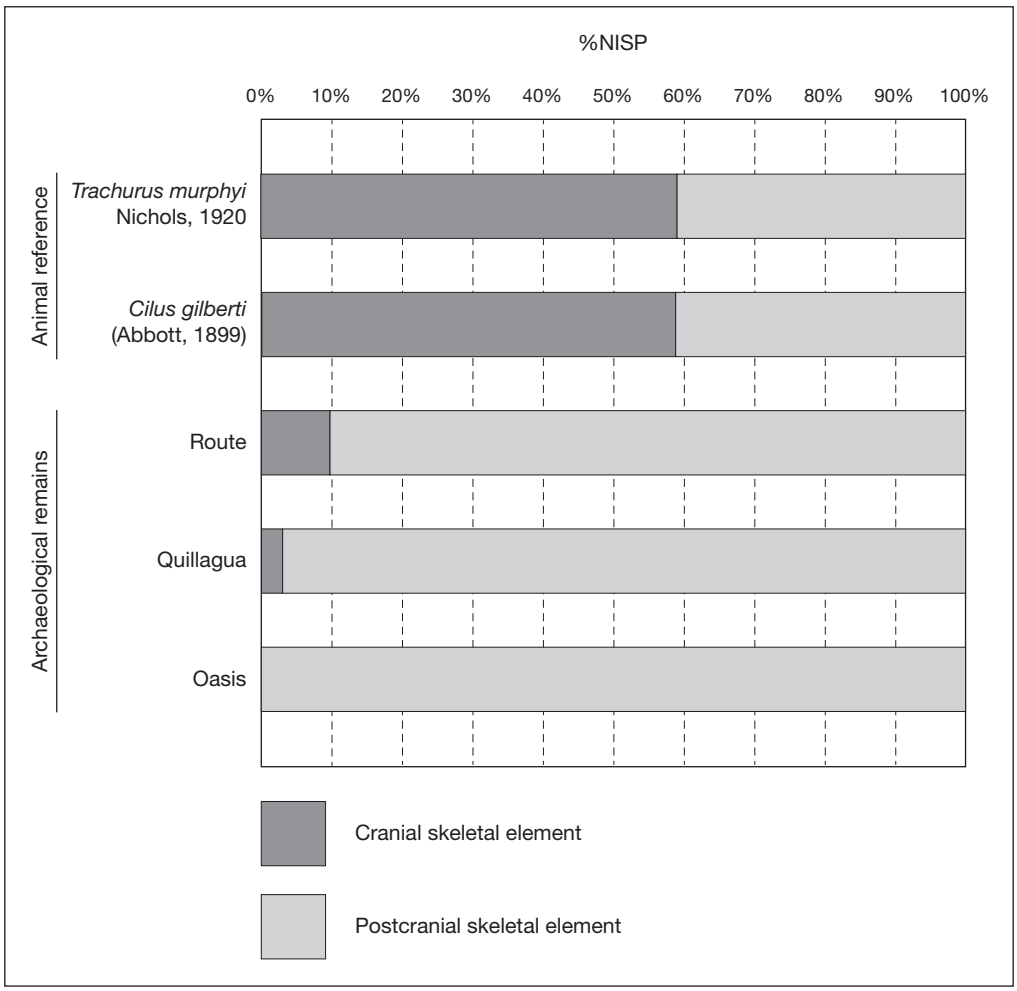

FIG. 9. — Graphic that indicates the relation between cranial and postcranial skeletal units in routes, Quillagua and interior oasis sites from the Atacama Desert during the Formative period. Both inferior bars show the same relation in reference skeletons from *Trachurus murphyi* Nichols, 1920 (60 cranial and 41 postcranial elements) and *Cilus gilberti* (Abbott, 1899) (60 cranial and 42 postcranial elements). Abbreviation: **NISP**, number of identified specimens.

changing panorama of traveling outsiders, exotic goods, new habitus, and novel customs that revealed and enabled new ways of being and doing. That atmosphere allowed groups, sectors, and communities to reinvent their cultures and may have catalyzed the emergence of individual and collective differentiation – a sociocultural tool for establishing political agency on a local and/or regional scale.

It is in precisely this sociopolitical and economic context that fish enters the game as a central player. As a proprietary product arising purely from coastal agency, during the Formative period this resource became increasingly attractive outside the geographical and social boundaries of the coast (Castillo 2011, 2015; Ballester & Clarot 2014; Gallardo *et al.* 2017a). It served as food along trade routes and in the oases for both coastal groups and agropastoralists of the interior. On the coast, consumption was intensive, as fish was a dietary staple that was consumed raw, dried, or cooked, butchered or whole (Arriaza 1995; Reinhard & Urban 2003; Ardiles *et al.* 2011; Pestle *et al.* 2015a). Owing to the distances involved, the sometimes precarious means of transport, storage limitations, and the desert conditions, in the interior fish was consumed dried, on a small scale, and was not necessarily available in equal quantity to all community members; rather, it was generally a compliment to food produced locally by gathering, horticulture, farming, and hunting (Rivera 2002; Pestle *et al.* 2015a, b; Pestle 2017).

In this regard we propose that fish, as a foreign and exotic product, considered as material culture, played a major role in the intralocal relations by supporting the construction and reproduction of internal differences among the collectives living in the inland desert valleys and oases, distinguishing between those who had and did not have access to this product and to what degree (Van der Veen 2003). This value was also expressed outside of the strictly dietary realm, as fish was a constant feature in funerary offerings, which demonstrates its polysemic value and its active multifaceted social role. Thus, beyond the economic plane, the adoption of a new culinary element transformed food preferences (Smith 2006) among interior agropastoralists, thereby modifying their own identity in response to new intercultural relations (Dietler 2007), as they forged closer ties with coastal groups without losing the elements of their own tradition. This phenomenon represents

the formation of a new cultural entity at the culinary level, constructed from local and foreign elements (Barthes 1961). A similar social and cultural phenomenon occurs in the other sense, as during the Formative period littoral collectives incorporate foreign cultivated vegetables and ceramic vessel produced by inland populations, completely changing part of their coastal culinary traditions as a way to create cultural affinities for maintain and reproduce their social ties with their interior neighbors (Carrasco *et al.* 2017; Correa *et al.* 2018).

On the macroregional scale, this phenomenon creates a culinary distinction between those who lived close to the Pacific and those residing in the interior, but more importantly, it testifies to their strong economic linkage and the cultural negotiations they had to engage in to maintain that bond. Thus, a new social structure and relational network based on food circulation emerged, in association with other kinds of goods, products, persons, and ideas. The economic cycle of fish, specifically, began with those who lived on the coast and was maintained and expanded over time as a consequence of the high culinary value assigned to fish by the people living in the Atacama Desert interior. In this context, dried fish did not merely satisfied a nutritional need; it became yet another element of the material culture that groups employed to maintain, strengthen, and reproduce the relations they had established with far away communities; furthermore, it provided a new avenue for marking distinctions between certain individuals and groups within the very heart of those inland communities.

Acknowledgements

FONDECYT 1160045 and 1090762, FONDAP 15110006. This article is an extended and more complete version of a previous work of the research team published in a monographic series (Castillo *et al.* 2017). We especially thank Mariana Ugarte and Charles Rees. We also express our gratitude to the two anonymous referees whose insightful comments and suggestions have helped us to improve this article.

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Submitted on 19 April 2018;
accepted on 26 September 2018;
published on 3 May 2019.