New radiocarbon dating and demographic insights into San Juan ante Portam Latinam, a possible Late Neolithic war grave in north-central Iberia

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Abstract

Objectives: San Juan ante Portam Latinam is one of a small number of European Neolithic sites meeting many of the archaeological criteria expected for a mass grave, and furthermore presents evidence for violent conflict. This study aims to differentiate between what is potentially a single episode of deposition, versus deposition over some centuries, or, alternatively, that resulting from a combination of catastrophic and attritional mortality. The criteria developed are intended to have wider applicability to other such proposed events.
Material and methods: Ten new AMS ^{14}C determinations on human bone from the site, together with previously available dates, are analysed through Bayesian modeling to refine the site's chronology. This is used together with the population's demographic profile as the basis for agent-based demographic modeling.
Results: The new radiocarbon results, while improving the site's chronology, fail to resolve the question whether the burial represents a single event, or deposition over decades or centuries – primarily because the dates fall within the late fourth millennium BC plateau in the calibration curve. The demographic modeling indicates that the population's age and sex distribution fits neither a single catastrophic event nor a fully attritional mortality profile, but instead may partake of elements of both.
Discussion: It is proposed that San Juan ante Portam Latinam was used as burial place for the mainly adolescent and adult male dead of a particular or multiple violent engagements (e.g. battles), while previously or subsequently seeing use for attritional burial by other members of one or more surrounding communities dead over the course of a few generations. The overall bias towards males, particularly to the extent that many may represent conflict mortality, has implications for the structure of the surviving community, the members of which may have experienced increased vulnerability in the face of neighboring aggressors.

Understanding the prevalence and contexts of intergroup conflict in prehistory is increasingly on the agenda, not only in terms of understanding the past in its own right, but also in terms of providing insights into modern conflict. San Juan ante Portam Latinam (henceforth referred to as SJAPL) is one of a small but growing number of European prehistoric sites meeting many of the archaeological criteria expected for a conflict-related mass grave (Knüsel, 2005): the presence of a body mass within the burial, disorder in the orientation of the skeletons, the deposition of the bodies in contact with one another, the evidence of a number of traumatic injuries, and a potentially common cause and manner of death for multiple individuals (Vegas, Armendariz-Gutiérrez, Etxeberria, Fernández & Herrasti, 2012). The possible simultaneousness of the deposit gains its particular importance from the fact that the number of individuals involved (at least 338) (Etxeberria & Herrasti, 2007) would make this the largest such event known for the European Neolithic/Chalcolithic. However, some apparent anomalies in the archaeological record (e.g. the presence of 'nests of skulls' near the walls and the identification of possible irregularities in the anatomical representation of some bones) (de-la-Rúa, Manzano, Cuende & Baraybar, 1995) and, above all, the variability seen in the ten previously reported radiocarbon determinations have called into question the single event scenario (Fernández-Crespo, 2007).

This paper aims to provide a robust radiocarbon and demographic dataset for SJAPL, to differentiate between catastrophic versus attritional mortality, or, alternatively, a combination of both. To this end we present ten new AMS ^{14}C determinations on human bone. While it will not be possible to categorically confirm a single event, it will be possible to refine the current chronology for the site, with Bayesian modeling facilitated by the presence of a superimposed sequence of skeletons in at least partial articulation. In conjunction with agent-based demographic modeling this may be sufficient to choose between the main options currently being debated for the site (Schulting & Fibiger, 2012).

1. THE SITE

SJAPL is located in the Rioja Alavesa region (mid-upper Ebro Valley, north-central Iberia), together with a relatively large number of coeval funerary sites (Fig. 1). The site was discovered in 1985. Rescue excavations carried out that very year and subsequent campaigns in 1990 and 1991 (after the controlled explosion of the collapsed roof, a 25 ton sandstone block) unearthed a 12 m^2 rockshelter with an impressive accumulation of human bones, comprising mainly articulated skeletons but also a number of instances of apparently isolated bones with minimal presence of soil separating them (Vegas et al., 2012) (Fig. 2).

A minimum of 338 individuals (201 non-adults and 137 adults) with a clear predominance of males (70% of the 153 adolescents and adults whose sex could be estimated) (Table 1) were buried in haphazard positions and orientations together with a number of artifacts (mainly arrowheads, blades and personal ornaments). A number of individuals exhibit skeletal evidence for violence, most notably comprising 13 clear cases of arrowhead injuries, affecting adolescent and adult males mainly, with five showing no signs of healing (Fig. 3a). Three additional cases, while less definite, may also represent projectile injuries (one of which shows no signs of healing). Moreover, 30 instances of cranial trauma (one with no signs of healing) (Fig. 3b), corresponding mainly to adolescent and adult males, and five healed 'parry' fractures of left and right ulnae have been observed (Etxeberria & Herrasti, 2007).

Prior to the present project, nine conventional and AMS ^{14}C determinations on human bone were available (Table 2). Of these, two conventional dates (I-14842 and I-14594) have error terms of 140 and 150 years, and are nearly 500 years earlier than all of the other results. They cannot be re-measured, since both samples comprised a mix of different bones from unassigned individuals. However, given their high error terms and clear difference from all the other dates, they are rejected from any further consideration. Another measurement, also obtained from several bones (though in this case presumably from the same individual), appears too recent (Ua-10415: 4200 ± 95 BP) and can also be discarded, since a repeat analysis of the same skeleton returned a substantially earlier estimate (GrN-21772: 4570 ± 40 BP; Vegas et al., 1999). The remaining six determinations cluster tightly, and indeed are not inconsistent with a single event (4506 ± 20 BP; χ^2-test: df = 5, T = 5.8 (5% 11.1)). That said, their modeled span is *0-198 years* (68.2%) or *0-441 years* (95.4%), hardly satisfactory in terms of choosing between a single event and long-term deposition. Moreover, in terms of representativeness, only two of these six dates correspond to individuals injured by projectiles (one showing signs of healing and, the other, both healed and unhealed injuries) while another comes from an individual whose skeleton was closely associated with a projectile. The remaining dates are on an adult with apparently no signs of violence, an infant, and another unassigned mixture of bones. Not included in the model is a date on a 'bog dog' (Ua-10357: 4325 ± 70 BP), which appears to post-date the site's main phase of funerary use.

2. MATERIAL AND METHODS

2.1. Radiocarbon dating

Ten new human bone samples were selected for AMS ^{14}C dating, each representing a unique individual (Table 3). They were targeted according to the following criteria:

1) The presence of healed or unhealed arrowhead injuries, so that those individuals exhibiting the clearest signs of violence were dated. Seven of the selected individuals have embedded projectile points, of which four are unhealed and three show healing. Five of these same cases (four unhealed and one healed) additionally have projectile points in close association, the suggestion being that these may also have been embedded in soft tissues.
2) The superimposition of skeletons, to facilitate Bayesian modeling employing informative priors (Buck, Cavanagh & Litton, 1996). In this regard, six of the new sampled individuals (of which three also show arrowhead injuries) relate to a superimposed series of at least partially articulated bodies identified in the northeastern corner of the rockshelter (Fig. 4), joining a previously obtained determination (GrN-21770) on another individual (C.234) in the same sequence.
3) The horizontal distribution of skeletons, to determine whether those from the outer areas of the rockshelter were more recently deposited than those from the inner part. The four selected individuals were found (cf. Fig. 4) in the southeastern and northwestern corners of the rockshelter, areas not represented by previous radiocarbon dates.
4) The age and sex of the individuals, reflecting their demographic range as much as possible, from younger children to older adults, including both males and females. The 10 new samples comprise an infant, five adolescents (four males and a probable female), three young adult males and a mature adult male. The paucity of females is due to the fact that all but one of the individuals injured by arrowhead are identified as male, and that this objective (1) was prioritized.

Collagen was prepared according to the standard protocols in place at the Oxford Radiocarbon Accelerator Unit (ORAU) and includes a 30 kD ultrafiltration step (Brock, Higham, Ditchfield & Bronk Ramsey, 2010).

The dates are calibrated in OxCal 4.2 using the IntCal13 calibration curve (Bronk Ramsey, 2013). All results are presented at 95.4% probability unless otherwise noted.

The results were modeled using Bayesian statistics in OxCal 4.2 (Bronk Ramsey, 2009a). Radiocarbon determinations come with a degree of statistical uncertainty defined by the error term. This is then further modified by the process of calibration, depending on the steepness of the curve for the time in question, and on the presence or absence of peaks and troughs. The end result is thus a probability distribution in which the true age of the event in question lies, with a specified degree of likelihood (usually reported as 68.2% and 95.4% confidence intervals). Bayesian modeling makes use of additional 'prior' information (e.g. a superimposed series of skeletons) with the goal of reducing this uncertainty (Buck et al., 1996). The viability of any Bayesian model (testing both the assumptions of the model, and of the individual ^{14}C determinations within it) is assessed through an 'index of agreement', which should attain values of at least 60% (see Bayliss, Bronk Ramsey, van der Plicht & Whittle (2007) and Bronk Ramsey (2009a,b) for an explanation of this statistic). Modeled results are presented in italics.

2.2. Agent-based demographic models

The age and sex data presented in the osteological analysis of the site (Etxeberria & Herrasti, 2007) are used as the basis for agent-based demographic modeling. We additionally use the preindustrial standard mortality table (i.e. Séguy & Buchet, 2013) as a proxy for prehistoric attritional mortality, together with skeletal age and sex data taken from other nearby Late Neolithic funerary sites to understand the demographics of the Rioja Alavesa region (i.e. Las Yurdinas II, Peña Larga, Alto de la Huesera and Longar (Fernández-Crespo & de-la-Rúa, 2016; Rivera, 2011)).

The software employed for the agent-based demographic models is the Population & Cemetery Simulator (PCS) (Duering, 2015), developed using NetLogo (Wilensky, 1999) and the Behaviour Composer programmed for the modelling4all.org project (Kahn & Noble, 2010). The PCS is used to model mortality populations. The fertility is generally normalized: menarche at age 17, menopause at age 40 and total fertility rate (TFR) of 5.0. Five scenarios have been modeled for SJAPL. In scenarios 1 and 2 each population is 'killed' multiple times to simulate single violence-related events (i.e. massacres), compared to life tables calculated using both the standard mortality profile and the combined regional population, respectively. In scenario 3 the virtual burials are recorded as if they are the result of purely attritional mortality, showing the age and sex distribution of a population burying their dead over an extended period, here and in the subsequent scenarios the minimum Bayesian modeled span of 0-115 years (68.2%). Finally, scenarios 4 and 5 include a mix of attritional mortality with some population inputs and outputs in certain age categories to simulate a burial place associated with one or more episodes of conflict (e.g. battles/raids). Specifically, we model: increased mortality of males aged 20 to 40 years (scenario 4); and increased mortality of males aged 15 to 40 and no burial at the site of 50 percent of individuals aged 0 to 4 years (scenario 5). The average age distributions of the modeled populations at the time of their death is recorded and compared to determine how well the theoretical models reproduce the observed age structure at SJAPL (cf. Duering & Wahl, 2014).

3. RESULTS

3.1. Radiocarbon dating and Bayesian modeling

All the samples yielded well-preserved collagen as assessed by yield, %C, %N and C:N ratios (DeNiro, 1985; van Klinken, 1999). When calibrated, the 10 new radiocarbon dates all fall in the late 4th millennium cal. BC (Table 4), consistent with the majority of those previously available. There is no indication that either marine or freshwater foods formed a significant part of the diet at SJAPL, and so no radiocarbon reservoir effects are expected (e.g. Fernández-Crespo & Schulting, 2017).

A model focusing just on the superimposed seven individuals gives a start date in the range *3365–3125 cal. BC*, ending *3335–3035 cal. BC* and spanning *0–115 years* (68.2%) or *0–260 years* (95.4%) (Fig. 5).The lengths of these spans are strongly affected by the late fourth millennium plateau in the calibration curve (cf. Ashmore, 2004).

Unfortunately, it is impossible to place the remaining dated humans stratigraphically vis-à-vis one another, considering that they come from different areas and their vertical positions cannot be correlated, due to both the rockshelter's uneven floor and to the compression of sediments caused by the fall of the large stone block. Nevertheless, they can be combined into a model with the stratified measurements, which considers the superimposed series of seven individuals as defining a phase of mortuary use of the rockshelter within which the other individuals are likely to fall. Excluding the three abovementioned outliers (I-14842, I-14594 and Ua-10415) and the 'bog dog', the remaining 16 new and previously published determinations on human bone are modeled as lying between *3380–3135 cal. BC* and *3315–3000 cal. BC*, spanning *30–205 years* (68.2%) or *0–315 years* (95.4%) (Fig. 6). As with the previously available dates on their own, the possibility of a single funerary event is not rejected (4498 ± 9 BP, χ^2-test: df = 15, T = 25.0 (5%, 25.0)), but again this needs to be seen in the context of the late fourth millennium plateau in the calibration curve.

3.2. Demographic modeling

Scenarios 1 and 2 present profiles averaging out the SJAPL spikes in the first decades of life (Fig. 7). However, substantially more infants and children were buried in the site than would have been theoretically present in a living population at any one point in time. The percentages of individuals aged 10-14 and 15-19 in the SJAPL sample are also very different from the modeled massacres. This speaks strongly against the interpretation of SJAPL as a whole as a single-event, conflict-related catastrophe. Scenario 3 shows a fully attritional profile, which is the least likely fit compared to the SJAPL data. Scenario 4 also does not replicate the observed SJPAL age profile, since high infant mortality of the preindustrial standard predicts twice as many infant deaths than represented in the sample. Additionally, the mortality peak of young adult males comes too late. By contrast, scenario 5 represents a better fit, especially regarding the shape of the curve in the first decades of life. The unusual mortality peak in the adolescent category (again, many of these are male where it is possible to estimate sex) could imply that some kind of catastrophic mortality is particularly affecting this age group. The old adult age category, however, is underrepresented in the SJAPL sample, though this might be the result of the not uncommon issue of underestimating the ages of older individuals in osteological analyses (Akroyd, Lucy, Pollard & Roberts, 1999).

4. DISCUSSION

While improving the site's chronology, the new radiocarbon results combined with Bayesian modeling still fail to resolve the question of whether the burial of a large number of individuals at SJAPL represents a single event, or deposition over decades or even centuries. The fact that all the dates fall within the late fourth millennium BC plateau in the calibration curve prevents us from attaining greater precision. However, the informative model making use of the superimposed skeletons does not exclude the possibility of a single event and provides reduced maximum timespans of *0–115 years* (68.2%) or *0–260 years* (95.4%) for the burial deposit. This becomes less precise in the model that includes the unstratified remains (*30–205 years* (68.2%) or *0–315 years* (95.4%)). There is no clear temporal trend in terms of age/sex or location among the dated individuals, nor can any chronological difference be detected between those exhibiting healed and unhealed projectile injuries.

In cases where the precision of absolute dating methods is limited, a mass grave can be misinterpreted as a long-term cumulative burial. However, the agent-based demographic models presented here suggest that SJAPL's sample corresponds neither to a simultaneous burial of the entire living population nor to a fully attritional cemetery. Thus, it is not unreasonable to argue that SJAPL is the result of a combination of attritional mortality and one or more catastrophic events (Weiss-Krejci, 2012). Epidemics and/or starvation do not fit well here as possible explanations, since a greater number of infants, young children and older adults would be expected, as, more importantly, would greater parity between the sexes (cf. Margerison & Knüsel, 2002). Violence, by contrast, is more likely to be the main reason for a mass interment element at SJAPL. Massacres would involve the indiscriminate killing of usually helpless or unresisting people, including men, women and children, and therefore seem unlikely to explain the demographic bias observed here. By contrast, warfare can significantly bias mortality towards adolescent and adult males (e.g. Jantzen et al., 2011), as warriorhood is restricted to them in most societies (López-Montalvo, 2015; Divale & Harris, 1976). A less immediately apparent but important consequence of both the sudden and attritional loss of adolescent and young adult males (some of which may themselves be the result of violence, e.g., deaths in battle, raids, revenge killings, etc.) would be the increased vulnerability of the surviving community to aggression on the part of neighboring communities, whether within the Rioja Alavesa region or beyond. The capture of women, for example, is a not uncommon in small-scale societies cross-culturally (Otterbein, 2000), and has been suggested for a number of Early Neolithic massacre sites in Central Europe in which the remains of young adult females are notably underrepresented (Meyer, Lohr, Gronenborn & Alt, 2015).

The available evidence for peri-mortem trauma in SJAPL may initially appear to be too limited to support the idea that a significant proportion of the burial population was the result of conflict. However, only about one in three arrows shot into the body are expected to strike bone and/or leave recognizable traces (Bill, 1862; Milner, 2005; Smith, Brickley & Leach, 2007). The identification of striations and fractures consistent with impacts in at least 36 of the 52 isolated arrowheads (Armendariz-Gutiérrez, 2007; Márquez, 2007) and of 23 cases of possible projectile injuries affecting soft tissues (based on the observation of close associations between skeletal elements and arrowheads) (Etxeberria & Herrasti, 2007), may suggest a larger number of victims. In this regard, the total number of arrowheads found at the site (n = 62), which broadly coincides with the surplus of at least 61 juvenile and adult males indicated by the sex imbalance, may provide a tentative estimation. The same limitation holds true for other forms of conflict-related trauma (mainly sharp or blunt force injuries). To put this into perspective, in the Bronze Age battlefield at Tollense, Germany, where most or all individuals are assumed to have died violently, evidence for violence could only be identified in eight of 83 individuals (i.e. 9.6%) and only four of those injuries are considered peri-mortem (Jantzen et al., 2011). We may, therefore, be seeing just the proverbial tip of the iceberg.

The predominance of adolescent and adult males across the site makes it difficult to recognize a demographic cluster pointing out to the possible stratigraphic position of any putative war layer/s. However, the location of those individuals showing unhealed arrowhead injuries in the northeastern corner and/or close to the walls of the rockshelter may suggest that SJAPL was used to bury the dead of a particular violent engagement if not at the very beginning, at least in an early stage of the site's mortuary use. The deposition of some injured skeletons directly on the floor and the apparently greater abundance of isolated projectile points in the lower deposits have previously been interpreted in these terms (Etxeberria & Herrasti, 2007: 274). The unusual location of the site –which so far is the only funerary rockshelter known in the valley of the Rioja Alavesa, where megalithic graves predominate despite the presence of hundreds of available rockshelters– may support its initial role as a makeshift and situationally dependent burial place. Subsequently, the site would have seen use for attritional burial, and perhaps additional victims of violent deaths.

In this context, the healed violent injuries found here and in other nearby coeval sites (e.g. Armendáriz-Martija, Irigaray & Etxeberria, 1994; Fernández-Crespo, 2016, 2017) can be seen as lending further credence to the likelihood of a recurrent and large-scale conflict, potentially promoted by a degree of territorial circumscription and resource concentration in the Rioja Alavesa region (Fernández-Crespo & Schulting 2017), which may have resulted in increased demographic pressure and heightened resource competition (cf. Carneiro, 2012). The results here highlight the value of considering multiple lines of evidence in the investigation of potential 'war graves'. Equally, they also demonstrate the difficulties of obtaining a definitive answer and the need to consider multiple possible scenarios. Further analysis of the SJAPL is ongoing and will no doubt shed new light on this important site.

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Table 1. Age and sex distribution of the individuals considered for MNI calculation at SJAPL (after Etxeberria & Herrasti, 2007).

		Age categories								Total
		Infant	Child	Adolescent	Indet. non-adult	Young adult	Mature adult	Older adult	Indet. adult	
Sex	Male	-	-	23	-	48	32	4	-	107
	Female	-	-	12	-	17	15	2	-	46
	Indet.	95	36	24	11	10	2	-	7	185
Total		95	36	59	11	75	49	6	7	338

Table 2. Previously available conventional and AMS ^{14}C determinations for SJAPL (Vegas et al., 1999), calibrated using OxCal 4.2 (Bronk Ramsey, 2009a).

Sample ID	Material	Individual	Taxa	Age	Sex	Skeletal signs of violence	Lab. ref.	Method	^{14}C yr BP	±	OxCal 4.2: unmodeled yr (BC/AD)		
											from	to	%
SJAPL-85B	Bone (several)	Unassigned	Human	-	-	-	I-14842	Conv.	5070	150	-4253	-3536	95.4
SJAPL-85A	Bone (several)	Unassigned	Human	-	-	-	I-14594	Conv.	5020	140	-4228	-3522	95.3
SJAPL-3	Bone	C.248	Human	25-30	Male	-	GrN-21772	Conv.	4570	40	-3496	-3103	95.3
SJAPL-7	Bone	C.225	Human	>50	Male	Unhealed arrowhead injury: left coxal bone Healed arrowhead injury: rib	Ua-10355	AMS	4520	75	-3498	-2933	95.4
SJAPL-5	Bone	C.123	Human	35-40	Male	Healed arrowhead injury. skull Arrowhead closely associated: neck Healed trauma: rib	GrA-5428	AMS	4520	50	-3366	-3031	95.4
SJAPL-1	Bone	C.234	Human	20-25	Male	Arrowhead closely associated: thorax	GrN-21770	Conv.	4510	40	-3361	-3090	95.4
SJAPL-8	Bone	C.330	Human	<5	Indet.	-	Ua-10356	AMS	4460	70	-3351	-2928	95.4
SJAPL-2	Bone (several)	Unassigned	Human	-	-	-	GrN-21771	Conv.	4440	40	-3335	-2927	95.4
SJAPL-9	Bone	6	Dog	Adult	Indet.	Cut marks on C3 vertebra	Ua-10357	AMS	4325	70	-3327	-2703	95.5
SJAPL-4	Bone	C.248	Human	25-30	Male	-	Ua-10415	AMS	4200	95	-3022	-2493	95.4

Table 3. Samples selected for the new radiocarbon approach at SJAPL.							
Sample ID	Material	Individual	Taxa	Age	Sex	Skeletal signs of violence	Location
SJAPL.C.161	Bone	C.161	Human	30-35	Male	Unhealed arrowhead injury: L1 vertebra Arrowhead closely associated: thorax	NW corner
SJAPL.C.229	Bone	C.229	Human	12-15	Male	-	NE corner. Superimposition (2)
SJAPL.C.221	Bone	C.221	Human	18-21	Male	Healed arrowhead injury: left coxal bone Right shoulder dislocation	NE corner. Superimposition (5)
SJAPL.C.218	Bone	C.218	Human	15-18	Male	Unhealed arrowhead injury: left scapula Arrowhead closely associated: skull/shoulder	NE corner. Superimposition (6)
SJAPL.C.270	Bone	C.270	Human	40-45	Male	Healed cranial trauma: frontal bone	NE corner. Superimposition (1 - bottom)
SJAPL.C.212inf	Bone	C.212inf	Human	ca. 3	Indet.	-	NE corner. Superimposition (7)
SJAPL.C.198	Bone	C.198	Human	15-18	Male	Unhealed arrowhead injury: thorax Arrowhead closely associated: left humerus	NE corner. Superimposition (8 - top)
SJAPL.C.212	Bone	C.212	Human	35-40	Male	Healed arrowhead injury: right radius Arrowhead closely associated: lumbar vertebra Healed cranial trauma	Centre
SJAPL.C.227	Bone	C.227	Human	20-25	Male	Unhealed arrowhead injury: T8 vertebra Arrowhead closely associated (2): forearm and coxal bone.	NW corner
SJAPL.C.2(B1)	Bone	C.2(B1)	Human	12-20	Female?	Healed arrowhead injury: thoracic vertebra	SE corner

Table 4. New ^{14}C determinations obtained at SJAPL, calibrated using OxCal 4.2 (Bronk Ramsey, 2009a).							
Sample ID	Lab. Ref.	Method	14C yr BP	±	OxCal 4.2: unmodeled yr (BC/AD)		
					from	to	%
SJAPL.C.161	OxA-V-2648-48	AMS - ultrafiltered	4566	30	-3492	-3109	95.5
SJAPL.C.229	OxA-V-2629-36	AMS - ultrafiltered	4544	29	-3366	-3104	95.5
SJAPL.C.221	OxA-V-2629-28	AMS - ultrafiltered	4520	29	-3356	-3101	95.4
SJAPL.C.218	OxA-V-2629-27	AMS - ultrafiltered	4511	29	-3352	-3099	95.4
SJAPL.C.270	OxA-V-2629-35	AMS - ultrafiltered	4491	29	-3347	-3092	95.4
SJAPL.C.212inf	OxA-V-2629-34	AMS - ultrafiltered	4490	31	-3348	-3039	95.4
SJAPL.C.198	OxA-V-2629-26	AMS - ultrafiltered	4488	29	-3346	-3090	95.4
SJAPL.C.212	OxA-V-2648-50	AMS - ultrafiltered	4462	31	-3338	-3022	95.5
SJAPL.C.227	OxA-V-2648-49	AMS - ultrafiltered	4433	31	-3328	-2928	95.4
SJAPL.C.2(B1)	OxA-V-2648-51	AMS - ultrafiltered	4432	31	-3328	-2927	95.4