ISSN: 2331-1959 Volume 7, Number 1, January 2019

Scientific Research Publishing

Archaeological Discovery

ISSN: 2331-1959

www.scirp.org/journal/ad

Journal Editorial Board

ISSN Print: 2331-1959 ISSN Online: 2331-1967

http://www.scirp.org/journal/ad

Archaeological Discovery, 2019, 7, 1-29
http://www.scirp.org/journal/ad
ISSN Online: 2331-1967
ISSN Print: 2331-1959

Table of Contents

Volume 7 Number 1 January 2019

Archaeological Discovery (AD)
Journal Information

SUBSCRIPTIONS

The *Archaeological Discovery* (Online at Scientific Research Publishing, www.SciRP.org) is published quarterly by Scientific Research Publishing, Inc., USA.

Subscription rates:
Print: $39 per issue.
To subscribe, please contact Journals Subscriptions Department, E-mail: sub@scirp.org

SERVICES

Advertisements
Advertisement Sales Department, E-mail: service@scirp.org

Reprints (minimum quantity 100 copies)
Reprints Co-ordinator, Scientific Research Publishing, Inc., USA.
E-mail: sub@scirp.org

COPYRIGHT

PRODUCTION INFORMATION

For manuscripts that have been accepted for publication, please contact:
E-mail: ad@scirp.org

Archaeological Discovery, 2019, 7, 1-19
http://www.scirp.org/journal/ad
ISSN Online: 2331-1967
ISSN Print: 2331-1959

The BDU West between WWII and Cold War

Giancarlo T. Tomezzoli

Etno-Archaeological Observatory, Munich, Germany
Email: gt21949@gmx.de

How to cite this paper: Tomezzoli, G. T. (2019). The BDU West between WWII and Cold War. *Archaeological Discovery, 7,* 1-19.
https://doi.org/10.4236/ad.2019.71001

Received: November 9, 2018
Accepted: January 12, 2019
Published: January 15, 2019

Abstract

In this article the recent history of the Domaine de Pignerolle, near Saint-Barthelemy d'Anjou, the organization of the BDU West and its role during the WWII, the after war and the Cold War are described. The visits on the BDU site showed that all the BDU barracks disappeared and all the BDU bunkers were in good preservation state. In particular, the visit of the Admiral bunker showed that its transformation in anti-atomic bunker for the French president and government was in an advanced phase, but not terminated and consequently it never was operative. The reasons of this transformation, despite the existence of other similar anti-atomic bunkers, and of its interruption remain to be determined.

Keywords

WWII, Cold War, Atlantic Wall, BDU West, *Admiral* Bunker, Pignerolle, Anjou, France

1. Introduction

The first visit of the Domaine de Pignerolle on 22nd August 2011 allowed identifying various BDU West bunkers, verifying their preservation state and identifying the BDU West role during the WWII. At that time, the *Admiral* bunker was not accessible; therefore the inspection of its interior was not possible. Only recently the Angers public administration given to the Association "Les Oubliés de Pignerolle" the task of supervising the bunkers preservation together with all the necessary authorizations and means for accessing them. The second visit on 16th September 2016, allowed reconstructing the BDU West organization and the evaluation of the transformation of the *Admiral* bunker, during the Cold War, in anti-atomic shelter for the French president and government.

2. Recent History of the Domaine de Pignerolle

The family Avril was proprietor of terrains around Saint-Barthélemy-d'Anjou

(Angers) already from 1680. She gave two canonicals to the Angers church and many directors to the Academie d'Equitation d'Angers. At the beginning of the XVIII cen., she purchased further terrains on the municipality of Saint Barthélemy and formed the Domaine de Pignerolle. On 1776 Mr. Marcel Avril lord of Pignerolle and Chauffour, director of the Academie, given to the architect Bardoul de la Bigotière the task to construct on the Domaine his castle. The castle was neoclassic in style, with a front and rear facades having seven bays and sides facades having five bays. The front facade comprised a front porch formed by four cylindrical, channelled columns, having ionic tops decorated with garlands and pendants, supporting a protruding balcony. Three bas-reliefs representing respectively: an angel presenting a rule and a compass to a lying vestal on the left, Apollo with the lyre at the centre, and angels crowning Aphrodite on the right, were on the front facade between the columns. The rear facade comprised four slightly protruding rectangular, channelled columns supporting a top fronton. Three bas-reliefs decorated by scrollwork and garlands were between the columns. Each window was surmounted by a fronton. The roof Italian in style was contoured by a balustrade. The apartments of Mr. Avril, were at first floor with a cabinet and a library. The park was a mix of French and English style garden (Coiffard, 2006).

The Academy admitted students from many European countries. On 16th January 1786 Arthur Wesley, future Duke of Wellington, arrived in Angers. At the Academie he learned dance, mathematics, languages, the use of weapons, and in the woods of the Domaine to be chevalier. Other relevant students of the Academy were brothers De Witt, stadtholders in Holland, the naturalist Buffon and the future statesman William Pitt. The Academy closed on 1792 at the time of the Revolution. Mr. Avril was arrested on October 1793 and imprisoned in Angers. The castle was occupied by revolutionaries and signets were posed on its doors. The Avril family migrated to another residence (Coiffard, 2006).

On XIX cen. the Domaine was sold by the descendants of Mr. Avril to Mr. P-A Blancler, rich Angers merchant. He renewed the castle in the 1st Empire style, built the orangery, a slate wall long several kilometres around the Domaine, two pavilion tours and grids at the Domaine entrance. After him, the Domaine was acquired by different families for arriving on 1905 in the patrimony of the viscount Joseph Coudrec de Saint-Chamant. He was graduated officer from the Saint-Cyr Academy, captain of the 27th Dragoons at Versailles and in service at the War Minister from 1900 to 1906. The WWI caused him to resume military service and the loss of his son Guillaume. In his memory, the viscount founded in Saint-Barthélemy the Saint-Guillaume school. The park was many times open to feasts, concerts and religious, rogation processions (Coiffard, 2006).

On 1st September 1939 Germany invaded Poland. Great Brittany and France declared war to Germany and mobilized their troops. The 125th Infantry Regiment was formed on the Domaine on 2nd September. Its headquarter and the

residence of its commander colonel Tauréu were on the Domaine. The regimental sections were lodged in the farms of the nearby municipality of Saint-Barthelemy, trained on the Domaine and tried their regulatory gas masks in the pavilion tours. Many horses were requisitioned, regimental arms and materials deposited at the garage Hutreau. The majority of the soldiers were Angers natives and went home each evening. On 9th September 1939 the Regiment received its flag in front of the castle porch for. On 13th September the last Regiment elements leaved the Angers Saint-Laud station for the Meurthe-et-Moselle region (Coiffard, 2006).

After the Polish army defeat in September 1939, in October 1939 the viscount received the castle requisition by a letter of the Anjou prefect, as consequence of the French Republic president decree about the nation war time organization. He did not oppose the requisition and leaved the castle. Upon invitation, the Angers authorities assigned different Angers residences to the Polish government in exile, residences around Angers to the polish ministers and accredited foreign embassies. The castle was residence of the Polish president Raczkiewicz, who took possession on 2nd December 1939. The activities, the choices and the correspondence of the Polish government were controlled and protection was assured against its opponents. A Polish army of 80,000 escaped Polish soldiers and migrated workers was formed and positioned to defend France strategic points. The rapid German invasion of France on June 1940 obliged, on 12th - 14th June 1940, the Polish government and president to leave for Great Britain. An English headquarter was at the castle for only two days. The Polish army was evacuated to Great Britain. On 17th June 1940 a *Luftwaffe* attack in the Loire estuary sank the ship Lancastria causing the death of many British, Polish and Czech soldiers (Coiffard, 2006; Lemesle, 1981).

The *Kriegsmarine* decision on 1943 to move the West headquarter of the commander of U-Bootes (Befehlshaber der Unterseebootes West, BDU West) admiral Dönitz briefly to Parisand subsequently to the Domaine, ideal for the absence of relevant radio interferences, was consequence of the 28th March 1942 *RAF* air raid on the U-Boote base of Saint-Nazaire and the menaces to the U-Boote base of Lorient and to the BDU West itself in Le Kernevel (Larmor-Plage). Six hundred foreign workers built on the Domaine a base named, according to German Angers defence maps, simply BDU. It comprised eleven bunkers and twenty barracks for hosting about thousand German seamen and about ten French servants. Many trucks, requisitioned in Paris, transported cement and sand arriving at La Pyramide station at the BDU. Two hangars of the farm Ambillons stocked the cement sacs (Coiffard, 2006).

The BDU commanded the Melun Saint-Assise transmission station connected to a 1 km long antenna for long wave transmissions and the French navy T.S.F. (Télégraphie Sans Fil - wireless) station of Basse-Lande (Brains). The BDU was connected to La Reux bunker in Saint-Barthélemy (Tomezzoli, 2018) a long range emission station used as auxiliary emitter and emergency antenna. A relay

at college Du Bellay in Angers completed the BDU. The French farmers had to leave the cultivations because of the guards around the BDU bunkers. The vessel captain (*Kaptänzur Zee*) Rösing had the BDU commandment dependent from the *Kriegsmarine* Upper Command (*Oberkommandoder Kriegsmarine* - OKM) at *Koralle Lager* near Berlin (Coiffard, 2006).

The BDU assembled and coordinated all the available information coming from centres on the North Sea, Tyrrhenian Sea, Aegean Sea, Black Sea, Indian Ocean and from *Kondor* planes of the *Luftwaffe* Atlantic headquarter (*Flieger Führer Atlantik*) based at Merignac (Bordeaux). The actions of the U-Boote flotillas of Brest, Lorient, Saint-Nazaire, La Pallice and Bordeaux were commanded directly from the BDU, which was never bombarded notwithstanding the information sent to London by French resistance networks. The allied probably found more fruitful to intercept messages to and from the BDU rather than to destroy it. The BDU was also a rest place for U-*Bootes* crews, which on free time played sports and hockey on the Domaine meadows. Admiral Dönitz visited frequently the BDU, which received also visits of Italian *BETASOM* admiral and officers based in Bordeaux and of a Japanese officer delegation. A foreseen Hitler's BDU visit never took place (Coiffard, 2006; Suquet, 2009; Suquet, 2010).

On 9th August 1944, after the German defeat in the Angers battle, Rösing abandoned the BDU after having ordered to set the *Admiral* bunker on fire. After four days the French firemen were still unable to turn off the main fire source. On the fifth day the firemen chief ordered the closure of the bunker armored, gastight doors to stifle the fire. The fire persisted still some day before to turn definitively off. The BDU was looted by the French population (Gautier, 1973).

American black troops sojourned in the BDU during the harsh winter 1944-45. After them, from April to November 1945 the BDU lodged a Jewish colony together with prisoners and deported people of different nationalities waiting repatriation. From 3rd January 1946 following the decree of Angers major Allonneau and up to 1964, the BDU served as provisory accommodation for about thousand Angers war victims and deported peoples, and hosted a school, a police station and a church located in the orangery. Two barracks burned respectively on 1958 and 1961. After the WWII, during the Cold War, the Admiral bunker undergone works to transform it in anti-atomic bunker for the French president and government (Coiffard, 2006).

3. The BDU Organization

As in the case of Parc de La Haye (Map N˚200b, Point E (1)) (Vincent, 2013) (Tomezzoli, 2018), the BDU barracks, after the WWII, were not dismantled but lodged Angers peoples. This preserved the original BDU structure and allows today at more than seventy years from the end of the WWII, by analysing French air reconnaissance images of the immediate after war, to have a precise vision of the BDU organization. **Figures 1-3** permit easily to recognize the castle, its dependencies and the BDU barracks and bunkers.

Figure 1. Domaine of Pignerolle: general view of the BDU: on the lower right, the castle and the BDU barracks and bunkers. C1522.0501_1948_CDP2928_0380, n˚380, 1/4866, Argentique, 02/03/1948.

Figure 2. BDU organization—South part: (1) route de Beaufort; (2) external guard post; (3) internal guard post; (4) six small barracks; (5) two corps barrack; (6) - (8) barrack; (9) three corps barrack; (10) bunker; (11) barrack; (12) pigeon house; (13) - (15) barrack; 16 castle dependence; (17) bunker; (18) - (22) barrack; (23) vegetable garden; (24) pool; (25) castle; (26) cultivated area; (27) internal path.

Figure 3. BDU organization—North part: (24) pool; (25) castle; (27) internal path; (28) administrative building; (29) - (30) barrack; (31) bunker; (32) (33) barrack; (34) barrack leaning to the *Admiral* bunker, (35) orangery, (36) barrack leaning to the *Admiral* bunker, (37) *Admiral* bunker, (38) (39) barrack; (40) bunker, (41) - (46) barrack; (47) bunker; (48) water tower; (49) barrack; (50) bunker; (51) - (53) barrack; (54) possible Flak position; (55) barrack leaning to the bunker (56); (56) bunker; (57) - (61) barrack, (62) internal path.

The visits of the BDU site took place on 22nd August 2011 and 16th September 2016. They showed that the pavilion tours and grids at the Domaine entrance, the entrance gate, the pigeon house (12), the pool (24), the castle (23) (47˚28'11.48"N, 0˚28'25.26"W, 42.29 m), the castle dependence (16), the vegetable garden (23) and the orangery (47˚28'14.48"N, 0˚28'21.98W, 42.52 m) (**Figure 4**) were perfectly restored with no damage due to the population looting. A museum dedicated to the communication was open in the castle, but was closed at the time of the second visit (Tomezzoli et al., 2013).

The barracks (4) - (6), (9) - (11), (13) - (16), (18) - (22), (28) - (30), (32) - (34), (36), (38) - (39), (41) - (46), (49), (51) - (53), (55) (57) - (61) disappeared and only different grass growths here and there on the meadows betrayed their past presence. Rests of the concrete base of the barrack (34) were visible near the *Admiral* bunker (37). The water tower (48) disappeared. The concrete barracks (7) (8) were perfectly restored with no damage due of the population looting and hosted offices of the Domaine garden service.

The BDU surviving components (**Figures 5-7**) included the bunker (10) buried

(a)

(b)

(c)

(d)

(e)

(f)

(g)

Figure 4. BDU site surviving components—(a) pavilion tours and grids at the Domaine entrance; (b) access lane; (c) entrance gate; (d) castle gate; (e) castle (25) front facade; (f) castle (25) rear facade, (g) orangery (35).

in the terrain; so that its type and internal and external preservation states have not been ascertained. The bunker (17) was accessible and used by the Domaine garden service. Its entrance side was covered by vegetation and a recent wood

(a) (b) (c) (d) (e) (f) (g)

Figure 5. BDU site surviving components—(a) barrack (8) front side; (b) barrack (8) rear side—on the far left barrack (7); (c) castle dependence (16); (d) pool (24); (e) mound covering bunker (10); (f) bunker (17) entrance side; (g) barrack hanging on bunker (17).

barrack, used as garage and store of garden materials, was leaning on the opposite bunker side. The interior was in good preservation state with original armoured doors still in place. Bunkers (31), (47), (56) closed during the first were accessible during the second visit. Their interiors were in good preservation state with armoured doors still in place. All the original furniture and components of

(a) (b)

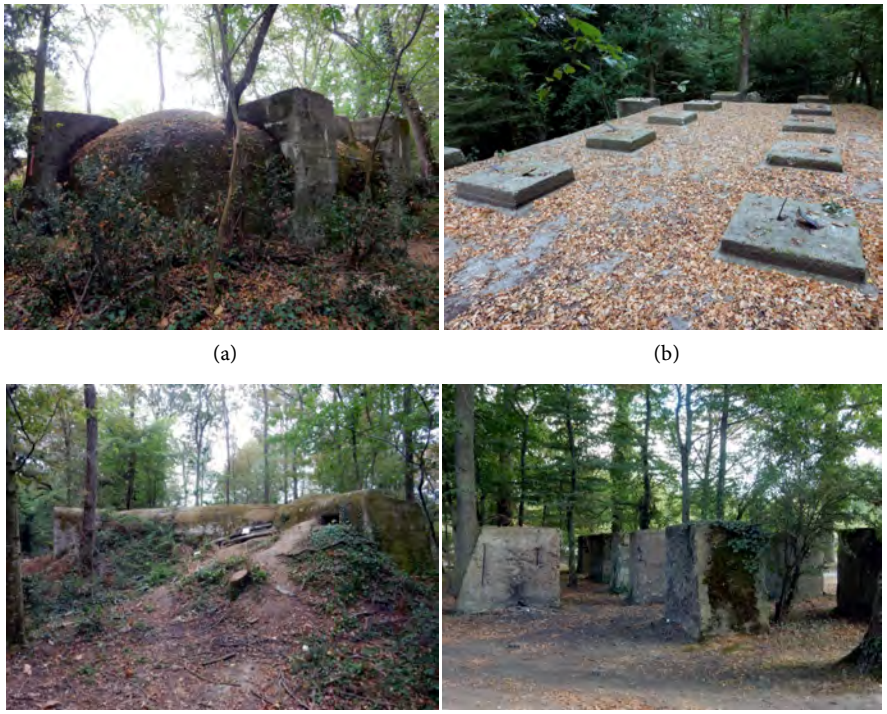
(c) (d)

(e) (f)

Figure 6. BDU site surviving components—(a) bunker (47); (b) bunker (50); (c) bunker (56); (d) bunker (31); (e) bunker (40); (f) concrete cistern.

its heating and aeration system disappeared. Only aeration conduit portions were in place on the walls. Their external concrete structures were in good preservation state. The coverage of bunker (31) was further covered by a recent metal sheet. Bunker (50) was accessible during the first visit. Its interior was in good preservation state with armoured doors still in place. All the original furniture disappeared and only aeration conduit portions were in place on the walls. Its external concrete structure was in good preservation state and the coverage was further covered by a recent metal sheet.

Admiral bunker (37) (about 1265 m^2) had the external structure in good preservation state. It was not accessible at the time of the first visit; therefore its interior preservation state has not been ascertained (Tomezzoli et al., 2013). However, its interior (**Figure 11(a)**) rooms (27) were used for radio reception, code



(a) (b)

(c) (d)

Figure 7. BDU site surviving components—(a) *Sonderkonstruktion*—side view; (b) *Sonderkonstruktion*—coverage with square supports bases; (c) R 611 or R 621—entrance side; (d) concrete aligned supports.

ciphering/deciphering and order transmissions through the antennas on the bunker coverage, which had top in shape of bicycle wheel; rooms (57) were used for statics about the sunken tonnage, calculations about the moonrise on all the seas and oceans, stored maritime maps, documents and files containing information about each U-Boot (Coiffard, 2006).

Bunker (40) was partially buried in the terrain, which obstructed its entrance. Therefore, its type and interior preservation state has not been ascertained. The emerging portion of its external structure was in good preservation state. A concrete cistern and two other bunkers (47˚28'9.34"N, 0˚28'8.35"W, 43.6 m) (**Figure 6** & **Figure 7**), outside **Figure 2**, were about 150 m east from the vegetable garden (23). The concrete cistern (2.5 × 10 m) was invaded by the vegetation at the time of the first visit but emptied and cleaned up at the time of the second visit. The bottom was in good preservation state, but the side walls were marked by large and deep cracks and some wall portions were displaced. One of the bunkers was of a special type (*Sonderkonstruktion*) partially buried in the terrain, which obstructed its entrance. Therefore, its interior organization and preservation state has not been ascertained.

Its emerging structure was in good preservation state with an obstructed emergency exit and eighteen square, support bases on its coverage. The other was an R611 or R621 partially buried in the terrain, which obstructed its fire room openings. Therefore, its interior preservation state has not been ascer-

tained. Its emerging structure was in good preservation state, with the circular aperture of the external observation post (*tobruck*) obstructed by a concrete layer.

Thirteen concrete aligned supports (47˚28'28.02"N, 0˚28'23.21W, 31.85 m) (**Figure 7(d)**), outside **Figure 3**, were about 380 m from the *Admiral* bunker beyond the state road 347 but still on the Domaine. Their external structure was in good preservation state with metallic joints still in place (Tomezzoli et al., 2013).

4. The *Admiral* Bunker

The second visit confirmed the good preservation state of the *Admiral* bunker external structure. On a wall the traces of the leaning barrack (36) were visible. No camouflage was painted on its coverage, and thirteen original antenna bases on the coverage disappeared.

The bunker interior (**Figures 8-10**) was accessible through the stair (A) which introduced to the underground tunnel towards the castle and the bunker entrance.

Both were in good preservation state with traces of construction formworks on the walls typical of the German masonry. The bunker anti-atomic transformation works were immediately evident.

A recent shower system was in place at the entrance, complete with its white rectangular base, hot and cold water mixing taps, but no splash guard. Recent toilets were in good preservation state. All the original armored doors were in

Figure 8. *Admiral* bunker (37)—on the left barracks (30), (33), the hanging barracks (34), (36), on the right barracks (38) (39) and bunker (40).

(a) (b) (c)

(d) (e) (f)

Figure 9. *Admiral* bunker (37)—(a) tunnel towards the castle; (b) bunker entrance, original light armored door 19P7; (c) shower system; (d) toilet in good preservation state; (e) original heavy armored door 434PO1 of a close combat defence room (2), on the wall defence original plate 483P2; (f) original armored port 434PO1.

(a) (b)

(c) (d)

(e) (f)

Figure 10. *Admiral* bunker (37)—(a) armored sliding door, on the right electrical, heating element; (b) internal room, suspended ceiling with white coverage panels in place; (c) modern galvanized aerator; (d) internal room, metallic suspension frame in place and white panels fallen on the floor; (e) internal room with metallic suspension frame and no white coverage panels; (f) internal room, white painted walls with marked traces of moisture.

place, sometime gray re-painted, sometime rusted but preserving their original blue painting.

The rooms (27), (32), (57), (85) were in a degraded state. The walls preserved the original white painting with marked stains of moisture. Original vertical wooden supports for a possible insulation system were in place. Modern galvanized sheet aerators on the walls replaced the original aerators. Original white tiles were in place on the floors. Somewhere, water puddles invaded the room floors. Modern suspended ceilings formed by white painted metallic suspension frames supported white coverage panels and casings of the lighting system each containing two neon tubes. The lighting system installation appeared completed. The panels fallen on the floor in one room let visible the suspension frame and the original, rusted bunker metal ceiling. One room was provided with suspension frame and casings but the panel installation was not terminated.

A room hosted a complete kitchen comprising a four leg electrical vegetables washing device Bonnet, a two-bowl sink furniture, an electrical cooking furniture having two circular plates, a hoven, a hot water reservoir, and a dishes furniture. Canteen furniture was not remarked in the room and in the nearby rooms.

A corridor introduced to the emergency electrical generator room (79) (**Figure 11** & **Figure 12**) closed on one side toward the exterior by an original double armored door 722P3. Two identical, well preserved, black painted electrical pumps each complete with control cabinet and cylindrical white painted distributor connected to white insulated conduits were in place on one room side. The conduits ascended to the ceiling and many red painted taps of the kind used on water conduits were on them. Galvanized, rectangular conduits of the aeration system ascended too to the ceiling. Four well preserved, grey painted pumps were connected with a portion of the conduits by cylindrical and galvanized conduits. Each pump was powered by a blue painted electrical motor but

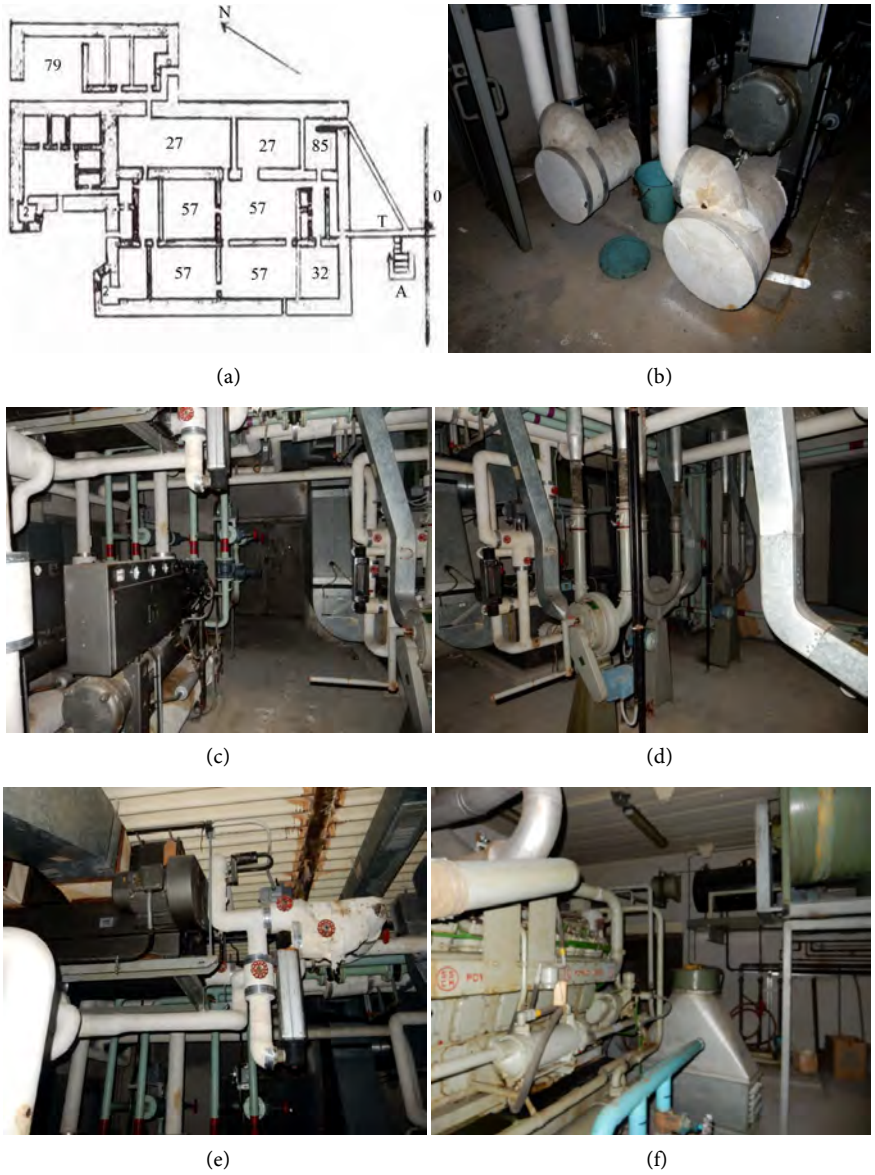
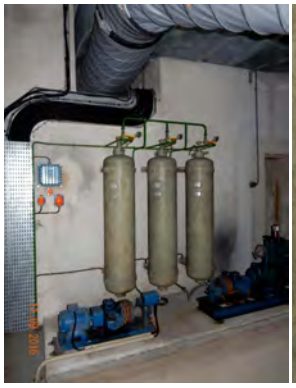


Figure 11. *Admiral* bunker (37): (a) plan: 2 close combat defence room, 27 computing room, 32 commander (Admiral room), 57 operation room, 79 emergency current, 85 foreman, A access stair, O orangery, T tunnel to the castle (Coiffard, 2006)—numbering according to Rudi, 1998; (b) black painted, electrical pumps with white distributors; (c) black pump on the left, armored door 722P3 in middle, galvanized conduit on the right; (d) grey painted pumps; (e) white insulated conduits with red painted taps; (f) diesel motor.

also provided with a crank for manual operation. The emergency electrical generator was in good preservation state (**Figure 11(a)**). It comprised a diesel motor connected to an alternator. The diesel motor hosted an oval label having the red letters SSCM inside and the red letters PDY outside. It received diesel fuel through a blue conduit, external air through a blue plastic conduit about 40 cm in diam. and evacuated exhausted gas through an insulated white conduit. The white painted alternator Leroy TA 450 leaked oil from its axis, and a stain formed on

(a)



(b) (c) (d)

Figure 12. *Admiral* bunker (37): (a) alternator Leroy TA 450, on the right grey painted control cabinets, on the ceiling, joints for the generator lifting; (b) alternator data plates; (c) cylindrical bottles and two air compressors on the floor; (d) two metallic labels on one bottle.

the white painted floor. On the room ceiling, white metal joints for the generator lifting were in place. The alternator grey and blue painted control cabinets were in good preservation state. A white arrow near two metallic black data plates and a silver data plate on the alternator indicated the rotation direction. The data plates (**Figure 11(b)**) informed:

metallic black plates:	metallic plate:
IMPREGNATION SPÉCIALE	ALTRENATEUR LEROY
POUR CLIMAT TROPICAL	ANGOULEME (FRANCE)
	TYPE SERIE N˚FABRICATION

Continued

	TA 450	M 4		439
CET ENSAMBLE EST TRANSISTORISÉ	PUISSANCE	COSφ	T/MIN	
NE PAS FAIRE D'ESSAI DIÉLECTRIQUE	440 kVA	0.8	1500	
NISONNER EN COURANTE ALTERNATIF	Ph HZ	VOLTS	AMP	
	6 50	Δ 220		
	SERVICE			AMP
	S. 1	Λ 380		
	PROTECTION	CLASSEISOLANTS	VOLTS	
	P. 21	B		
	PERIODICITE DE			AMP
	GRAISSAGE	800 h		

The alternator technical sheet adds, among other, the information:

Type: TA 450 M 4 (420)	Série: ARES No: 439 …	No de bon: 26050
RECETTE EFFECTUÉE	Expedié: 22 JANV 1968	

Three well preserved cylindrical, metal bottles of pressurized air were suspended to a room wall. Green tubes departed from them to the diesel motor and to two blue painted air compressors on the room floor. Two metallic data plates on one of the bottles (**Figure 11(d)**) informed:

CHAUDRONNERIE SOUDÈE MODERNE	
Etabl[ts] ROSSIGNOL	**ATTENTION**
67, Rue Henry Balliosse, 67 Argenteuil	Réservoir pour **AIR**
Vol. 100 N. 72075	**DANGER** d'utiliser
PE 63 Bars DATE 16 1 68	un autre **GAZ**
DATE DATE	

5. Discussion

The components of the BDU West were spread around the castle. The castle and concrete barracks (7) (8) lodged officers. The six small barracks (4) at the BDU entrance were probably linked with the guard corps service. Barracks (5) (6), (9) - (11), (13) (14), (18) - (22), (28) - (30), (33) - (34), (36), (38) - (39), (41) - (46), (49), (51) - (55), (57), (59) - (61) and the castle dependence (16) lodged operators of the *Admiral* bunker, guards and service personnel and U-Boote crews back from missions or preparing for missions. The barrack (28) was formed by six joined barracks and due to its extension and central position in the BDU probably hosted different services: administration offices, post office, library, reading room, kitchens, cantinas, cinema, and theatre. The barrack (15) has un-

common shape and unknown purpose. The barrack (22) was provided with ten opened spaces showers. Barracks (34), (36) together with the orangery camouflaged the *Admiral* bunker (37). Bunker (10) was an ammunition bunker buried after the war for security reasons. Due to its clear colour, the barracks (6), (9), (11), (15), (19) (20), (22), (30) - (32), (36), (39), (43) (44), (46) had a metallic roof. Due to the dark colour, the barracks (4) (5), (7) (8), (10), (13) (14), (16), (18), (21), (28) (29), (33) (34), (38), (41) (42), (45), (49), (51) - (55), (57), (59) - (61) had a tile or slate roof. A parade ground is not recognizable in **Figure 2** & **Figure 3**, however it was probably located in the oval space between the castle and barrack (28). Pool (24) and the pool near the R611 let the BDU seamen to swim and provided water in case of fire in the bunkers and barracks, as already seen at the German bases "The Bank" (Tomezzoli, 2016) and Kerlezerien (Tomezzoli, 2013). A blue plate of 8th April 2000 on a side of the castle dependence informed in French that: "After the Second World War, because of the housing crisis, nearly a thousand inhabitants of Angers were lodged in the barracks left in this place by the German army".

The bunker (31) was an infirmary bunker. Bunkers (47), (50), (56) were shelters for the BDU seamen in case of attack. The purpose of bunker (40) is unknown. The R611 was a bunker for a 150 mm gun; the R621 was a shelter for personnel. In case of R611, this bunker protected the east side of the BDU and it is surprising that no other such bunker was built for protecting the other sides of the BDU. The square support bases on the *Sonderkonstruktion* coverage probably supported a *Flak* guns platform. The thirteen concrete aligned supports probably supported another *Flak* guns platform. The cistern was probably the first constructed near the R611 or R621 and the *Sonderkonstruktion*. It stored water necessary on the construction yard of said bunkers, and not easily available on the yard. It provided water for knead the concrete, to quench thirst of working animals and against possible fires of the wood stocks for formworks.

All the U-Boote missions were coordinated at the *Admiral* bunker. All its original German furniture and sensitive devices disappeared looted by the population or confiscated by the American or French military authorities. The original heating system, ventilation system, electrical system, illumination system and antenna bases on the bunker coverage disappeared during the transformation works in anti-atomic bunker. The recent metal covers on bunkers (31), (50) were probably placed at the time of the transformation works. The shower system in place at the bunker entrance was a decontamination device. The incorrect location of the emergency generator in the bunker *Admiral* plan (Coiffard 2006) has been corrected in **Figure 9**. The original double armored door 722P3 facilitated the introduction of materials in the room (79). The diesel motor and alternator Leroy TA 450 replaced the originally installed diesel motor and alternator damaged by the fire. The vintage images of the original diesel motor and alternator of the bunker did not permitted to ascertain whether they were of German construction or rather of French construction as those installed at the German

submarine base of La Pallice or that of the French diesel-electric locomotive 262 AD.1 or 262 BD.1 of the degaussing station at the Bouvet basin of Saint-Malo port (Tomezzoli & Pottier, 2016). The original radiators, visible in vintage images, were replaced by electrical, heating elements. The black pumps and the insulated, white tubes circulated hot water of the heating system. The grey pumps, the galvanized tubes and aerators circulated air of the ventilation system. The blue tube distributed diesel fuel to the diesel motor. The bottles and the green tubes circulated compressed air to the diesel motor. The dates 16 1 68 on a metallic label of an air bottle and the 16 JANV 1968 on the technical sheet of the Leroy alternator permit to date the transformation works of the *Admiral* bunker between the 1964, year of the closure of the BDU as provisory accommodation centre and the year 1968.

The presence of a complete kitchen, room electrical, heating elements, a complete lighting system and a complete emergency electrical generator suggest that the transformation of the *Admiral* bunker in anti-atomic bunker was in an advanced phase of completion, but the suspension frame with incomplete tile coverage in one room, the absence of canteen furniture and the total absence of furniture in rooms (27), (32), (57), (85) suggest that the adaptation of the bunker was not completed and consequently it never was operative.

6. Conclusion

The reason of the disappearance of the BDU barracks was clearly the Saint Barthelemy and Angers housing expansion after the WWII. On the other hand, the reasons of the transformation works of its *Admiral* bunker in anti-atomic bunker for the French president and government, despite the existence already from 1963 of an anti-atomic commandment place coded Gypse at the BA 921 base near Taverny and another one under a hill near Lyon, and the reasons of the interruption of said transformation works remain to be determined.

Acknowledgements

I wish to thank Mr. C. Marquet of the French Association "Les Oubliés de Pignerolle" who allowed me to visit the Admiral bunker, Mr. D. Kugler and Mr. J. Kreutz of the European Patent Office for the stimulating discussions concerning the emergency electrical system, Mr. De Butler of Leroy-Somer company for the technical sheet of the Leroy TA 450 alternator and Mr. Fleuridas for his information concerning the R611, R621, the *Sonderkonstruktion* and the concrete cistern.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

Coiffard, J.-L. (2006). *Domaine de Pignerolle - Temoin d'une grande Histoire.* Château-Musee

de la Communication—Angers Loire Tourisme.

Gautier, R. (1973) Récit du Colonel Gautier. *Courrier de l'Ouest, 4-1-1973*.

Lemesle, M. (1981). *Angers sous l'occupation*. Ouest France.

Rudi, R. (1998). *Typologie du Mur de l'Atlantique*. Beetsterwaag, NUGI 923.

Suquet, G. (2009). *Mûrs-Érignéet la Deuxième Guerre Mondiale* (5è ed.).

Suquet, G. (2010). *D'Anger le Danger 1942-1945*. Murs Érigné.

Tomezzoli, G. (2013). Landerneau während des II. Weltkrieges, *DAWA Nachrichten, Ausgabe 62, 38-59*. Deutsches Atlantikwall Archiv, Köln.

Tomezzoli, G. T. (2016). The German Base "the Bank" at Mûrs-Érigné (Anjou-FR). *Archaeological Discovery, 4,* 37-47. https://doi.org/10.4236/ad.2016.41004

Tomezzoli, G. T. (2018). WWII German Military Structures in Angers (FR). *Archaeological Discovery, 6,* 300-318.

Tomezzoli, G. T., & Pottier, L. L. (2016). Journey through the Defences of the Festung Saint-Malo(FR) - 2. *Archaeological Discovery, 4,* 143-169. https://doi.org/10.4236/ad.2016.44011

Tomezzoli, G., Pottier, L., Marquet, C., & Letertre, M. (2013) Les Installations de la Kriegsmarine au Domaine de Pignerolle, *39-45 Magazine*, 60-72.

Vincent, H. (2013). Temoignage. *La cité "des Baraquements" du parc de la Haye de 1944 à 1950*. Wiki Anjou. 10th March 2013. https://www.wiki-anjou.fr/index.php/Avrill%C3%A9_-_Parc_de_la_Haye_Val_d%27Or_P%C3%A9pini%C3%A8res

Archaeological Discovery, 2019, 7, 20-29
http://www.scirp.org/journal/ad
ISSN Online: 2331-1967
ISSN Print: 2331-1959

A Study of Dog Coprolite from Late Neolithic Pile-Dwelling Site in Slovenia

Tjaša Tolar[1*], Alfred Galik[2]

[1]Scientific Research Centre of the Slovenian Academy of Sciences and Arts (ZRC SAZU), Institute of Archaeology, Ljubljana, Slovenia
[2]Austrian Archaeological Institute, Vienna, Austria
Email: *tjasa.tolar@zrc-sazu.si

How to cite this paper: Tolar, T., & Galik, A. (2019). A Study of Dog Coprolite from Late Neolithic Pile-Dwelling Site in Slovenia. *Archaeological Discovery, 7,* 20-29.
https://doi.org/10.4236/ad.2019.71002

Received: November 8, 2018
Accepted: January 12, 2019
Published: January 15, 2019

Abstract

More than 5000 years old dog's coprolite was found during rescue excavation at *Črnelnik* pile-dwelling site in Slovenia. Although human and dog diets may overlap considerably, the content of the consumed and digested food, consisting of plant and/or animal remains biologically diverse. While the investigated fossil excrement contained many fish head bones, scales and teeth of Cyprinidae family, we believe that we are dealing with an individual that had only eaten fish heads, that is why it was suggested to be of dog. Beside the origin and the daily diet of the individual together with the nutritional habits of the dog in the Late Neolithic, the analyses of coprolite provide more important information, for example: the time of year of the deposit, the environmental conditions there, the size and the health of the animal as well as care (or the status) of domesticated animal for humans. The discovery confirms again that animal dung should be an important part of archaeological investigations, specially at waterlogged sites.

Keywords

Archaeobiology, Nutrition, Late Neolithic, Coprolite, Dog

1. Introduction

Archaeobotany and archaeozoology are important natural sciences that supplement archaeological investigations. Both botany and zoology are closely connected to human activities. Nutrition supplies (for people and domesticated animals), as well as material for building activities or weapon and tool production are all connected with natural materials, both plant and animal. Archaeobiological material can be well preserved in waterlogged conditions where organic

remains are often preserved in an uncarbonised state and in large amounts. Circum-Alpine prehistoric lake-shore settlements are typical such archaeological sites. The Ljubljansko barje region in Slovenia with more than 40 pile-dwelling sites from the 5th to the 2nd millennium cal BC (Velušček, 2004) is the most southeasterly region of those sites (**Figure 1**).

Archaeological layers of lake-shore pile-dwelling sites are always composed of a variety of components derived from human and animal activity (Jacomet et al., 2004). Well preserved coprolites (fossil excrement remains) can often be found as well (Byrne, 1973; Akeret & Jacomet, 1997; Kühn et al., 2013). They are found whole or fragmented, uncarbonised and from various animals such as mice, sheep/goats, cattle, dogs etc. as well as from humans. Beside the daily diets of the individuals and their nutritional habits, the analyses of coprolites can provide more important information, for example: the time of year of the deposit, the environmental conditions there, the size and the health of the animal, care (or the status) of domesticated animals for humans, endoparasites if present, and finally also an exact C14 dating of the consumed plant/animal macroremains. The organic material of terrestial plants and animals preserved in waterlogged conditions are one of the most suitable archaeological matter for radiocarbon dating. Therefore animal dung should be an important part of archaeological investigations at waterlogged sites. Goat and sheep faeces have been investigated relatively often because they are compact and, therefore, are not always destroyed by sieving (Akeret & Jacomet, 1997; Akeret et al., 1999; Kühn et al., 2013). Cattle dung is often a mixture of faeces, stable litter, fodder and material that had nothing to do with cattle management (Kühn et al., 2013). Not so often, but randomly, dog or human coprolites can be found as well, when the excavation is careful and precise (Byrne, 1973). They are compact and therefore easy to

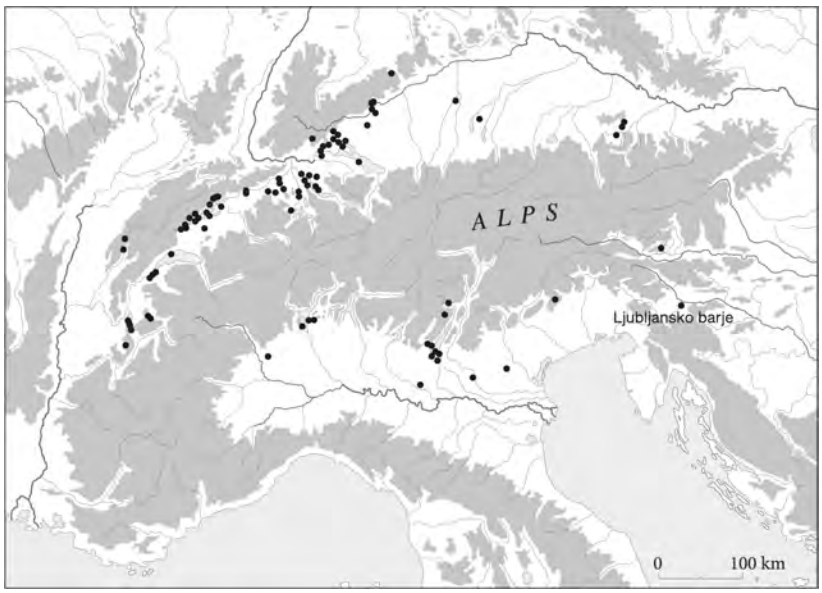


Figure 1. Geographical position of the Ljubljansko barje (longitude: 14˚29"; latitude: 46˚0") in the European Circum-Alpine lake-shore (pile-dwelling) sites.

recognize. While their outer structure and shape are similar to human or pig coprolites, the inner composition may differ (Byrne, 1973). While many studies have been made on goat/sheep faeces in order to investigate prehistoric management of domesticated animals and transhumance (Akeret & Jacomet, 1997; Akeret et al., 1999; Kühn et al., 2013), dog coprolites have not often been analysed, although the osteological investigations on them show that the dog was an important human companion in the Eneolithic (Bartosiewicz, 1999, 2002). The probable reason for the previous lack of study is that dog coprolites are not so often found.

2. Materials and Methods

Presumably dog or human well preserved waterlogged excrement in the cultural layer of the Late Neolithic pile-dwelling site *Črnelnik* in Slovenia was found in 2014, when the mechanical excavation of the ditch for the sewerage began (Velušček et al., 2018). Excrement of *Canis familiaris* (dog), as well as of human, mostly show an elongated, sometimes segmented shape (Jones, 1990). Well-preserved specimens are rarely found (Brönnimann et al., 2017). The one from *Črnelnik* site was dark brown, with a length of ca. 6 cm, and a width of ca. 2-3 cm (**Figure 2**).

The typical shape, colour and structure suggest that it is of dog or human origin (Byrne, 1973; Harrison, 2011; Brönnimann et al., 2017 and Link—http://www.scirpus.ca/dung/mammal.php). While the content of the consumed and digested food, consisting of plant and/or animal remains biologically diverse, the content of digested materials was investigated in the archaeobotanical laboratory by the methods of gently disaggregation and washing over 0.056 mm mesh sieve (following Jouy-Avantin, 2003). Then the macroremains caught on the sieve were sorted out and identified using a Leica MZ75 stereomicroscope with up to 50x magnification, with the aid of the reference collection of the plant remains at the Institute of Archaeology, ZRC SAZU and osteological fish bone reference collection at the Austrian Archaeological Institute. Identification atlases and keys were used as well (Schmid, 1972; Granadeiro & Silva, 2000; Cappers et al., 2006).

Figure 2. The coprolite from *Črnelnik* site. Photo: D. Valoh.

3. Results and Discussion

On the first view, the coprolite showed mineralized structure, it was compact, hard and resistant to pressure, therefore it was not easy to disaggregate it. As the coprolite was waterlogged preserved, the remains caught on the sieve were mostly uncarbonised preserved. They were precisely sorted, counted and identified in wet conditions. All togehter, 20 ml of the organic fraction was caught on the sieve. Animal remains, mostly uncountable unidentifiable flat bone fragments and fish scales and pharyngeal teeth of the Cyprinidae family prevailed. Among plant macroremains, six taxa were identified (**Table 1**; **Figure 3**). Some very small fragments of charcoal were present as well.

We found out that the specimen (most probably the dog) enjoyed diverse food. The scales, teeth of fish, and uncountable unidentifiable flat—most likely skull bone remains of fish heads, prevailed (**Figure 3(a)**, **Figure 3(b)**). Interestingly, there were, except of one individual (**Figure 3(f)**), no fish vertebrates included, indicating that the specimen only fish heads had eaten. Therefore we conclude that the excrement most likely belongs to the dog. Rare plant remains testify that the dog also enriched its menu with vegetable food as well. Jones (1986) established that less than 10 % of ingested bones survived passage through an animal's digestive system: beside some skull and cranial elements, the vertebrae survived as well. Beside the absence of the vertebrae, the absence of larger content of plant macroremains (except individual seeds; **Table 1**, **Figure 3(c)**) additionally convinced us that this is most probably dog's excrement. Byrne (1973) has recognized the differences between dog coprolites which contain

Table 1. The content of macroremains in the coprolite from *Črnelnik* site.

Number	Content
PLANT REMAINS	
4 seeds	*Rubus fruticosus* agg. (blackberry)
1 seed	*Linum usitatissimum* (flax)
3 seeds	*Chenopodium album* (white goosefoot)
1 seed	*Brassica rapa* (turnip)
1 seed	*Betula* sp. (birch)
1 frg. of fruit and 1 frg. of leaf	*Trapa natans* (water chestnut)
FISH REMAINS	
x	skull and cranial element fragments
x	pharyngeal teeth of Cyprinidae
x	scales of Cyprinidae
3 fragments	finrays
1	epihyale
1 fragment	vertebra fish unident.

x—many, not counted.

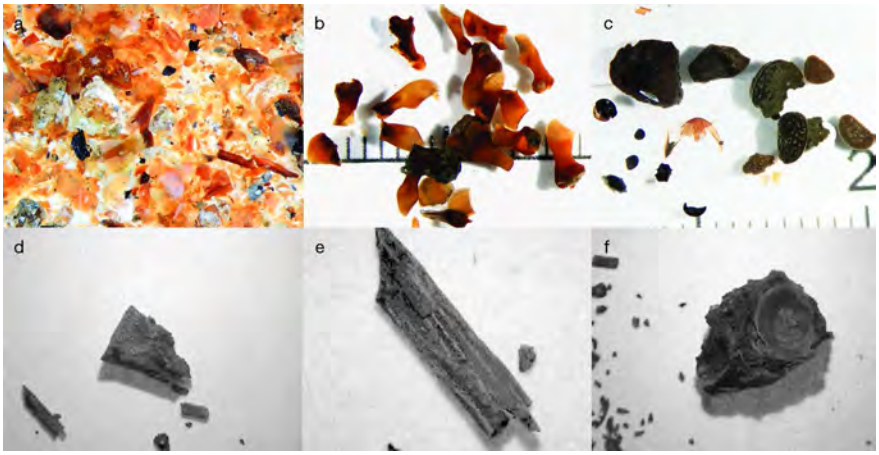


Figure 3. An example of macroremains from the coprolite, after processing in the archaeobotanical laboratory. Numerous flat fish remains, scales (a) and teeth (b), plant macroremains (c), epihyale fragment (d), finray fragment (e) and single vertebra remain (f). Photos: D. Valoh (a-c) and A. Galik (d-f).

mainly fish bone fragments, and human coprolites which contain mainly plant remains. The absence of fur or animal hair suggest that we are neither dealing with a wolf, for which larger content of hairs are typical in the excrement (Skrbinšek, 2010 and Link—http://www.volkovi.si/wp-content/uploads/2014/10/zimsko-sledenje_navodila-koncna.pdf).

Beside nutrition habits and the diet of the individual, the preserved macroremains give also other important information. The size (the width) of the excrement suggest that the dog was some smaller than a wolf, for example, which excrement measures about 3 cm in width, smaller wolfs 2 cm, while the biggest ones up to 4 cm in width (Skrbinšek, 2010).

Another information gives the remain of birch fruit for example, which extend its seeds from the late summer till the winter time; and also other recognized seeds/fruits (i.e. of water chestnut, flax, turnip, blackberry and goosefoot) are mature in late summer or autumn, what gives the information of the deposit (excrement) period of the year and consequently the settling period, which was most probably permanent (during whole year seasons; Čufar et al., 2010; Tolar et al., 2011).

Ecological conditions at and around the site could be discussed as well. Birch and water chestnut evidence marshy ground and the existence of slow flowing river or a lake, while the others (flax, turnip and goosefoot) evidence fields and other antrophogenic areas (Kreuz & Schäfer, 2011; Tolar et al., 2011). Fishes of the Cyprinidae family, collectively called cyprinids, that includes carp, true minnow, and their relatives, is the largest known fish family with about 3000 living and extinct species in about 370 genera. Some of the fish remains are isolated pharyngeal teeth (**Figure 3(b)**) of typical freshwater species like rudd or roach (Kottelat & Freyhof, 2007).

Predominantly uncarbonised remains of fish heads in the coprolite indicate

organic refuse management as well. The culture of eating fishes and the importance of the lake for the neolithic economy can be illustrated at various pile-dwelling sites (Torke, 2000; Govedič, 2004; Hüster-Plogmann, 2004; Jacomet et al., 2004; Jörg, 2006; Kottelat & Freyhof, 2007; Galik, 2009). One of the explanations could be that humans ate fish bodies, while the heads were thrown to dogs (Ewersen & Schmölcke, 2013), very likely even before roasting, while the fish remains were uncarbonised preserved. More evidences (with more dog coprolite investigations) should be performed to confirm this hypothesis. Aditionally, the care (and the status) of domesticated animal for humans colud be discussed. It seems that dog's master knew that fish heads are safer food for his dog than fish bodies (with lots of peaked bones), what leads to a suspection that humans took care for dogs, what consequently prove that the dog had an important status for humans (Bartosiewicz, 2002; Ewersen & Schmölcke, 2013; Janssens et al., 2018).

4. Conclusions

Coprolites of *Canis familiaris* (dog) as well as of human are regularly reported in various archaeological contexts (Macphail, 2000; Ismail-Meyer & Rentzel, 2004 and etc.), but rarely as completely preserved specimens. Therefore dog faeces from the *Črnelnik* site is valuable and remarkable find that has been worthwhile to investigate. We assume we are dealing with the coprolite of dog origin, because uncarbonised remains of fish heads (teeth, scales and flat bones) of Cyprinids were mainly preserved (**Figure 3**). It would make sense to re-excavate at the *Črnelnik* site, not only for the possibility of obtaining some more coprolites that are possibly abundant at that site, other archaeological and archaeobiological investigations could also be carried out at the same time, since other very interesting finds have been found at this site (Velušček et al., 2018). The investigation of only one well preserved coprolite sets out to explore the possibilities of coprolite analysis in wetland prehistoric archaeology. The presented initial strategy of investigating macroremains content in the waterlogged faeces is going to be the basis for future researches of newly excavated material (possibly dog or human coprolites) in Slovenia (Ljubljansko barje), as well as at other wetland sites. If more material (i.e. coprolites) available, different possible means of extracting data could be performed, beside plant and animal macroremains, also parasites (which beside biological origin of the sample, brings with it information that relates to many domains: primarily, palaeopathology and sanitary conditions, but also palaeodietetics, organic refuse management and cultures; Bouchet et al., 2003; Le Bailly et al., 2003, 2005), micromorphology (Macphail, 2000; Akeret & Rentzel, 2001; Ismail-Meyer & Rentzel, 2004; Brönnimann et al., 2017), pollen (Martin & Sharrock, 1964; Horrocks & Irwin, 2003), C14 dating, DNA extraction (Iñiguez et al., 2003) as well as biomarkers (such as lipids and stable isotopes which evidence totally digested food such as dairy products; Gill et al., 2009). All the investigations are intended to provide a range of information about past life in the pile-dwelling settlements, not only about the diet. If more

canine coprolites investigated, cultural heritage could be discussed as well, for example why the hunter-gatherers kept dogs; were they domesticated dogs and kept only for particular purposes such as helping with hunting, or were they regarded also as pets, and how were they kept, fed and what care or importance were they given (Ewersen & Schmölcke, 2013; Janssens et al., 2018)?

The presented research is the first investigation of coprolites in Slovenia, the most southeasterly region of Late Neolithic circum-Alpine lake-shore sites, where such finds are not rare. It has an important impact for the development of new research directions there, and on the other hand, it contributes to the database which is already available from comparable prehistoric waterlogged contexts in Europe (Bouchet et al., 2003; Le Bailly et al., 2003; Kühn et al., 2013; Maicher et al., 2017 and Link—http://www.scirpus.ca/dung/mammal.php). While this type of find material is scarce and hard to obtain, and therefore only rarely investigated, each analysis of it counts and is original and exceptional.

Acknowledgement

The project was financed by the Slovenian Research Agency (funding No. P6-0064 and No. J7-6857). Many thanks to technical assistant Dragotin Valoh for preparing figures and to James Greig for improving the English language.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Akeret, Ö., & Jacomet, S. (1997) Analysis of Plant Macrofossils in Goat/Sheep Faeces from the Neolithic Lake Shore Settlement of Horgen Scheller—An Indication of Prehistoric Transhumance? *Vegetation History and Archaeobotany, 6,* 235-239. https://doi.org/10.1007/BF01370444

Akeret, Ö., & Rentzel, P. (2001) Micromorphology and Plant Macrofossil Analysis of Cattle Dung from the Neolithic Lake Shore Settlement of Arbon Bleiche 3. *Geoarchaeology: An International Journal, 16,* 687-700. https://doi.org/10.1002/gea.1016

Akeret, Ö., Hass, J. N., Leuzinger, U., & Jacomet, S. (1999) Plant Macrofossil and Pollen in Goat/Sheep Faeces from the Neolithic Lake-Shore Settlement Arbon Bleice 3, Schwitzerland. *The Holocene, 9,* 175-182. https://doi.org/10.1191/095968399666631581

Bartosiewicz, L. (1999) Recent Developments in Archaeozoological Research in Slovenia. *Arheološki Vestnik, 50,* 311-322.

Bartosiewicz, L. (2002) Dogs from the Ig Pile Dwellings in the National Museum of Slovenia. *Arheološki Vestnik, 53,* 77-89.

Bouchet, F., Harter, S., & Le Bailly, M. (2003) The State of the Art of Paleoparasitological Research in the Old World. *Memorias do Instituto Oswaldo Cruz, 98,* 95-101. https://doi.org/10.1590/S0074-02762003000900015

Brönnimann, D., Pümpin, C., Ismail-Meyer, K., Rentzel, P., & Egüez, N. (2017) Excrements of Omnivores and Carnivores. In: Nicosia, C. and Stoops, G., Eds., *Archaeologi-*

cal Soil and Sediment Micromorphology (pp. 67-82). Oxford, UK: Wiley Blackwell. https://doi.org/10.1002/9781118941065.ch7

Byrne, D. (1973) *Prehistoric Coprolites: A Study of Human and Dog Coprolites from Prehistoric Archaeological Sites in the North Island of New Zealand.* M.A. Thesis, University of Auckland.

Cappers, R., Bekker, R. M., & Jans, J. E. A. (2006) *Digitale Zadenatlas van Nederland (Digital Seed Atlas of the Netherlands).* Groningen: Barkhuis Publishing & Groningen University Library.

Čufar, K., Kromer, B., Tolar, T., & Velušček, A. (2010) Dating of 4th Millenium BC Pile-Dwellings on Ljubljansko Barje, Slovenia. *Journal of Archaeological Science, 37,* 2031-2039. https://doi.org/10.1016/j.jas.2010.03.008

Ewersen, J., & Schmölcke, U. (2013) Untersuchungen zur Haltung und Nutzung von Haushunden auf meso- und neolithischen Fundplätzen im nördlichen Deutschland. Universitätsforschungen zur prähistorischen Archäologie. B. Ramminger, 240, 267-299.

Galik, A. (2009) Die Bedeutung des Fischfangs in der Horgener Seeufersiedlung Wallhausen-Ziegelhütte am Überlinger See, Hemmenhofener Skripte, 8, 138-144.

Gill, F. L., Crump, M. P., Schouten, R., & Bull, I. D. (2009) Lipid Analysis of a Ground Sloth Coprolite. *Quaternary Research, 72,* 284-288. https://doi.org/10.1016/j.yqres.2009.06.006

Govedič, M. (2004) Fishes from the Archeological Site at Hočevarica. In: Velušček, A., Ed., *Hočevarica—An Eneolithic Pile Dwelling in Ljubljansko Barje*, Opera Instituti Archaeologici Sloveniae, 8, 133-151.

Granadeiro, J. P., & Silva, M. A. (2000) The Use of Otoliths and Vertebrae in the Identification and Size-Estimation of Fish in Predator-Prey Studies. *Cybium, 24,* 383-393.

Harrison, T. (2011). Coprolites: Taphonomic and Paleoecological Implications. In: Harrison, T., Eds., *Paleontology and Geology of Laetoli: Human Evolution in Context* (pp. 279-292). Vertebrate Paleobiology and Paleoanthropology Series, Dordrecht: Springer. https://doi.org/10.1007/978-90-481-9956-3_14

Horrocks, M., & Irwin, G. J. (2003). Pollen, Phytoliths and Diatoms in Prehistoric Coprolites from Kohika, Bay of Plenty, New Zealand. *Journal of Archaeological Science, 30,* 13-20. https://doi.org/10.1006/jasc.2001.0714

http://www.scirpus.ca/dung/mammal.php

http://www.volkovi.si/wp-content/uploads/2014/10/zimsko-sledenje_navodila-koncna.pdf

Hüster-Plogmann, H. (2004). Fischfang und Kleintierbeute. Ergebnisse der Untersuchung von Tierresten aus den Schlämmproben. In S. Jacomet, U. Leuzinger, & J. Schibler (Eds.), *Die jungsteinzeitliche Seeufersiedlung Arbon/Bleiche 3, Umwelt und Wirtschaft. Archäologie im Thurgau 12* (pp. 253-276). Kanton: Huber & Co AG.

Iñiguez, A. M., Araújo, A., Ferreira, L. F., & Vicente, A. C. P. (2003). *Analysis of Ancient DNA from Coprolites: A Perspective with Random Amplified Polymorphic DNA-Polymerase Chain Reaction Approach*. Mem. Inst. Oswaldo Cruz, 98/1.

Ismail-Meyer, K., & Rentzel, P. (2004). Mikromorphologishe Untersuchung der Schichtabfolge. In S. Jacomet, U. Leuzinger, & J. Schibler (Eds.), *Die jungsteinzeitliche Seeufersiedlung von Arbon Bleiche 3, Umwelt und Wirtschaft. Archäologie im Thurgau 12* (pp. 66-80). Frauenfeld.

Jacomet, S., Leuzinger, U., & Schibler, J. (2004). *Die jungsteinzeitliche Seeufersiedlung Arbon/Bleiche 3. Umwelt und Wirtschaft. Archäologie im Thurgau 12* (pp. 1-458).

Kanton: Huber & Co AG.

Janssens, L., Giemsch, L., Schmitz, R., Street, M., & Van Dongen, S. (2018). A New Look at an Old Dog: Bonn-Oberkassel Reconsidered. *Journal of Archaeological Science, 92,* 126-138. https://doi.org/10.1016/j.jas.2018.01.004

Jones, A. K. G. (1986). Fish Bone Survival in the Digestive Systems of the Pig, Dog and Man: Some Experiments. In D. C. Brinkhuizen, & A. T. Clason (Eds.), *Fish and Archaeology, Studies in Osteometry, Taphonomy, Seasonality and Fishing Methods* (pp. 53-61). BAR International Series 294.

Jones, A. K. G. (1990). Coprolites and Faecal Concretions. In M. Bell (Ed.), *Brean down Excavations* (1983-1987) (pp. 242-245). Archaeological Report No. 15, London: Historic Buildings and Monuments Commission for England.

Jörg, S. (2006). The Economy and Environment of the 4th and 3rd Millennia BC in the Northern Alpine Foreland Based on Studies of Animal Bones. *Environmental Archaeology, 11,* 49-64.

Jouy-Avantin, F. (2003). A Standardized Method for the Description and the Study of Coprolites. *Journal of Archaeological Science, 30,* 367-372. https://doi.org/10.1006/jasc.2002.0848

Kottelat, M., & Freyhof, J. (2007). *Handbook of European Freshwater Fishes*. Berlin: Kottelat Cornol, Switzerland and Freyhof.

Kreuz, A., & Schäfer, E. (2011). Weed Finds as Indicators for the Cultivation Regime of the Early Neolithic Bandkeramik Culture? *Vegetation History and Archaeobotany, 20,* 333-348.

Kühn, M., Maier, U., Herbig, C., Ismail-Meyer, K., Le Bailly, M., & Wick, L. (2013). Methods for the Examination of Cattle, Sheep and Goat Dung in Prehistoric Wetland Settlements with Examples of the Sites Alleshausen-Täschenwiesen and Alleshausen-Grundwiesen (around cal 2900 BC) at Lake Federsee, South-West Germany. *Journal of Environmental Archaeology, 18,* 43-57. https://doi.org/10.1179/1461410313Z.00000000017

Le Bailly, M., Leuzinger, U., & Bouchet, F. (2003). Dioctophymidae Eggs from Coprolites from Neolithic Site of Arbon-Bleiche 3 (Switzerland). *Journal of Parasitology, 89,* 1073-1076. https://doi.org/10.1645/GE-3202RN

Le Bailly, M., Leuzinger, U., Schlichtherle, H., & Bouchet, F. (2005). Diphyllobothrium: Neolithic Parasite? *Journal of Parasitology, 91,* 957-959.

Macphail, R. I. (2000). Soils and Microstratigraphy: A Soil Micromorphological and Micro-Chemical Approach. In A. J. Lawson (Ed.), *Animal Husbandry in Later Prehistoric Wiltshire* (pp. 47-71). Salisbury: Wessex Archaeology.

Maicher, C., Hoffmann, A., Côté, N. M. L., Palomo Pérez, A., Saña Segui, M., & Le Bailly, M. (2017). Paleoparasitological Investigations on the Neolithic Lakeside Settlement of La Draga (Lake Banyoles, Spain). *Holocene, 27,* 1659-1668. https://doi.org/10.1177/0959683617702236

Martin, P. S., & Sharrock, F. W. (1964). Pollen Analysis of Prehistoric Human Feces: A New Approach to Ethnobotany. *American Antiquity, 30,* 168-180. https://doi.org/10.2307/278848

Schmid, E. (1972). *Atlas of Animal Bones for Prehistorians, Archaeologists and Quaternary Geologists*. Amsterdam, London, New York: Elsevier Publishing Company.

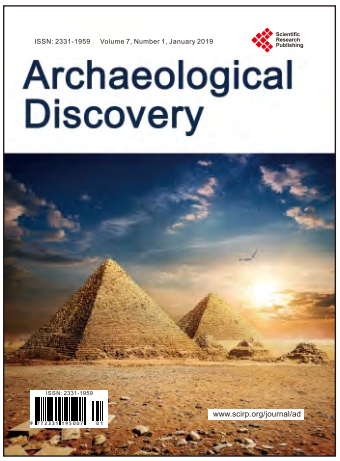
Skrbinšek, T. (2010). *Navodila za sodelovanje pri raziskavi volkov s pomočjo genetike*. Ljubljana: Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za biologijo. http://www.volkovi.si/wp-content/uploads/2014/10/brosura-genetika-slowolf-web1.pdf

Tolar, T., Jacomet, S., Velušček, A., & Čufar, K. (2011). Plant Economy at a Late Neolithic Lake Dwelling Site in Slovenia at the Time of the Alpine Iceman. *Vegetation History and Archaeobotany, 20,* 207-222. https://doi.org/10.1007/s00334-010-0280-0

Torke, W. (2000). Fischreste aus den neolithischen Moorsiedlungen Henauhof I Hartöschle am Feedersee und aus weiteren Fundplätzen Oberschwabens. Berichte zu Ufer-und Moorsiedlungen Südwestdeutschlands III. *Materialh, Arch. Baden-Württemberg, 52,* 345-357.

Velušček, A. (2004). Past and Present Lake-Dwelling Studies in Slovenia. Ljubljansko Barje (the Ljubljana Marsh). In F. Menotti (Ed.), *Living on the Lake in Prehistoric Europe, 150 Years of Lake-Dwelling Research* (pp. 69-82). London and New York: Routledge.

Velušček, A., Podpečan, B., Tolar, T., Toškan, B., Turk, J., Merela, M., & Čufar, K. (2018). Črnelnik and Devce, Newly Discovered Copper Age Sites at Ljubljansko Barje. *Arheološki Vestnik, 69,* 9-68.



Call for Papers

Archaeological Discovery

ISSN Print: 2331-1959 **ISSN Online: 2331-1967**

http://www.scirp.org/journal/ad

Archaeological Discovery (AD) is an international journal dedicated to the latest advancement in the study of Archaeology. The goal of this journal is to provide a platform for scientists and academicians all over the world to promote, share, and discuss various new issues and developments in different areas of Archaeological studies.

Subject Coverage

All manuscripts must be prepared in English, and are subject to a rigorous and fair peer-review process. Accepted papers will immediately appear online followed by printed hard copy. The journal publishes original papers covering a wide range of fields but not limited to the following:

- Aerial Archaeology
- Archaeological Method and Theory
- Archaeological Science
- Archaeometry
- Art Archaeology
- Environmental Archaeology
- Ethnoarchaeology
- Experimental Archaeology
- Field Archaeology
- Geoarchaeology
- Historical Archaeology
- Island and Coastal Archaeology
- Lithic Studies
- Maritime Archaeology
- Prehistoric Archaeology
- Religious Archaeology
- Social Archaeology
- Underwater Archaeology
- World Archaeology
- Zooarchaeology

We are also interested in: 1) Short reports — 2-5 page papers in which an author can either present an idea with a theoretical background but has not yet completed the research needed for a complete paper, or preliminary data; 2) Book reviews — Comments and critiques, special peer-reviewed issue for colloquia, symposia, workshops.

Website and E-Mail

http://www.scirp.org/journal/ad **E-mail: ad@scirp.org**

What is SCIRP?

Scientific Research Publishing (SCIRP) is one of the largest Open Access journal publishers. It is currently publishing more than 200 open access, online, peer-reviewed journals covering a wide range of academic disciplines. SCIRP serves the worldwide academic communities and contributes to the progress and application of science with its publication.

What is Open Access?

All original research papers published by SCIRP are made freely and permanently accessible online immediately upon publication. To be able to provide open access journals, SCIRP defrays operation costs from authors and subscription charges only for its printed version. Open access publishing allows an immediate, worldwide, barrier-free, open access to the full text of research papers, which is in the best interests of the scientific community.

- High visibility for maximum global exposure with open access publishing model
- Rigorous peer review of research papers
- Prompt faster publication with less cost
- Guaranteed targeted, multidisciplinary audience

Scientific Research Publishing

Website: http://www.scirp.org

Subscription: sub@scirp.org

Advertisement: service@scirp.org