



FIELD AND LABORATORY TESTS OF UNDERWATER PAINT USED BY OLGA BELKA

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ABSTRACT

This independent field and laboratory testing is prompted by public demand to know if the paint used by the underwater artist Olga Belka is detrimental to the coral reef environment. The tests shall determine the type of paint, its properties when used underwater and its potential to pollute the surrounding environment. A preliminary test on the properties of the paint is carried out in prevention of pollution during this study. The paint must pass four stages of preliminary tests to be allowed to be taken underwater for testing. Additionally, materials and techniques in the process of painting underwater are also documented. Once the paint passed the preliminary non-immersion and immersion test protocols, it is allowed to proceed to the underwater test in actual conditions in the field. The test in the field is to determine if the paint disperses in the water that can

potentially reach the corals surrounding the artist. A test rig consisting of intake tubes is placed in two positions near the painting. The intake tube is connected to a pump that collects the sample and delivers it to the surface sample collector. The samples are placed in portable spectroscope to monitor if there are molecules of the pigment materials that can be detected. Secondly, laboratory tests are conducted to confirm the field tests as well as identifying the ingredients of the binder and its properties. The paint is subjected to analysis in atomic absorption spectroscopy to reveal the chemistry of the binding agent and its pigment. From these findings, the paint properties and chemical composition is checked against American Society for Testing and Materials (ASTM D4236 (2021)). As there are no prior research or standards pertaining to the impact of artist paint in coral reef environment, the test must be documented for submission.

PRELIMINARY ASSESSMENTS

The purpose of this preliminary test is to determine if the underwater paint is safe to be allowed to be used in the coral reef environment. For this purpose, Ocean Quest Global allowed its coral nursery site to be the test location. However, this preliminary test must be completed, and the paint must pass before it is allowed to be brought underwater near the corals. The location of this test is at Uncle Chang Sipadan Mabul Dive Lodge (Lat. 04,14.58.27, Lon.118.37.37.13). At this location there are ten (10) coral nurseries that are built and maintained by Ocean Quest Global. This preliminary test is divided into four parts where the general property of the paint is tested to determine its dispersal and potential of contamination. The paint shall not be allowed for further testing at the site if one or more of its properties can cause contamination and is detrimental to the environment. Passing this test allows the paint to be taken underwater for further testing.

PRELIMINARY TEST PROTOCOL

There are four stages in the preliminary test to determine if the general property of the paint is safe for underwater use:

1. Solubility test without agitation.
2. Solubility test with agitation.
3. Clouding test.
4. Solvent/oil content test.

For the understanding of the public, the test description is provided as following:

SOLUBILITY TEST WITHOUT AGITATION

This test is to determine if the paint dissolves when it is immersed in the water sample. Two vials are prepared for this test. Paint sample is placed in the vial and it is filled with the water sample. The vials are placed in a protected place and let to rest for 24 hours. After 24 hours, observation is made if the paint sample holds its shape or dissolved in the seawater solution.

SOLUBILITY TEST WITH AGITATION

Two vials are prepared for this test. Paint sample is placed in the vial and it is filled with the water sample. Both samples are subjected to agitation to breakdown the binding properties of the paint. The test solution is agitated at 5 minutes interval for 20 repetitions. When agitation is complete, the paint property in the test solution is observed.

CLOUDING TEST

This is a simple test to determine if the paint will disperse on initial submersion in seawater. Any paint that will disperse in the water will be observed as clouds of the paint material in the water column. The paint is kept in its container and the container is submerged in seawater. Observation is made when the container is opened to determine if there is any dispersal of the paint material.

SOLVENT / OIL CONTENT TEST

Solvent and oil are lighter than seawater. When immersed in seawater, they will be seen as a shiny sheen on the surface of the water. Oil and solvent also release fumes that can be detected by smell. In this test, observation is made on the surface of the water when the paint is first submerged. Surface film or trail of the substance can be detected. Paint containing solvent, oil or any flow medium is not allowed to be used in the sea.

REPETITION OF TESTS

All tests are made in three (3) repetitions.

PRELIMINARY TEST REPORT

TEST NUMBER	TEST	REPETITION	RESULT
1	SOLUBILITY W/O AGITATION	3	NOT SOLUBLE
2	SOLUBILITY W AGITATION	3	NOT SOLUBLE
3	CLOUDING	3	NO CLOUDING
4	SOLVENT CONTENT	3	NO SOLVENT

CONCLUSION OF PRELIMINARY ASSESSMENT

The underwater paint used by this artist (Olga Belka) has passed the preliminary testing and is not a potential threat to corals. It may continue to be tested in the Ocean Quest Global coral nursery.

FIELD TEST PROTOCOL AND METHOD

This protocol is the foundation designed to accomplish the tests and observations about the potential impact of underwater paint on the environment. The field process includes:

1. The preparation of the test must include placement of equipment, movements and activities surrounding the test area. External factors that can influence the accuracy of the test are minimized through isolation. The test subject is positioned more than 100 meters from any underwater activities. During the progress of the tests, no other divers including the researcher are in the water. Therefore, the movement of researchers will not be a factor influencing the result.
2. Test samples are gathered using mechanized means of pumps and sample collectors. Two peristaltic pumps like the ones used in medical purposes are connected to two intake lines placed 1cm and 100 cm from the painting respectively. Check valves are installed at the intake to prevent back flow of water samples.
3. The delivery lines are surgical tubing made of silicone. This intake draws samples and delivers them to the sample collector on the surface. Before sampling, the peristaltic pumps are run for 30 minutes to purge the system and to ensure that the line is cleared. Once cleared, the pump delivers constant flow of water drawn from the sampling intake to the surface.
4. Samples are collected at intervals of 15 minutes and placed in an insulated box to prevent external temperatures from influencing the analysis.
5. One hour before the painting starts, water samples from the site are collected and tested. This establishes the baseline chemistry and quality of the seawater at the site. Minerals that exist in seawater like zinc and copper and their concentrations must be measured. These minerals are of interest as they are also present in the pigments of the paint. These are indicators

that can be detected if there is molecular level contamination present during the painting process.

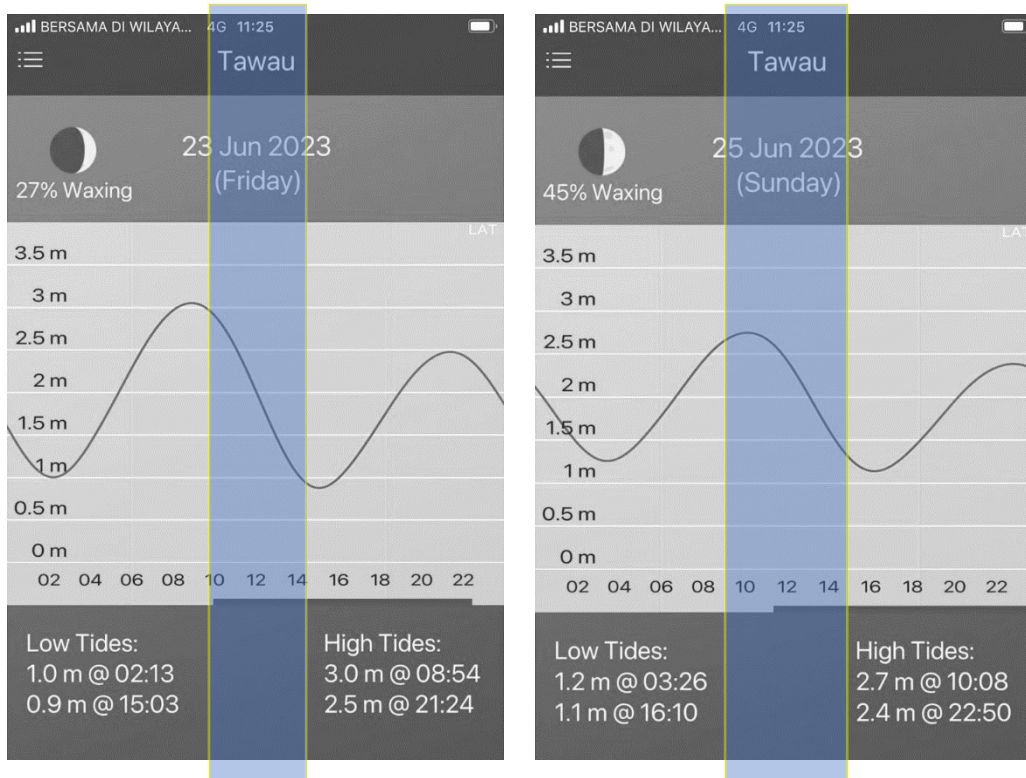
THE ENVIRONMENTAL CONDITIONS

As environmental conditions affect how materials disperse in the water, the test is set up to include simulation of mild water movement. This is associated with all the working conditions suitable for artist work underwater.

Time. The test is conducted over two days:

1. June 23, 2023, beginning from 10.00 and ending at 14.15 hours. Total time 4 hours 15 minutes including preparation time.
2. June 25, 2023, beginning from 08.55 and ending at 14.30 hours. Total time 5 hours 35 including preparation time.

Tide. Semidiurnal on both days. The painting takes place between the slack water of high level and slack water of low level.



Tidal range reduction and currents during the sampling are as follows:

DAY 1 – 23 JUNE 2023

TIME	WL (M)	RANGE (CM)	DRIFT M/S
08.54	3	Slack Period at High Water	< 0.1
09.55	3		< 0.1
10.56	2.65	35	0.2
11.57	1.95	70	0.3
12.58	1.25	70	0.3
13.59	0.9	35	0.2
15.03	0.9	Slack Period at Low Water	< 0.1
16.00	0.9		< 0.1

Blue indicates the working period and the corresponding tidal range and current.

DAY 2 – 25 JUNE 2023

TIME	WL (M)	RANGE (CM)	DRIFT M/S
10.08	2.7	Slack Period at High Water	< 0.1
11.00	2.7		< 0.1
12.00	2.43	27	0.1
13.00	1.89	54	0.2
14.01	1.35	54	0.2
15.01	1.08	27	0.1
16.02	1.08	Slack Period at Low Water	< 0.1
17.02	1.08		< 0.1

Blue indicates the working period and the corresponding tidal range and current.

The two days test is conducted in mild current during ebbing tide. This establishes the potential transmission parameters if any contamination should exist in the water. The test is done on 23 and 25 June respectively. 24 June the first layer of paint is let to dry before the artist can continue to the second layer.

THE PAINT

Chemical analysis of the paint in this test is focused on the detrimental impact to the coral reef. Detrimental impact in this context is the dispersal and magnitude of spread of the paint into the environment. How the paint is transported from the surface of the canvas to the reef particularly. Therefore, factors other than this analysis are not the scope of the study. This dissertation must include levels and concentrations of the paint in comparison with another known paint pollutant that is common in marine environments.

PAINT GENERAL PROPERTY

From the chemical analysis, the binder substance of the paint is flax (linseed), a plant based high cellulose fatty compound. It is non soluble in seawater. 73% of the binding agent of this paint is cellulose derived from flax. The binding agent is thickened by alginate. A stable material commonly found in processed food and dental products. The paint also contained mineral based pigments. Minerals in pigments have low risks of contamination simply because they are contained in the binder.

PAINTING TECHNIQUE

Painting technique and preparation steps of the artist play a role for potential cause of contamination. This study also includes observations on the technique. This is an important factor in determining the contamination in the environment. Because the purpose of this test is to determine the risk of pollution, it is necessary to follow the process of painting. Assessment includes:

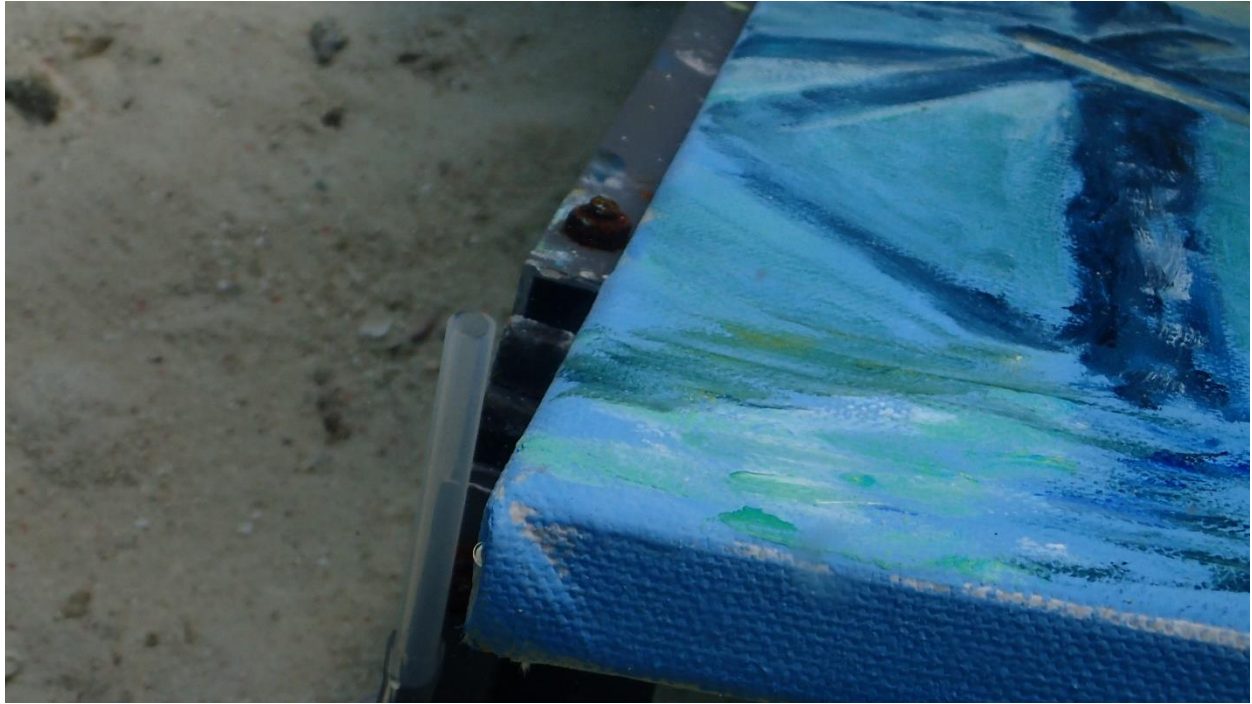
1. Containment of the paint material during transport from the surface to the underwater site. The artist observed the importance of containing paint material from accidental spills.
2. Placement and positioning of the work site must be on empty seafloor away from coral colonies.

3. A barrier sheet is placed on the seafloor where palette and painting materials are placed.
4. No solvent or flow medium is used during the painting process. Any substance that can affect the binder in the paint causing it to leach into the water is not in use.
5. Painting or the paint and tools are never left on the seafloor unattended.
6. Painting can only be done in calm conditions.

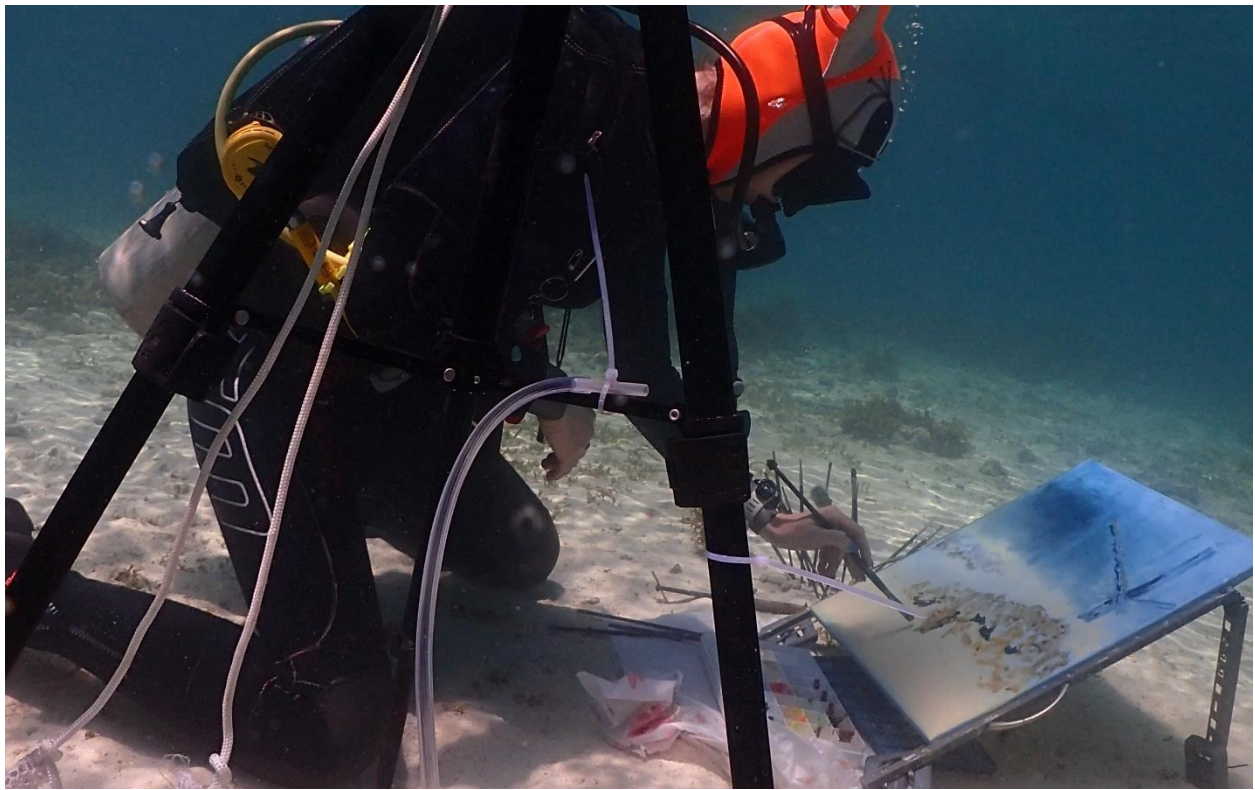
THE FIELD TEST RIG

The equipment used in this test is customized because they are not readily available. It consists of:

1. Two sampling intakes to draw the sample from targeted points.
2. Pump box with 2 peristaltic unit.
3. Sample collector unit.
4. Portable spectrophotometer (Hach's D1900)
5. Data logger with SD
6. Computer
7. Power bank



Intake #1 is placed 10 millimeters from the surface of the painting. Thickness of the frame is 12 millimeter as comparative dimension of the distance of the intake tube.



Intake #2 placed 1 meter facing the surface of the canvas.

FIELD AND LABORATORY WATER ANALYSIS

This analysis is conducted strictly to find and document if the paint used in underwater painting is polluting the environment or otherwise. This is not an experiment using live organisms. It is a dispersal test that observes the property of the paint when in use in the marine environment. Dissolution and dispersal of soluble materials contaminates water and has direct impact on corals. Once the property of the paint is known through the preliminary assessment, it is taken underwater where the system of analysis can take place. Sampling is made in controlled conditions after elimination of all external factors that can affect the accuracy of the test.

TEST PARAMETERS

The test is a two-step process involving field level and laboratory level analysis. Before testing commences, water sample is collected for analysis of the quality prior to the experiment. The field level analysis includes sampling intervals of 15 minutes with three tests repetitions for each sample. The samples are tested for metal ions that may leach from the paint into the water. These metal ions common in pigments of paint are:

1. Cadmium (Cd 112.414)
2. Cobalt (Co 58.933)
3. Copper (Cu 63.546)
4. Zinc oxide (ZnO)

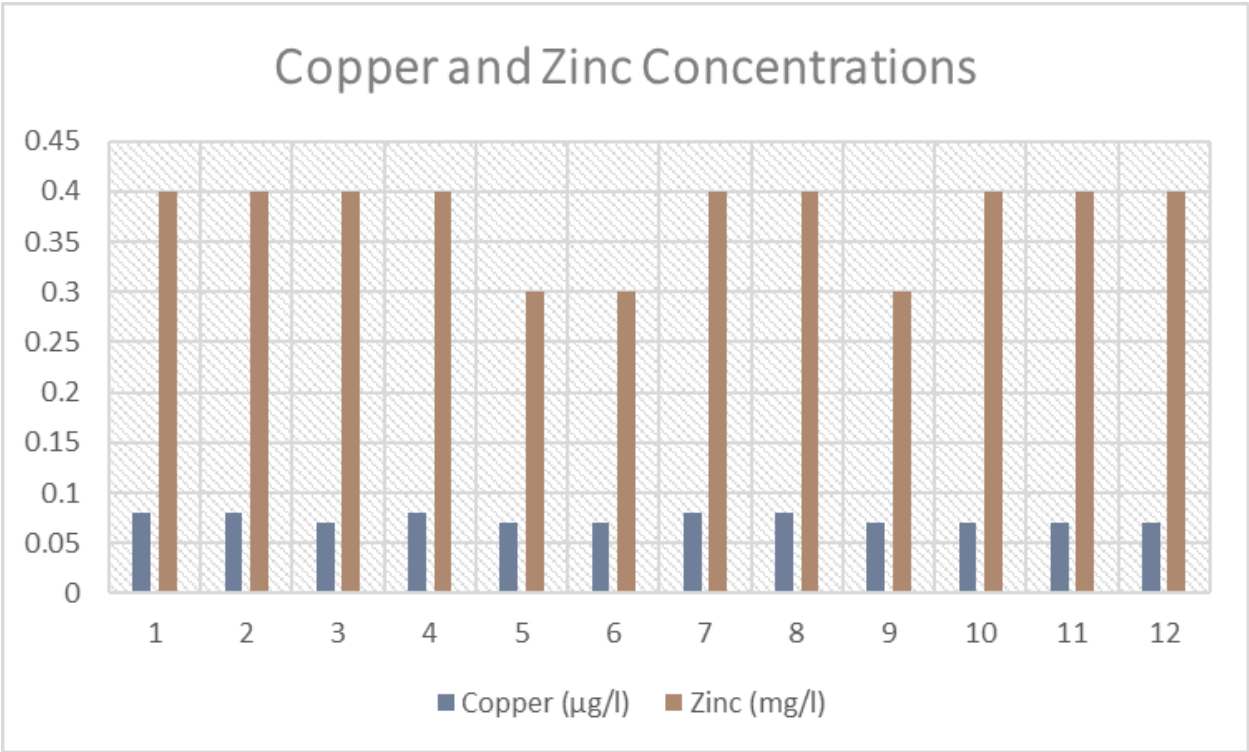
TEST METHODOLOGY

Field analysis on the target contaminants is carried out using portable spectrometer (Hach's D1900). Sample seawater collected from the collector unit is transferred to vials and inserted into the analyzer with the respective reagents as per the list. The method of testing is:

FIELD ANALYSIS METHOD TABLE			
Description	Method	Reagent	Ref.
Cadmium	Dithizone	8017	2242200
Cobalt	PAN	8078	2651600
Copper	Bicinchoninate	8506	2105869
Zinc	Zincon	8009	2429300

TEST RESULT

Two of the four metal namely Cadmium and Cobalt is eliminated from the potential dispersal in the seawater as both are not detected in the sample before and during the test. Copper and Zinc ions are detected in the seawater from samples collected before the test and during the test. The concentration of both Copper and Zinc did not raise in the samples taken during the test. It remains same concentration as per the samples taken before the test (see graph).



Absent of any spike of the concentration of Zinc and Copper in the measurements of seawater tested at site. The samples tested in the laboratory also yields same result.

CONCLUSION

The paint used by Olga Belka on the underwater paintings did not leach into the surrounding environment. Therefore, its potential to contaminate the coral reefs is unlikely. The tests are conducted under controlled environments and in actual conditions. External factors that can influence the accuracy of the test is fully eliminated. With this result, I concluded that the paint and the technique used for the underwater art is safe for the coral reef environment.

References

Section 8.3.4.4 in the ANZECC & ARMCANZ (2000) guidelines

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