Journal of Visualization, Vol. 12, No. 2 (2009) 173-180

Regular Paper

Patterns of Ink in Water and Air:

Creating Radial Spreads of Ink in Water

Pery Burge *

* Artist
E-mail: pery@mac.com

Received 28 July 2008
Revised 12 November 2008

Abstract : Radial spreads are made by placing different types of ink and paint over each other. Then, when gravity 'activates' the spread, causing the ink to move outward, the resulting patterns of ink are photographed. Recent work shows how different types of ink react to the force of the spread (by, for instance, forming thin films, or becoming filamentous). Different types of ink can be used in conjunction to reveal different parts of the spread. Regular shapes in tessellations, underwater 3D forms, and airborne radial spreads have been observed. Radial spreads of ink in water can be seen in terms of both art and science. Artistic aspects include an exploration of ink textures, and comparisons are made with other natural and man-made materials. Parallels between radial spreads and organic life forms are made, and new juxtapositions of the 'birth, life and death' of the spreads are found. Connections are made between the small-scale world of ink in water, and large-scale objects, e.g. cosmic phenomena. Ambiguous imagery, requiring an imaginative contribution from the viewer, is explored. Long-term aims are to collaborate with those interested in the science of diffusion to build up visual profiles of inks, and also to develop 3D chromatography. Artistically, links with other natural forms will be explored. More images are at www.chronoscapes.co.uk.

Keywords : Art, Radial spread, Ink, Water

1. Introduction: fluidic patterning, and details of the method

The existence of patterns in nature holds a fascination for scientists and artists alike. Patterns of flow have been the subject of recent observation and analysis, and examples of geometric patterning in the form of hub or spoke structures have been identified (Fujisawa et al., 2007, Uchida and Shirayama, 2007, Fujisawa and Watanabe, 2008). The work presented here builds on investigations started a few years ago (Burge, 2007). The process invokes differing surface tensions of different types of ink combined with paint. A round stainless steel bowl, 20 cm in diameter, is filled to a depth of 3.5 cm with water, coloured with a little ink. A small drop (0.25 ml) of gold paint with a base of xylol and oil, is placed on the water's surface with a thin plastic dropper. The paint takes up a flat, circular shape, diameter ranging from 1-3 cm. Inks with high surface tension, such as writing ink or acrylic water-based fabric ink, are then placed on top of the gold paint using a thin glass dropper. Different colours and types of ink may be superimposed. The ink forms dome shapes about 0.5 cm across. In sufficient quantity the ink can become too heavy to hold its dome shape, and, after several seconds, gravity overrides high surface tension, causing the 'piled up' ink to drop downwards slightly and burst outwards, moving in patterns emanating from the stagnation point. The radial spread happens too quickly for the human eye to see in detail. Photographic sequences, with exposures of one or more per second, capture the patterns and their evolution. The images often show the initially high speed of the spread because they record the path of the ink as it travels outward. I then choose which images to crop and magnify, and, treating the image as a whole, I may heighten colour and contrast a little to emphasize patterns. The bright inks, shot in full sunlight, do not need much enhancement.

2. Combining different kinds of ink

Different inks, when superimposed on the gold paint mentioned in the method, may reveal different aspects of the spread. Some inks mix easily with the water, moving downward and visualizing the spread's activity below the surface. For instance in Fig. 1, brown writing ink, having mixed well with the water, forms a toroidal vortex emanating from the stagnation point. The yellow fabric ink also used resists mixing, becoming ridged on the water surface and filamentous when it sinks.

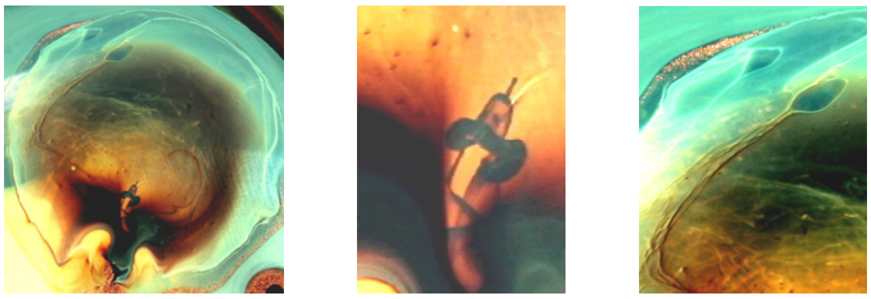


Fig. 1. Two types of ink: the whole spread (diameter 9 cm) and details of central vortex and ridged ink.

3. Patterns

The following sequence (Fig. 2) shows a similar tendency for two kinds of ink to behave differently, and to occupy different areas of the spread. Blue writing ink and yellow fabric ink were used. In the first frame a blob of ink is waiting to burst above an older spread. When it bursts, most of the yellow ink moves outward, leaving a gap between it and the mainly blue mushroom-shaped vortex. We see the spread becoming partly airborne in the third frame, where the outward force of the spread causes it to rise out of the water at the back, taking on an elongated shape outlined in gold.

Fig. 2. Ink behaviours contrasted within one spread. Frames separated by 12 and 2 seconds. Radial spread diameter grows from I cm (left) to 7 cm (middle), to about 14 cm (right).

Different coloured inks can accentuate the 3D nature of the forms created within the radial spread, particularly if light and dark colours are used together as in Fig. 3, left, where red and yellow are clearly contrasted. In Fig. 3, middle, the new spread at the lower right of the image has yellow networking linked by a strand of ink to the toroidal vortex forming further down. The blue ink forms its own pattern below the surface. In the older spread (left side of image), form is accentuated by contrasting colours, although some mixing has begun. There is a tendency for inks to remain separate even if they are of a similar kind, like the blue and yellow fabric inks used in Fig. 3, right. This picture shows the centre of a spread in its initial phase of movement when the ink moves too fast to have time to mix. A yellow vortex pushes upward behind the blue film of ink. Gold paint appears below in a U-shape at the stagnation point.

Fig. 3. Left: New spread, 1 cm across. Centre: spread, right, 5 cm across. Right; U-shape 1 cm wide.

4. Patterns - moving towards hexagonal shapes

There is a huge variety of patterning - each spread is unique. The fabric ink used in Figs. 3 and 4 is filamentous, and is therefore particularly useful for visualizing shapes. Films of ink both on the surface and below tend to retract into networked patterns. In such networks familiar shapes may emerge in two dimensions (across the water) or three dimensions (down through the water and even above it). Oval or circular holes can occur; in groups, these often tend to straighten off at the sides and may develop features in common with hexagons (Fig. 4).

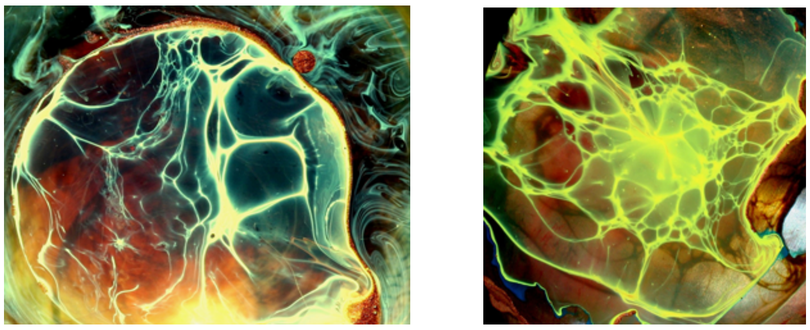


Fig. 4. Patterns taking form; both spreads 9 cm across. Left: some ink is still 'filmy'; still retracting; elsewhere, it forms networked patterns. Right: Structural radial lines of ink, like 'spokes' in a cobweb.

I have often seen hexagon-type shapes in networks, rather like honeycomb patterning where roughly spherical objects may be packed together efficiently (Stewart, 2001). Angled shapes reminiscent of hexagons may also be generated from a central point which forms the common vertex for them (Fig. 5, left).

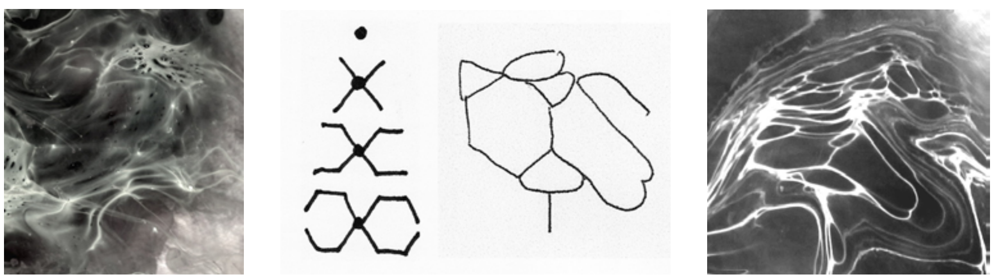


Fig. 5. Left, foreground: Spider-like forms, here 2 cm wide, can be points of origination for hexagon-like shapes as in left diagram. The right diagram is a detail of the photo, right, showing fully formed shapes about 1 cm wide interspersed with triangular and square shapes as found in semi-regular tessellations.

Hexagonal shapes may also start from a single bifurcation of a strand of ink which leads to networking, as in Fig. 6, left, which contains open 'forks' of yellow ink. The networks often contain other shapes, reminiscent of squares and equilateral triangles, which act as fillers around the hexagons. There may be a link with tessellation patterns; it is well known that hexagons, squares and equilateral triangles together form the tessellations found in tiling patterns and polyhedra (Stewart, 2001). In Fig. 5, shown above, the right-hand image contains curvy analogs to such tessellations, and the right-hand image in Fig. 6 shows three, four and six-sided shapes.

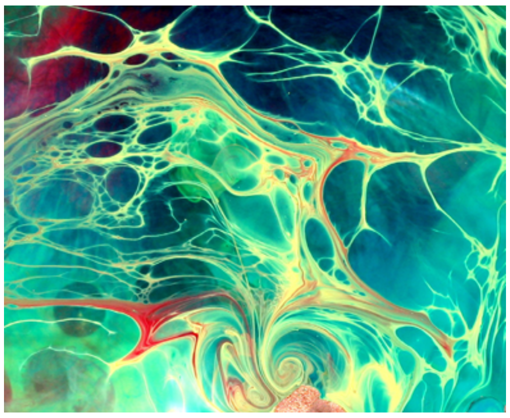
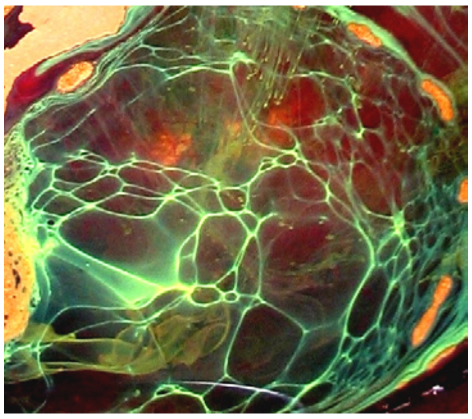



Fig. 6. Networking of shapes, 1-3 cm wide. Left: Hexagonal formations. Right: an irregular tessellation.

In Fig. 7, below, the left and centre images contain one hexagonal hole each. These hexagonal shapes are near the stagnation points of the spread, and are therefore subject to less distortion than shapes near the edges. Elongation of shapes at a spread's edges is seen in Fig. 7, right. A correlation between the amount of shape distortion and speed of flow (faster at the spread's edges) becomes apparent. The networking is at its most regular near the stagnation point.

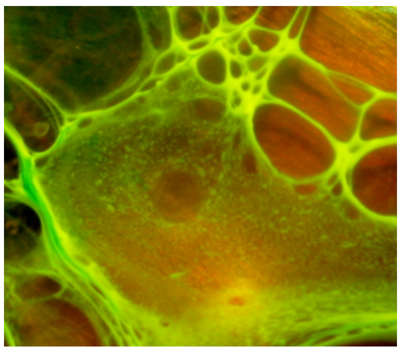
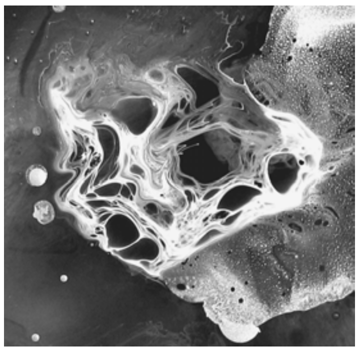
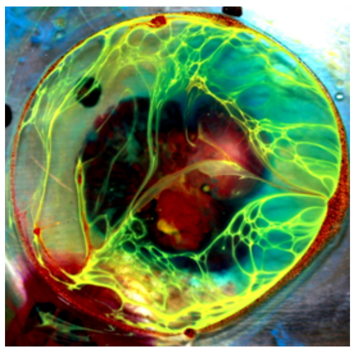




Fig. 7. Left: a hexagonal-shaped hole, 0.5 cm across, is just visible at the centre of the film of ink. Centre: a six-second-old radial spread which has developed an almost regular hexagonal hole, 1.5 cm wide, at the centre. Right: 3D shape distortion at edges in a spread 8 cm wide.

5. Patterns: non-hexagonal formations

Tessellations including hexagonal shapes are common, but are not universal. Ink may take up other patterning as in Fig. 8, where it has made opaque films edged by scalloped or meandering lines. In these examples, textures are more plastic looking, perhaps because of oil initially added to the gold paint, then going in the water and causing the ink to retract. It is clear that the ink's appearance is determined by many factors such as its chemical composition, and its reaction with the surrounding water and any additives like oil. Furthermore, airborne ink may take on a unique, often jagged line quality, as it moves unimpeded by water (Fig. 8, middle image, part of a fast-moving spread).

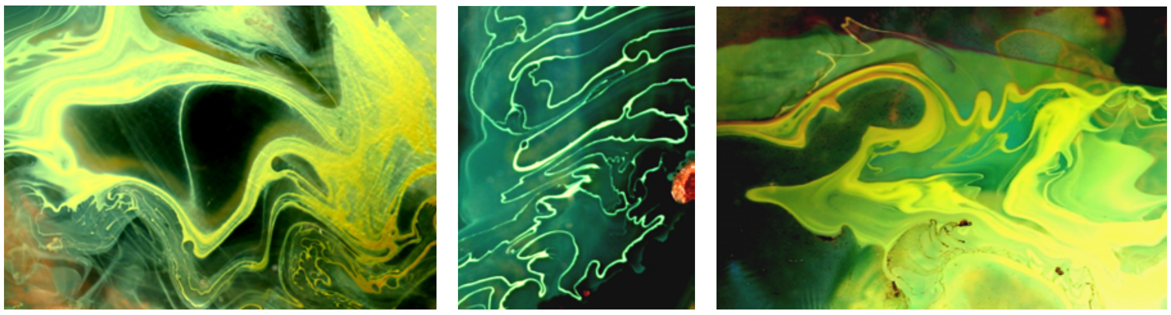


Fig. 8. Left, centre: details of a 16 cm wide, fast-growing spread. Right: slower ink; detail 4 cm across.

6. Outlying structures

I have seen regular structures situated at some distance away from the spreads. These may occur when the spread moves out fast. and ink goes beyond the gold wall of paint. It is also possible that the action of the spread has a 'knock-on effect', setting up outlying patterns in the water. These patterns are visualized by outer strands of ink (Fig. 9, photo). This 3D form may derive from hexagons on the water's surface which then 'bend round' inside the water, as shown in the diagram.

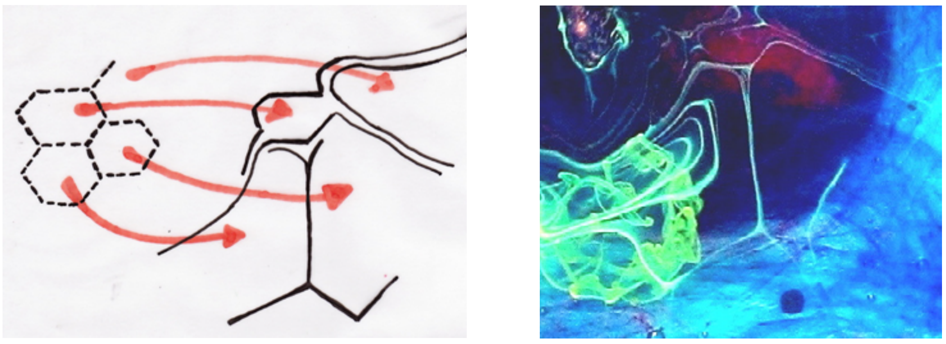


Fig. 9. 2D hexagonal shapes (dotted lines), bending into a 3D shape 3 cm wide as in photo, right.

7. Visualizing the speed of flow of radial spreads

I mentioned above that there appear to be different rates of flow within the confines of the radial spread. Regular patterning may be subject to modification and shapes may elongate. Fig. 10, left image, shows varying rates of ink flow within one spread. At its left, yellow vortices emanate slowly from the stagnation point. Meanwhile most of the ink has travelled towards the right at high speed, developing networking and scalloped outlining. Slow-moving ink has fallen in the centre, developing vortices below the surface.

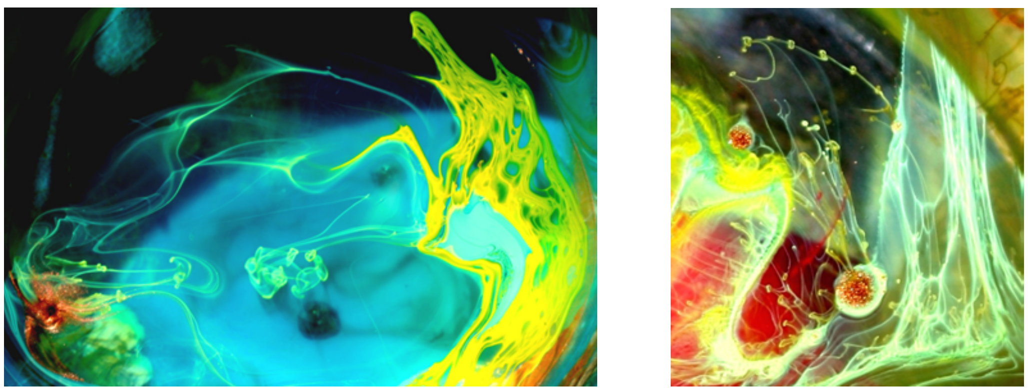


Fig. 10. Left: Large spread, 10 cm wide. Right: upward-moving ink ribbon 3 cm long.

In addition to variations of speed within the spread, its speed as a whole will vary. One variable influencing rate of flow is the amount of ink in surrounding water; more ink impedes the spread's flow; less or no ink causes the spread to move faster and become larger. High speeds may cause ink to become airborne, and upward jets may develop to become several centimetres long (Fig.12, right).

8. Jumping spreads

Photography (as opposed to the naked eye) shows that some spreads are moving so fast that they lift right out of the water. In Fig. 11 the spread's circular shape becomes oval as it pushes outward.

Fig. 11. Pictures separated by 4 and 3 seconds. The spread becomes 11 cm high (right).

There is also evidence of tessellations or networking developing within the ink whilst it travels through the air. In Fig. 12, the colour images show two stages of a fast-moving airborne jet of ink coming from a radial spread, with detail of second image on the right. Geometric shapes develop from within the ink. I would welcome any explanation for this surprising phenomenon.

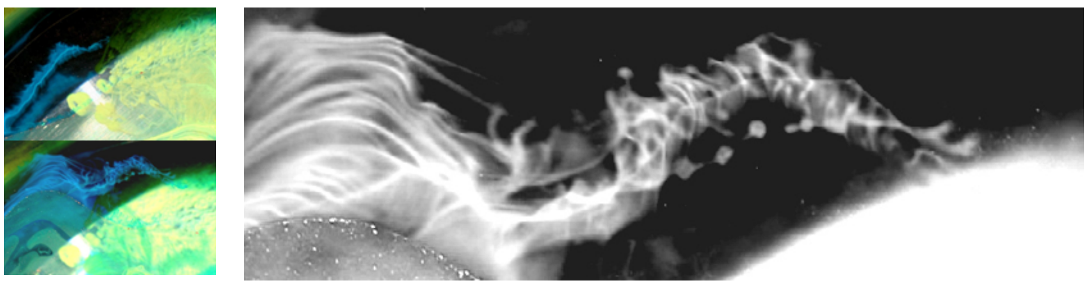


Fig. 12. Airborne ink at two stages separated by 11 seconds. Diamond shapes and hexagonal forms develop along the 6 cm long jet of ink as shown in monochrome detail, right.

9. Artistic aspects

7.1 Textures

A new awareness of the different qualities of ink has prompted me to think of these images in terms of texture. The ink may look solid, as if it were rope or string; it may appear to be elastic like bread dough, perhaps like a piece of paper torn in half. The characteristics of ink can be viewed in terms of its chemical composition or perhaps its Schmidt number. Artistically, the inks take on an aesthetic value partly because they are beautiful in themselves, but also because they remind us of other things. Fig. 13 has two examples of subjective comparisons made with other materials. There is a certain magic about liquid looking like lace or paper, metal or glass, and it seems appropriate to form a collection of photographic details of contrasting forms. I hope that this collection, combined with a chemical knowledge, may form an equally useful and aesthetic profile of the materials used.

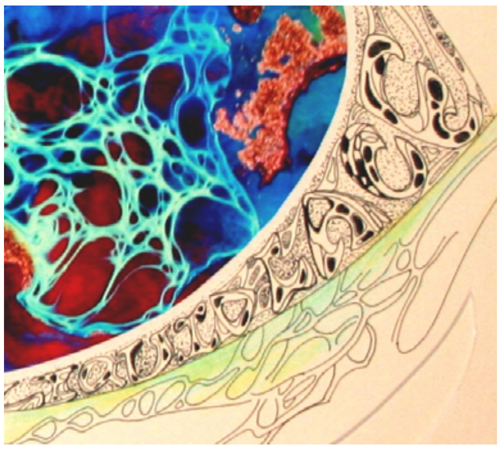
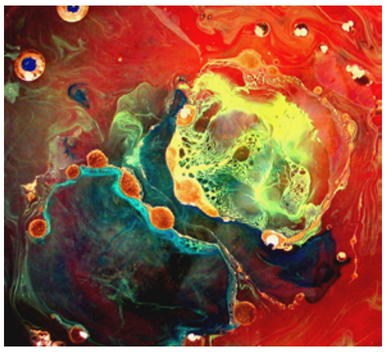
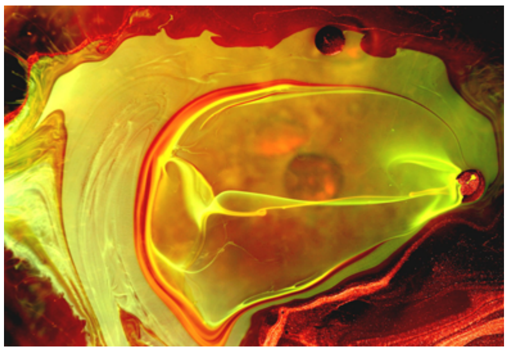


Fig. 13. Left: 'Textures' detail, 5 cm wide. Photo & drawing. Right: 'Torn ink, torn tissue' Photo, 8 cm wide

7.2 Organic Forms

Radial spreads may remind us of living forms (Fig. 14), and I like to produce photos which reflect this aspect of them. Microscopic photography collections (Burgess et al., 1987) offer many parallels with radial spreads, which have their own 'life cycle' from their initial rapid 'birth' to a slower maturity, then a death-like transformation into dendritic patterns of falling ink. In 'Monochromaforms', we see three stages of the spread: one about to burst (upper left of image), and new and dying spreads face to face (centre). Radial spreads may also suggest a broad metaphor for life. 'Soft-lit form' is suggestive of light defining form to give it substance; its inner structure has an incandescent quality. 'Imagozoa' is reminiscent of a sea creature making its way through the water.





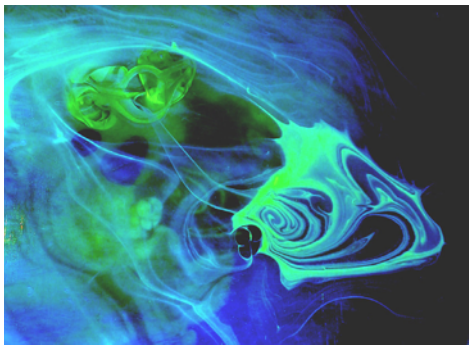


Fig. 14. Top: 'Monochromaforms', 'Soft-lit form'; both 11 cm wide. Bottom; 'Imagozoa' 10 cm wide

7.3 Small - large connections

An increased consciousness of visual links between the small-scale world of ink in water, and large-scale objects such new stars, has led me to explore images that are deliberately ambiguous. Many pictures also have a time-rich aspect, e.g. 'Complex Space' (Fig. 15), where we can trace the ink's outward progress, for example where new filaments push upward behind the hexagonal shape, centre. This image is a record of its own creation, and it also has cosmic qualities. 'Unfolding Time' (Fig. 15, right) is also cosmic in mood, like the edge of a new space form leaving distant stars behind. Its unusual line quality is suggestive of how matter acts in surprising ways at high speeds.

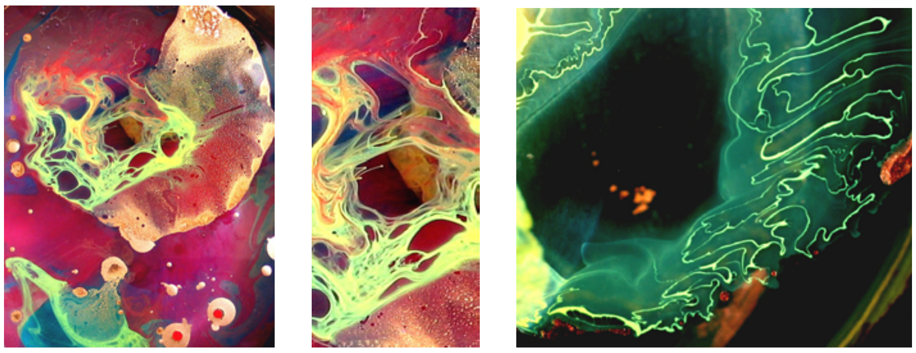


Fig. 15. Left and middle: 'Complex Space' 12 cm wide, and detail. Right: 'Unfolding Time' 10 cm wide

10. Conclusion

Radial spreads are an intriguing area to explore; the more I look, the more astonishing I find them. One aspect I particularly want to pursue is airborne spread flow. Another is 3D chromatography; a possibility discussed elsewhere (Burge, 2007). For me, nature is the best artist, and I look forward to participating in a fascinating and unpredictable natural process, and to discovering surprising connections with other natural phenomena. I also hope to collaborate with others to make visual profiles of ink patterns and textures, which I believe will have both artistic and scientific merit.

References

Burge, P., 'Hidden Patterns: creating radial spreads of ink in water' Journal of Visualization, 10-2, (2007), 171-178.
Burge, P., 'Looking Beneath the Surface: The Radial Spread of Ink in Water' Leonardo, 40-5, (2007) 484-488.
Burgess, J., Marten, M., Taylor, R., 'Microcosmos' (1987), 88-123, CUP, Cambridge.
Fujisawa, N., Verhoeckx, M., Dabiri, D., Gharib, M. and Hertzberg, J., Recent Progress in Flow Visualization Techniques towards the Generation of Fluid Art, Journal of Visualization, 10-2 (2007), 163-170.
Fujisawa, N. and Watanabe, M., Fluid Art of Turbulence in Unsteady Non-Penetrative Thermal Convection. Journal of Visualization 11-3 (2008), 183.
Gasson, P. C., 'Geometry of spatial forms '(1983), 225-226, Ellis Horwood Ltd.
Stewart, I., 'what shape is a snowflake? Magical Numbers in Nature' (2001), 19, 74-75, Weidenfeld & Nicolson.
Uchida, M., Shirayama, S., Formation of Patterns from Complex Networks, Journal of Visualization 10-3 (2007), 253-255.

Author Profile

Pery Burge: She trained as an artist in London and Cambridge, has been working professionally since the early 1990s, and since then, has been using ink on paper to create abstract landscapes without a brush. A few years ago she started working with ink in water, initially visualizing turbulence and rotation, and more recently making paintings in water and exploring the phenomenon of radial spread, with the help of a camera. She has won several photographic awards for her images of radial spreads. She is a full member of the National Society of Painters, Sculptors and Printmakers, and has exhibited across the UK.