

# NATURE, WEAVE AND COLOR

## PLANT RESOURCES IN THE SUSTAINABLE DESIGN AND MANUFACTURE OF ACCESSORIES FOR PROSPERITY FASHION

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## Abstract

This article presents an innovative methodological alternative devised from both a technical and artistic approach, in order to offer a systemic response to sustainability in the fashion industry through the use of ecofriendly materials and techniques, inspired by artisanal tradition and knowledge of nature, on which research is carried out by determining and formalizing the final product. An analysis of natural fibers and pigments has been carried out, as well as experimental tests with chromatic treatment and plant printing techniques, such as “Ecoprint” and “Shibori”, which have resulted in the design and development of a tote bag model as a practical example. From these initial solutions, the project remains open to the incorporation of new patterns and traditional techniques, always respecting ecological processes. This initiative aspires to consolidate itself as a comprehensive sustainable fashion proposal that, since its inception, is committed to authenticity, aesthetics and respect for the environment.

**Keywords:** *Natural materials, Botanical dyes and textiles, Sustainability, Design, Handicraft*

## INTRODUCTION

The history of natural fabrics and dyes is centuries old, being used and perfected over the years by our predecessors until the arrival of the Industrial Revolution. Since ancient times, colors have been used to enhance life, whether through art, jewelry, body paint, tattoos, or dyeing clothing. Colors served to indicate social status, protect against evil spirits, and provide pleasure. Dyes were derived from sources such as mollusks, lichens, insects, minerals, peat bogs, and plants (Flint, 2008). This era modified the processes, opting for more complex and polluting ones, changing natural fabrics and pigments for new materials of synthetic origin, with the aim of reducing costs. This change has had and continues to have adverse effects on

nature, especially on water resources, which are already scarce.

The present research developed in Spain at *Universitat Politècnica de València*, UPV, from the *Faculty of Fine Arts* and the *Art and Environment Research Center* within the unit: *Languages, Techniques and Pictorial Processes*, tries to offer within the field of fashion industry alternative techniques and procedures that increase eco-sustainability in its function.

This project devises and materializes a series of textile accessories made from ecological materials and processes. The interest in this topic arises from the need to look for sustainable alternatives in the production of products, which are in tune with the values of preserving and protecting

the environment and minimizing the impact that our products cause on the environment.

According to Mancuso (2017), plants have historically devised optimal solutions to many of the challenges faced by humans, encompassing aspects such as resource efficiency, energy autonomy, resilience, and complex adaptive strategies. Over millions of years of evolution, plants have fine-tuned their responses to environmental stressors, mastering ways to thrive in even the harshest conditions. Learning how and where to observe these natural solutions is essential, as they offer a wealth of knowledge that remains largely untapped by human innovation.

Mancuso encourages us to study these natural processes closely and to recognize that plants do not merely survive or adapt to their environment, but actively contribute to optimizing their ecosystems. Plants participate in a highly efficient resource management system, in which each component plays a role and nothing is wasted. They create a closed cycle in which nutrients are reused, waste is minimized and energy is maximized. By examining how plants achieve this level of efficiency, we can discover valuable strategies for addressing today's environmental challenges, especially in pollution management and waste reduction.

In parallel to the scientific-technical study, the suitability and usefulness of some plant fabrics and pigments is tested through various experimental experiments in the creation of sustainable fashion accessories, such as totebags.

These searches have demonstrated their benefits and processual characteristics, with the emphasis on artisanal production, using natural fabrics and implementing dyeing and vegetable printing techniques such as Ecoprint, Bundle Dye and Shibori. The confection, in turn, is configured as meticulous and personalized work, from the design of patterns to the execution of the sewing, practices that give each product inherent authenticity and uniqueness.

Now we are able to rediscover sustainable alternatives like those of our ancestors, without their costs increasing excessively, which also allows us to differentiate our products from those produced in series. This entity not only symbolizes a fashion proposal, but also aspires to merge contemporary aesthetics with artisanal tradition, presenting exclusive products that have in their entirety an essential consideration of respect for the

environment. An initiative that we have promoted through the creation of a series of totebags that address the distinctive essence of this collection and gives us the opportunity to introduce these manufactures to the market. The initial progress of this study is based on the ideas developed in a previous investigation, which explored the integration of natural pigments in artisanal textile printing processes. Pigments have started to be applied, and although it is still too early to draw definitive conclusions, preliminary results suggest that the use of these natural dyes could significantly reduce the environmental impact of fashion accessory production (Escandell, 2024).

In this way, the present work tries to contribute to defying the concept of "prosperity fashion" by integrating sustainability as a synonym for success, manifested through the revitalization of ancient dyeing techniques with natural pigments and the handcrafted creation of textile accessories.

## **MANUFACTURING PROCESS AND ETHICAL ASPECTS**

Fashion, identified by the United Nations Conference on Trade and Development (UNCTAD) as the second most polluting industry after oil, faces an urgent need to integrate sustainable practices throughout its entire production chain. The textile process involves multiple stages, starting with the preliminary procurement of raw materials, which can be of two types: natural fibers, the more traditional ones, derived from plants and animals (such as cotton, wool, linen, and silk), or synthetic fibers, the more recent ones, produced through industrial processes using petrochemicals (such as polyester and nylon). The extraction of natural fibers, with its corresponding agricultural process, and the processing of synthetic fibers, which requires chemical manipulation, pose complex environmental challenges. Spinning and weaving the fibers involve different methods that affect the texture and strength of the resulting material (Manzano, 2014). Bleaching, necessary to remove the natural color of the fibers, often involves chemicals that require responsible management to prevent environmental harm. Similarly, the treatment and printing processes use natural or synthetic dyes that must be properly handled to minimize their impact on ecosystems (Smith & Block, 1982).

Regarding industrial approaches, "fast fashion" has contributed to increased production

and rapid obsolescence of garments, while “slow fashion” represents a sustainable approach aimed at product durability and quality. This model advocates for ethical practices and responsible manufacturing, promoting mindful and participatory consumption that takes into account the environmental impact throughout the value chain. Both models are immersed in the contemporary context of consumer habits, where “fast fashion” reinforces a consumerist and competitive system, while “slow fashion” offers a more deliberate and committed alternative that prioritizes sustainability.

This debate highlights the need to rethink current textile practices and suggests the possibility of a shift towards more sustainable and ethical alternatives. This shift involves not only reducing the production of new goods but also encouraging the creation of durable items, using quality materials and techniques that minimize environmental impact. In a scenario where fashion reflects not only trends but also ethical and environmental values, it is essential to understand the role these practices play in consumer purchasing decisions. According to the assessments in Megan Mary Adriana O’Driscoll’s thesis, the solution to the problem of fast fashion is to promote and create more ethical fashion initiatives:

To understand ethical fashion, one must learn the meaning of what the word “ethics” means. Ethics is based on well-founded rules of right and wrong that prescribe what humans should do, usually in terms of rights, obligations, benefits to society, equity, or specific virtues. The word “ethics” means that the product or service in question has been made with morals, people, and the well-being of the planet in mind. “Ethically made” fashion means made conscientiously. That is, the garment was made by people who enjoyed their work because it gave them a chance and their basic human rights were not abused. It means that the planet was considered, and best efforts are being made within the constraints to reduce the negative impact and create positive impact in some way (O’Driscoll, M. 2018, p. 15).

## NATURAL COLOR IN THE TEXTILE PROCESS

This project presents an integrated proposal where several disciplines converge, as its approach considers the coexistence and interaction of various complementary facets, which will be detailed throughout the discourse. As emphasized, while

the historical use of natural dyes, refined over time by various cultures, dates back centuries, it eventually led to the creation of synthetic pigments. The transition to synthetic pigments in the 20th century was initially driven during the Industrial Revolution by growing demand and the need to optimize industrial processes, following the rise of the petrochemical industry (Cardón, 2007). Although this evolution brought economic and functional benefits, it also resulted in negative environmental consequences, affecting both water resources and other ecosystem components.

Societies worldwide have used natural pigments in cultural and commercial practices, making these elements an integral part of their identity. Notable examples include indigo, used in India for textile dyeing and spiritual practices (Flint, 2008), and carmine, derived from cochineal, used in pre-Columbian civilizations in Latin America, later becoming a prized resource for European colonizers (Cardón, 2007). In Europe, the *Rubia tinctorum* plant has been a significant source of plant-based pigments since the Middle Ages, while turmeric, native to South Asia, has been utilized in these regions not only for its chromatic properties but also for medicinal and culinary uses (Duerr, 2011). In such a way that only certain natural components possess dyeing properties, including flavonoids, carotenoids, anthocyanins, tannins, and betalains, which enable the absorption and reflection of different light wavelengths, producing a variety of colors (McLaughlin, 2014). Materials in the focus of this interest that have also been used in recent research from other areas of industry, such as modern food technology:

Recently, the food industry has increased the interest to replace the use of synthetic dyes with natural pigments such as betalains, which are mainly used for the red color they impart. In addition, betalains are substances that have antioxidant and anti-degenerative activity against various diseases. They are water-soluble nitrogenated pigments, betalamic acid derivatives: betacyanines (red-violet) and betaxanthines (yellow-orange). However, the use of said pigments has been restricted due to its instability to various factors, such as temperature, pH, light, water and enzymatic activity, as well as the presence of oxygen and / or metals. The aim of this review was to synthesize the advances on the stability of betalains in the presence of diverse physicochemical factors. (Flores Mancha, M. A. et. al. 2019, p. 318.).



Flavonoids, for instance, generate a wide range of hues from yellows to reds, while carotenoids, being lipophilic, produce intense colors that require more preparation for fixation on textile fibers (Britton, 2008). Tannins are known for their ability to bind to fibers and resist washing, responsible for ochre and brown tones (Petrovska et al., 2015).

In this research, the extraction of natural dyes begins with the collection of raw materials, an essential step that, as Talens (2011) explains, has been a vital practice throughout history. This process not only serves a functional purpose but also represents an act of preservation and a deep, emotional connection with nature. The selection of raw materials is highly influenced by the seasonality and environmental conditions, which play a significant role in determining the types of pigments that can be obtained.

In the case of natural pigments, the availability and quality of raw materials can vary greatly depending on the time of year. During spring and summer, fresh flowers and young plants are ideal for pigment extraction, as their vibrant colors are at their peak. The tender, delicate parts of the plant are harvested when they are most colorful, yielding dyes with bright and fresh tones. In contrast, autumn and winter are more suitable for collecting leaves, barks, and other plant materials that have surpassed their peak maturity. At this stage, these materials are often considered by-products or even waste, yet they provide deep, earthy hues, contributing to a more sustainable practice by utilizing what would otherwise be discarded.

Moreover, the diversity of plant species available for dye extraction is influenced by the specific regional climate and local environmental conditions. Each ecosystem offers a unique palette of plants, allowing for a broad spectrum of natural colors that reflect the distinctive characteristics of the surrounding landscape. The interaction between the plant's natural habitat and its pigmentation properties can lead to unique, location-specific dye profiles that are impossible to replicate with synthetic alternatives.

Extraction techniques are another critical aspect of this process, and they can vary depending on the type of pigment desired and the characteristics of the raw materials. Techniques typically involve dissolving the plant material in either cold or hot water, with each method producing distinct results. Our experimental approach,

using standardized tests, has shown that cold-water extraction tends to yield softer, subtler shades, preserving the delicate properties of the pigments. This method is particularly effective for more fragile plant materials, where heat could degrade the color compounds. On the other hand, hot-water extraction intensifies the color saturation and enhances uniformity when applied to fibers, creating vibrant and consistent hues. The application of heat breaks down the plant cell walls more effectively, releasing a greater concentration of pigments, which results in a richer, deeper color.

This comprehensive approach to material collection and dye extraction not only highlights the importance of understanding seasonal and regional variations but also emphasizes the need to choose appropriate techniques to optimize color yield and quality. By embracing these traditional, sustainable practices, we are able to connect with centuries of artisanal knowledge while also contributing to more environmentally friendly and resource-efficient methods. This aligns with a broader movement towards natural dyeing processes that respect the rhythms of nature and reduce our reliance on synthetic chemicals, ultimately offering a more harmonious and sustainable approach to textile production.

In these tests, techniques such as Japanese *Shibori* were used, which involves tying or folding the fabric to create patterns through dye resist (Wada, Rice & Barton, 2011), and the *Bundle Dye* method, which entails rolling plant materials into the fabric and applying heat to transfer pigments, yielding unique results (Behan, 2018). As seen in Fig. 01, several results of the *Bundle Dye* technique show onion and sumac print on cotton micro-corduroy.

To complement this proposal, the botanical printing technique or *Ecoprint*, derived from the *Bundle Dye* method, was employed, focusing on using flowers and leaves to transfer their natural pigments directly onto the fabric. This technique was included because it allows for the creation of personalized and sustainable textiles, promoting a meditative connection with nature and its cycles (Duerr, 2011). As seen in Figure 02, the left image shows the *Ecoprint* technique, while the right image depicts a hot dye bath with pomegranate peel.

Finally, it is important to emphasize the role of the *Ecoprint* technique in textile printing. Introduced by the artist India Flint, this method



Fig. 01

uses mordants like alum to fix plant colors onto fabrics, maintaining a respectful approach to natural resources. Wrapping the fabric with leaves and subjecting it to steaming allows for the unique transfer of colors and patterns, making it impossible to replicate exact results but enriching each piece with unique singularity (Flint, 2008). On the other hand, in connection with the research recent published by Bordacconi and Galbis on techniques and processes in sustainable artistic production from plant matter, materials of natural origin contain in their own formal and substantial essence a great evocative power to transmit artistic intuitions:

When natural substance becomes material for artistic practice, nature becomes a support and color, a matrix and instrument of its own representation. Matter for artistic practice and not material, deriving beyond this concept, these vehicles are the closest thing to the Aristotelian idea of matter as “mater” or mother, that from which something derives as the primary matrix of becoming (Irwin, 1996). Its plant origin presupposes a relationship with the environment, being the bearer of a history that recalls suggestions about its habitat and place

of origin, as well as its evolutionary process, the result of our use. In itself, its technical processing as an artistic substance contains a metaphorical meaning: from the raw material, which is also the element contemplated, the concrete image of a vision of the natural world and an emotional feeling in relation not only to the plant product, but also to the place lived and experienced, becoming its figurative synthesis (Bordacconi, E., & Galbis, A. 2024, p. 182).

As textile practices evolve, techniques like *Ecoprint* and other forms of natural dyeing offer sustainable solutions that not only preserve traditional craftsmanship but also enhance the connection with the environment. These natural dyeing techniques achieve unique colors on textile pieces, reflecting a commitment to sustainability and craftsmanship. Thus, the project not only meets aesthetic demands but also seeks to maintain a deep bond with nature and its renewable cycle, providing a viable alternative to highly polluting industrial processes. The project has successfully achieved its objectives, supporting a vision where each piece becomes a unique product, born from the commitment between aesthetics, sustainability, and ancestral knowledge.

## SUSTAINABLE TOTE BAG COLLECTION

The proposal culminates in the development of a sustainable tote bag collection, distinguished by the application of artisanal techniques and the use of eco-friendly materials. Starting from an experimental approach, through various trials and adjustments, this project has successfully defined and consolidated a final product that meets both functional needs and current market trends in sustainability and aesthetics.

The design evolution began with experimentation on larger fabric formats, exploring different print combinations using natural techniques such as *Ecoprint* and plant-based dyes. Initial trials were fundamental in identifying the best material and technique combinations, offering a detailed understanding of how natural pigments react with different textile fibers. The use of leaves, petals, and bark in the printing process generated unique and organic patterns, each carrying significant aesthetic and symbolic value.

Further experimentation focused on creating patterns and initial prototypes, aiming for a versatile and accessible product design. The



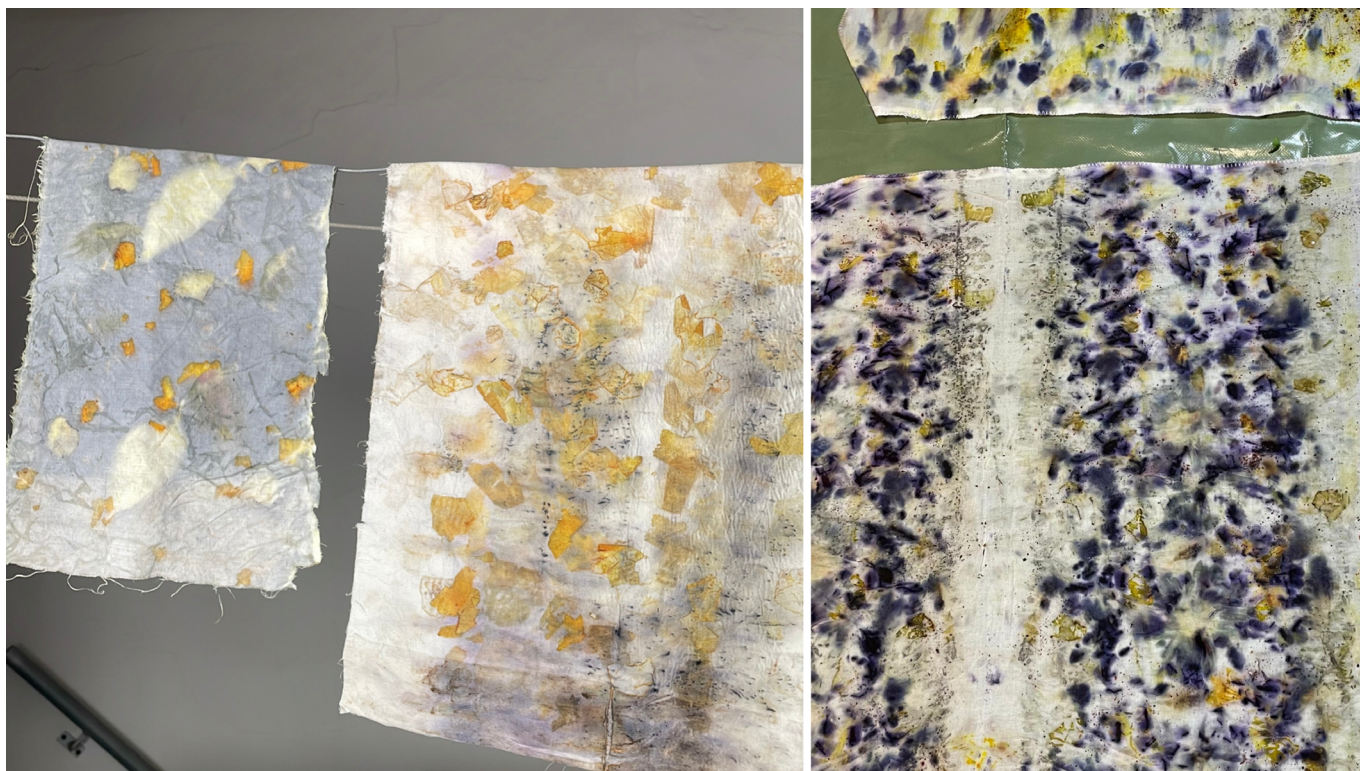


Fig. 02

choice to create tote bags arose from evaluating the selected fabrics ability to provide the necessary structure. Although the simple bag format was preferred for its functional and visual appeal, the potential applications of these techniques in future research are broader.

Throughout this phase, small-scale prototypes tested various patterns and sewing techniques, refining details such as handle size and placement, as well as assessing fabric durability and finish. Challenges with material rigidity led to the use of interfacing for added structure. As seen in Fig. 03, a reversible variant was also developed, offering new possibilities in terms of functionality and aesthetics.

As seen in Fig. 04, the final collection consists of five tote bag models with a cohesive design focus on functionality and aesthetics. The color palette is achieved through natural dyeing processes using materials like pomegranate peel, logwood, cochineal, and Rubia tinctorum, imparting an organic and timeless hue to the designs, underscoring the commitment to sustainability and artisanal methods.

Ecoprint techniques are reserved for exterior elements, particularly pockets, adding a

distinctive touch to each piece. The layout of the prints is carefully considered to achieve visual balance, ensuring each tote bag has a unique identity without overwhelming the design.

Functionality features include quick-access exterior pockets and a drawstring closure system, enhancing both security and aesthetics. The collection embodies key concepts of sustainable design and textile craftsmanship, offering a final product that balances aesthetics and functionality.

## CONCLUSION

This project demonstrates its innovative capacity, highlighting the development and application of advanced natural dyeing and printing techniques. The combination of traditional processes with contemporary methods has resulted in a collection that merges artisanal and modern finishes, yielding unique and distinguished designs. The commitment to sustainability has been a priority throughout the creative process, as reflected in the choice of natural pigments and the implementation of responsible and eco-friendly practices.

Research in this field has revealed the potential of sustainable methods, not only as a





Fig. 03



Fig. 04

response to the current environmental crisis but also as a way to revalue ancestral knowledge, granting it a relevant place in modern textile design. This integration of tradition and modernity reflects a growing trend in the fashion industry: the pursuit of more conscious and ethical practices that meet the demands of an increasingly informed and discerning consumer.

In summary, the development of this collection has not only met the stated expectations but has also exceeded the proposed challenges, making a significant contribution to both the field of textile design and the exploration of sustainable techniques. It has achieved a balance between aesthetics, functionality, and sustainability, setting a precedent for future initiatives that may explore similar paths and contribute to the development of more ethical and conscious textile design.

The contributions of the congress seemed excellent to us, demonstrating their transversal value and their ethical and aesthetic commitment. The quality and depth of the presentations, combined with the relevance of the topics addressed, have made this gathering an essential space for reflection on the future of fashion. The effort of the organizers to bring together top-level experts is truly admirable, fostering such a valuable dialogue around sustainability, innovation, and the evolution of the sector. Without a doubt, the ideas and perspectives shared at this congress will continue to resonate and contribute to the development of a more conscious and prosperous industry.

## CAPTIONS

[Fig. 01] Ecoprint and color bath. Personal archive.

[Fig. 02] Onion and sumac print on cotton micro-corduroy & bundle dye. Personal archive.

[Fig. 03] Design and result of a reversible tote bag with uniform color and eco-print. Personal archive.

[Fig. 04] Final collection of tote bags featuring eco-print and color bath. Personal archive.

## REFERENCES

Behan, B. (2018). *Botanical Inks: Plant-to-Print Dyes, Techniques and Projects*. Quadrille Publishing.

Bordacconi, E., & Galbis, A. (2024). Papel y color natural. Técnica y procesos en la producción artística sostenible a partir de la materia vegetal. *EME Experimental Illustration, Art & Design*, (12), 180-193. <https://doi.org/10.4995/eme.2024.20998>

Escandell, C. (2024). *Artesanía y sostenibilidad: Estampación botánica con pigmentos naturales, diseño y manufactura de una colección de accesorios textiles*. Tesis de grado, Dpto. de Pintura, Universitat Politècnica de València, UPV (Dir. Amparo Galbis).

Cardon, D. (2007). *Natural Dyes: Sources, Tradition,*

*Technology and Science*. Archetype Publications.

Duerr, S. (2011). *The Handbook of Natural Plant Dyes: Personalize Your Craft with Organic Colors from Acorns, Blackberries, Coffee, and Other Everyday Ingredients*. Timber Press.

Flint, I. (2008). *Eco Colour: Botanical Dyes for Beautiful Textiles*. Murdoch Books.

Flores Mancha, M. A. et. al. (2019). Estructura y estabilidad de las betalainas. *Interciencia*, vol. 44, núm. 6, pp. 318-325.

Mancuso, S. (2017) *El futuro es vegetal*. Editorial Galaxia Gutenberg, 2020, p. 127.

Manzano, M. (2014). *La Industria Textil: Procesos y Sostenibilidad*. Editorial Textil.

McLaughlin, C. (2014). *Un jardín para teñir: cómo usar plantas del jardín para crear colores naturales para telas y fibras*. St. Lynn's Press.

O'Driscoll, M. (2018). *Las iniciativas de moda ética en Madrid, España: estereotipos y mitos*. Tesis de grado, Facultad de Ciencias Económicas y Empresariales. Administración y Dirección de Empresas, Universidad Pontificia de Comillas. (Dir. Carlos Ballesteros).

Petrovska, B., Cvetanovska, L., & Trajkovska, A. (2015). Pomegranate peel as a textile dye. *International Journal of Advanced Research in Science and Technology*.

Smith, JD, y Block, I. (1982). *Procesamiento y propiedades textiles: preparación, teñido, acabado y rendimiento*. Elsevier.

Talens, A. (2011). *La transformación de la experiencia de la naturaleza en arte. El nomadismo y lo efímero*. Tesis doctoral. Universitat Politècnica de València. p. 177.

Conferencia de las Naciones Unidas sobre Comercio y Desarrollo (UNCTAD). (2023). "Moda sostenible: un desafío global". Obtenido de la UNCTAD.

Wada, Y., Rice, M., & Barton, J. (2011). *Shibori: The Inventive Art of Japanese Shaped Resist Dyeing*. Kodansha International.