D

Disruptive Coloration

Thomas E. White
School of Life and Environmental Sciences, The University of Sydney, Sydney, NSW, Australia

Definition

A set of markings that creates the appearance of false edges and boundaries and hinders the detection or recognition of an object's, or part of an object's, true outline and shape.

Introduction

The threat of predation has driven the evolution of diverse anti-predator adaptations in nature, of which camouflage – or concealment – is widespread. One striking form of camouflage is disruptive coloration, in which contrasting markings are used to break up and obscure an object's appearance. First alluded to by the naturalist Poulton (1890), and later formalized by Thayer in *Concealing Coloration in the Animal Kingdom* (1909) and Cott in *Adaptive Coloration in Animals* (1940), the efficacy of disruptive coloration has been convincingly demonstrated across the natural world. From the banded wings of tropical butterflies, to the bold spots of isopods, to the changeable patterns of cuttlefish (Merilaita 1998; Hanlon et al. 2009), the study of disruptive coloration has advanced our broader understanding of adaptive coloration and predation-prey interactions and has also inspired developments in human technologies.

Mechanisms

Disruptive coloration functions by creating the appearance of false boundaries (Stevens and Cuthill 2006). This may occur both within an object to disrupt its internal shape or at its edges to confuse the distinction between an object and its background. Numerous sub-principles have been proposed that detail the mechanisms underlying the efficacy of disruptive coloration, though five appear to capture the key processes of interest (Stevens and Merilaita 2009), namely:

1. *Differential blending* occurs when parts of a color pattern match the viewing background, while others are strongly contrasting, thereby breaking up an object's contours.
2. *Disruptive contrast* describes the use of highly conspicuous, contrasting pattern elements set adjacent to one another, with the expectation that a higher degree of contrast will be more effective in inducing disruptive effects.
3. *Disruption of surface through false edges* occurs when contrasting internal markings generate illusory boundaries on the surface of an object, thereby masking its true shape.

J. Vonk, T. K. Shackelford (eds.), *Encyclopedia of Animal Cognition and Behavior*,
https://doi.org/10.1007/978-3-319-47829-6_676-1

4. *Disruptive marginal patterns* are those which make contact with an object's edge, to blur the distinction between parts of an object and its background and/or generate the impression of discontinuity.
5. *Coincident disruptive coloration* describes the geometry of disruptive color pattern elements, which may spread across distinct body regions to confuse the otherwise clear boundary between them.

These principles are nonexclusive and typically act in concert to achieve their full effect. Marginal patterns, for example, are often combined with differential blending, to engage the viewing background itself in breaking up an object's form (Cuthill et al. 2005). Similarly, coincident disruptive coloration is particularly effective in conjunction with strong disruptive contrast, to both mask the boundaries between regions and the overall form of an object (Barry et al. 2015).

Technological Applications

Like so much in the natural world, the cryptic color patterns of animals have served as inspiration for varied applications in human affairs. The work of Thayer (1909) directly inspired early efforts at military camouflage during World War I, and disruptive patterns are now a defining feature of many military uniforms (Newark et al. 2002). As in nature, however, the use of such a strategy has proven challenging under dynamic real-world conditions, as the efficacy of disruption is severely reduced, for example, against variable backgrounds, while in motion or in unfavorable viewing conditions. And just as an animal's visual camouflage is less effective against predators that draw on diverse sensory input, the development of radar has rendered the use of disruptive coloration largely redundant for larger-scale military structures, such as planes and ships. More recent efforts have also seen the principles of visual disruption applied to everyday situations, such as in conspicuously colored "shark-repellent" wetsuits and surfboards. These rely on boldly contrasting patterns to inhibit the identification of swimmers as potential food sources by sharks which, incidentally, are largely color-blind.

Conclusion

Disruptive coloration hinders the detection and recognition of an object's form by creating false internal and/or external boundaries with contrasting markings. It is a common mode of camouflage in nature and is a highly active area of research in the study of adaptive coloration.

Cross-References

▶ Adaptation
▶ Camouflage
▶ Cryptic Coloration
▶ Predator Defence
▶ Visual Recognition of Prey and Predators

References

Barry, K. L., White, T. E., Rathnayake, D. N., Fabricant, S. A., & Herberstein, M. E. (2015). Sexual signals for the colour-blind: Cryptic female mantids signal quality through brightness. *Functional Ecology, 29*, 531–539.

Cott, H. B. (1940). *Adaptive coloration in animals*. London: Methuen.

Cuthill, I. C., Stevens, M., Sheppard, J., Maddocks, T., Párraga, C. A., & Troscianko, T. S. (2005). Disruptive coloration and background pattern matching. *Nature, 434*, 72–74.

Hanlon, R. T., Chiao, C.-C., Mäthger, L. M., Barbosa, A., Burech, K. C., & Chubb, C. (2009). Cephalopod dynamic camouflage: Bringing the continuum between background matching and disruptive coloration. *Philosophical Transactions of the Royal Society B, 364*, 429–437.

Merilaita, S. (1998). Crypsis through disruptive coloration in an isopod. *Proceedings of the Royal Society of London B: Biological Sciences, 265*(1401), 1059–1064.

Newark, T., Newark, Q., & Borsarello, J. F. (2002). *Brassey's book of camouflage*. London: Brasseys UK Limited.

Poulton, E. B. (1890). *The colours of animals: Their meaning and use. Especially considered in the case of insects*. London: Kegan Paul, Trench Trubner, & Ltd.

Stevens, M., & Cuthill, I. C. (2006). Disruptive coloration, crypsis and edge detection in early visual processing.

Proceedings of the Royal Society of London B: Biological Sciences, 273, 2141–2147.

Stevens, M., & Merilaita, S. (2009). Defining disruptive coloration and distinguishing its functions. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 364*, 481–488.

Thayer, A. H. (1909). *Concealing coloration in animal kingdom: An exposition of the laws of disguise through color and pattern*. New York: Macmillan.