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The Camouflage Mechanism behind the Pokémon Move Transform in Ditto

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Abstract
In the Pokémon game and anime series, the Pokémon Ditto and Mew have a unique move that allows them to assume the form of any other Pokémon they are faced with. The visual change is temporary, and results in a complete physical change to the physical appearance of the Ditto and Mew. Focusing only on Ditto, this article studies mimicry in plants and camouflage mechanisms in cephalopods in order to produce a potential mechanism for how Ditto can change visual forms to use the move Transform.

Keywords: *Game; Biology; Mimicry; Pokémon; Anime; Ditto*

Introduction
Pokémon, short for Pocket Monsters, are creatures that inhabit a fantasy world that has become the subject of multiple games and an anime series [1, 2, 3]. Pokémon have specific types and moves, which owners of Pokémon, or trainers, use in battles. Battles are won by one trainer making all the opponent trainer's Pokémon faint. Known only by a few Pokémon, the move Transform enables the user to visibly replicate another Pokémon and, in the Pokémon Ditto, this is through rearranging its cell structure [1]. However, the Pokédex in Pokémon Diamond expands on this ability and explains that Ditto can transform into "whatever it sees" [2] rather than only living things or Pokémon. This is later confirmed as, in the anime, Jesse and James show their Ditto a book with a picture of Dratini, but Ditto transforms into the book instead [3]. By studying natural camouflage in octopi and cephalopods, as well as the mimic plant *Boquila trifoliolata*, the cellular mechanism of the move Transform will be explored.

The mimic plant
The plant *B. trifoliolata* has the ability of flexible leaf mimicry, and has also been shown to be able to mimic the leaves of an artificial plant host, with differences in details [4]. It was thought that genes could be passed from one plant to the mimic plant but, as it could copy a plastic plant without genes, this was disproven [4]. Ditto also has the ability to copy inanimate objects, as shown in the anime when a Ditto transforms into a book [3]. Gene transfer, therefore, cannot be the mechanism behind Ditto's transformations. For *B. trifoliolata,* it is thought that cells within the plant's leaves can act as ocelli to sense and perceive the host plant's leaves [4].

Figure 1 – Catch card showing the physicality of Ditto [5]. The catch card from Pokémon Go of Ditto, highlighting the physiology including eyes and limb like protrusions [5]. Taken on: 30/01/2023.

Ditto, as shown in Figure 1, has eyes which can perceive the target Pokémon. *B. trifoliolata* shows mimicry that can copy the: shape, colour, orientation, petiole length, vein conspicuousness, and vein patterns of the nearest foliage and, over time, showed improvement in its mimicking abilities [4]. This is consistent with Ditto's abilities, as it is said that Ditto makes mistakes when attempting to transform from memory only, and would become more accurate over time [1]. From *B. trifoliolata*, it is plausible that Ditto could also have the ability to mimic an inanimate object's shape and colour that is induced by ocelli or eyes.

Colour changes

Similarly to cephalopods, the camouflage system used by Ditto has to facilitate reversible changes in colouration, opacity, and luminescence [6]. Generally, in cephalopods, the skin consists of multiple layers with different arrangements of pigments, in chromatophores, iridophores, and leucophores [6]. The chromatophores in particular can change the size of the pigment [6] which occurs at sub second speeds [7] and leads to the observable colour change that comprises the camouflage mechanism. In cephalopods, the expansion of the chromatophores is directed by motor neurons with common innervation of clusters by single neurons [7]. This indicates that areas of the skin, which will broadly be the same colour in the final camouflage, are directed by the same nerves. Ditto has longer to react to the Pokémon in front of it and to recognise the different colours and forms required to mimic it. Furthermore, Ditto could direct the chromatophore expansion and induce colour and form changes through its nervous system. Acetylcholine, a common neurotransmitter, can be used to activate reflectin phosphorylation by innervation, which generates a variety of colours in iridocytes [8]. In cephalopod skin, multiple signalling cascades regulate the body patterning [8] both innately and actively [9] which Ditto could also use during the move Transform. To Ditto, the colour change mechanism will therefore be similar to blinking or walking to humans.

Body form changes

Ditto must have a highly mechanically deformable [6] body in order to achieve the diverse range of Pokémon forms that it can replicate. If Ditto were to utilise a neuronal network for body pattern changes, it is feasible that Ditto could also use it to change its body shape in order to replicate the exterior of other Pokémon. Using cephalopods as an example, as well as the chromatophore nervous system, they have a peripheral nervous system to coordinate their arms [9]. In Benthic octopuses, their arms are coordinated using localised coordination with arm ganglia integrating spatial information to control movement details [9]. In humans, limbs are controlled and directed by the nervous system, and so Ditto could have its own form of "arms" that are also controlled by neurons. From Figure 1, Ditto appears to have two arms, but there could be other smaller tendrils that also have specific neurons to control them. The connection to a neuronal network would mean that Ditto could induce the physical changes on demand, and could replicate a form in front of it, or from memory.

Conclusion

The move Transform allows Ditto to resemble any and all other Pokémon that it encounters, as well as inanimate objects [3]. The system of mimicry cannot be based on gene transfer from the host to the Ditto, and so is instead likely linked to colouration and shape changes that are induced by electrical signals from the neuronal network. The reversibility and rapid response times in Ditto suggest that epigenetic factors would not be suitable to induce the changes as their response times would be too long for in a short battle. By sensing the target of mimicry using its eyes, Ditto could utilise that information to configure its form, both in shape and colour, into another. The move Transform could act like drawing; drawing with a reference is often more accurate than from memory, it can be improved by training, and both are innervated by the nervous system.

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