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Original Article

Marcescence is Tukdam?

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Abstract - Both the phenomena of marcescence and tukdam are currently unexplained. Here, it is argued that the two are equivalent; the experiment is proposed and performed to test the hypothesis.

Keywords - Decay, Decomposition, Meditation, Life science, Tukdam.

1. Introduction

Some advanced meditators among Tibetan Buddhists die in a consciously controlled way (Center for Healthy Minds 2024; Coleman et al. 2022). When they die in this way (during meditation), the body is clinically dead - there is no physical difference between a fresh corpse and a person in this state (Lott et al. 2020); however, its decomposition and decay may be delayed for up to two weeks or more (Tidwell 2024). The phenomenon is referred to as tukdam. Now consider marcescence in deciduous trees (Heberling and Muzika 2023), a phenomenon of leaf retention during winter. Some species of oak (Abadía et al. 1996) and beech (Svendsen 2001), for example, do not shed their leaves in autumn but keep them until spring, when they are replaced with new leaves.

This is especially common in young trees but occurs in lower branches of larger trees as well (Svendsen 2001). The brown leaves in marcescence are dead, but their departure, decomposition and decay are all delayed. Marcescent leaves and petioles also exhibit postmortem rigidity, which could explain why living branches associated with marcescent leaves break more easily (Karban and Pearse 2021). To date, as already noted by others (Heberling and Muzika 2023; Mudrák et al. 2023), not much research has been done on marcescence. It is also assumed that the reason for the slow or delayed decay of leaves in marcescence is the lack of contact with soil, where primary decomposers are most active. Degradation can be accelerated abiotically, with intense solar radiation (Mudrák et al. 2023), and marcescent litter incorporated in the soil organic layer can exhibit either accelerated (Angst et al. 2017) or decelerated (Angst et al. 2024) decomposition, however, up to now, there have been no studies testing decomposition of marcescent leaves in soil contact while they are still attached to the tree. The tukdam phenomenon is even more understudied; however, if marcescent leaves exhibit delayed decomposition and decay even when buried in the soil, the two phenomena may be highly correlated and understanding one phenomenon could help in understanding the other.

2. Background and Aim

Conventional reductionism in modern science has led to acute discrimination between different forms of life on different levels. Living organs, organelles, and cells are all treated very differently than living organisms. Although there are exceptions (Margulis 2001; Baluška and Reber 2019), the components of an organism, apart from the brain, are usually considered mindless or non-conscious. However, even if complex levels of extroverted consciousness are definitely correlated with brain activity, there is no evidence that the mental aspect of being

requires a brain. The brain may be just a tool required for complex physical or extroverted interaction, but non-complex physical expression obviously does not require it. Consciousness probably should be generally correlated with self-organized networks of relative neurons (neurons), where relative neurons are not necessarily neural cells of brains but rather any organic entity able to hold and process information. In other words, brains should be relativized. A relative neuron, for example, maybe a bacterium in a biofilm (Futo et al. 2021) or a fungus in fungal networks (Morris 2000; Sheldrake 2020), even if extroverted expression of distinct consciousness of such networks may be low. As bodies and minds coevolve and affect each other, such networks may be interpreted as potential precursors of conventional organisms or proto-conscious proto-organisms. Mind-body dualism does not imply that the mind is absolutely non-physical. Instead, a carrier of consciousness may be a particle with its associated field of potential, even if it exists on a scale unobservable by human technology. Such particles may be coupling or localizing to bodies of ordinary matter, synchronized with the self-organization of that matter.

Moreover, this coupling could be weak and short-lived, as it may be in the case of a flock of birds, for example. Duality has the potential to explain the effects of the mind on the body, such as those in tukdam. Now, coupling of consciousness with a leaf in marcescence may be low (which may not be true for its deeper layers or the subconscious; how many layers are there?). Perhaps any sessile (immobile) organism is an organ as well - e.g. plants can be interpreted as organs of the Earth, which, of course, does not mean that mobile organisms are not parts of a bigger organism. Relatively, they probably always are. And what about extreme introversion? Deeper introversion is probably highly correlated with deeper subconscious communication. A leaf is an organ of the plant organism (or, the leaf is an organelle of the plant organ; it is all relative). It may be interpreted as a respiratory organ, but it has other interpretations as well. In any case, a leaf is probably a relatively conscious living being on its own. A leaf in marcescence is then clinically dead, but its decay is delayed, and, just like a person in tukdam, it has not departed. The carrier of consciousness, or the soul, has not fully decoupled from the body. Correlation does not end there. Note that a leaf is immobile, just like a meditating person. Marcescence is prevalent in resource-conservative species in resource-limited habitats, like those of the Himalayas (Chondol et al. 2024). The same can apparently be said for tukdam - advanced meditators commonly are resource-conservative and commonly live in resource-limited habitats, particularly the Himalayas. In a leaf, the decoupling of the soul from a body may also be relatively simultaneous with the decoupling of the body from a branch. For Buddhists, tukdam is not a localized phenomenon – it is claimed that a person in tukdam affects the environment and other people in the vicinity.

Similarly, a leaf in marcescence may be affecting the branch it is attached to, as it has been found that these branches break more easily, even though they are still living (Karban and Pearse 2021). A leaf in marcescence may be affecting decomposers as well. Delayed decay then may be correlated with decelerated delocalization of the soul, and delocalization could be correlated with the effects on the environment, where the effects are proportional to spatial and/or temporal entanglement – which is in the realm of physical forces usually inversely proportional to distance [squared]. So why are decay and decomposition delayed in states of marcescence and tukdam? Possibly because saprotrophic fungi and bacteria, directly or indirectly, sense that the soul of the host is still there (and/or the souls of the constituent cells of the body), entangled or coupled with the body – or they do not act because they do not sense death. Information may be exchanged between souls with changes in entanglement between them. When a soul decouples from a body, entanglement is [relatively] broken.

This information propagates through the fields of subconsciousness (fields, rather than fields, as different scales of energy may be involved). The signal of departure is received and interpreted by local souls as death, which can then be correlated with other actions leading to decomposition and decay. The concept of fields in biology is not new (Sheldrake 2011), which is not surprising, as it can explain a lot. In fact, this intimate link between physics and biology across scales, similar to the intimate link between consciousness and life, suggests that one should not look at biology (life/consciousness) as emerging from physics (the dance of subatomic particles and forces), rather as the two sides of the same coin. In other words, interpretation is in the eye of the observer, but the universe, as a whole,

is unbiased and does not favour one interpretation over the other. Note that advanced meditators can affect their body using the mind only - e.g. increase body temperature (Kozhevnikov et al. 2013). Meditators in tukdam may produce an effect on the body similar to the effect of formaldehyde (commonly used in embalming). If so, do they produce it consciously or subconsciously at the time of death? In any case, an experiment could be set up where a leaf in marcescence (still attached to the tree) is touching the ground or is buried into the ground. Suppose such a leaf is still decomposing and decaying slowly. In that case, it must be ignored (at least to some degree) by ground microbes and worms, so this could be interpreted as strong evidence for the existence of souls (since the leaf is clinically dead, by conventional theories, decomposers should treat it as any other dead leaf). Note that differences in behaviour could exist between worms and microbes and even between species of microbes. Some species (e.g. parasites) may not make a distinction and would not mind munching on leaves in marcescence. This study aims to test whether delayed decay in marcescent leaves is due to lack of soil contact. A negative result may then be correlated with tukdam and mind-body dualism.

3. Materials and Methods

The experiment was performed on a location in Sibinj (near Slavonski Brod), Croatia, starting near the end of February, when, with increasing temperatures, increasing activity of decomposers is expected. At this point, the leaves in marcescence are past the resorption phase of abscission (carotenoids have degraded). The experiment ended about a month later. Visual and tactile inspection was used in the analysis. Details and logs of the experiment are shown in Table 1.

Table 1. The experiment log

Date	Action
2024.02.23	A low-lying branch of a young oak (Quercus petraea) exhibiting marcescence was buried with a layer of soil some 10-15 cm deep. A thin layer of gravel was deposited on the ground, followed by a thin layer of clay. Then, the branch has been bent and fixed with a brick to the deposit. To that, a couple of leaves in the same state of decay (but not attached to the branch) were added. A thick layer of wet clay with a significant amount of humus and living earthworms has been added on top to cover the leaves. On top of that, a layer of drier, crumbly clay was added.
2024.03.26	The buds of trees were starting to open and leaves in marcescence were not clinging strongly to branches anymore. Thus, a decision was made to end the experiment. About half of the leaves were still attached to the branch; some of them fell off as the branch was dug out. The soil was moist, and earthworms were still present.

The branch used in the experiment is shown in Figure 1.

Fig. 1 The branch before burial

The same branch, fixed with a brick and buried in soil, is shown in Figure 2.

Fig. 2 The branch after burial, on 2024.02.23

Figure 3 shows the experiment setup on 2024.03.26, minutes before the branch was dug out.

Fig. 3 The state of the experiment on 2024.03.26, just before digging

The branches and leaves, after being dug up, are shown in Figure 4.

Fig. 4 The branch after being dug up, all bright coloured leaves are leaves that were attached to the branch while it was buried (some of them are still attached), dark coloured leaves (marked by red arrows) were buried but were not attached to the branch

4. Results and Discussion

Apart from the softer tissue in leaves that were buried, no notable difference was observed between buried leaves that were attached to the branch and leaves in marcescence that were not buried (all leaves that were not buried are brittle, not soft). No notable difference was observed, even between the leaves lying on the ground around the tree and the leaves in marcescence. However, buried leaves that were not attached to the branch are clearly of a darker colour and are showing a more advanced stage of decay. The softer tissue of buried leaves (whether in marcescence or not) is not surprising. The effect is equivalent to softness commonly observed in leaves growing in shade (elevated moisture levels). However, there is a striking difference in colouration between leaves that are still attached to the branch (or were, prior to the dig) and other leaves that were buried.

This colouration and decay cannot be attributed to earthworms or other larger decomposers for different reasons, one being that the leaves are still young and probably still contain tannins (note that all leaves were of the same bright colour prior to burial). Tannins are not a problem for primary decomposers, dark colour here should then indicate colonization by fungi and bacteria. Furthermore, these saprotrophs obviously show a preference for leaves which are not attached to the branch (not in marcescence), even in wet soil. In fact, it seems that marcescent leaves have been completely ignored. The question, now, is why? Saprotrophs feed on non-living organic matter. Have they detected leaves in marcescence as still-living? What if these are clinically dead? There are no hormones involved here. The presence of rooting hormones may deter saprotrophs, but any significant presence of rooting hormones in oak leaves here and even in branches can be ruled out. Oaks do not have a natural tendency for vegetative reproduction, and no roots were observed here. It appears, thus, that marcescence is indeed equivalent to tukdam, and at least some decomposers are not reacting to the death of the body but rather are awaiting some other signal. One could argue that fungi are not touching the leaves in marcescence because they somehow sense the leaves are still attached to the branch. However, is that the case and why would it matter? If the tissue is dead, the plant does not use it, and there is no reason for the plant to delay decomposition by signalling attachment. Note that if some kind of signalling is present, any signalling involving chemicals probably can be ruled out, as signalling pathways between the branch and attached leaves are blocked. Moreover, if chemicals are leached into the soil, how would the decomposers associate these exclusively with attached leaves, not with other leaves close to the branch?

4.1. Statistical Analysis

Here, the hypothesis that the state of leaf decay is independent of marcescence is tested.

H_0: Attributes 'state of decay' and 'state of attachment' are independent of each other.
H_1: Attributes 'state of decay' and 'state of attachment' are not independent of each other.

Table 2. Contingency table

State of Attachment	State of decay		Total
	No Significant Decay	Advanced Decay	
Leaves in Marcescence	12	0	12
Detached Leaves	0	5	5
Total	12	5	17

Chi-squared statistic test, with Yates's correction:

$$\chi^2 = \sum_{i=1}^{n} \frac{(|O_i - E_i| - 0.5)^2}{E_i} = \frac{(|12-6|-0.5)^2}{6} + \frac{(|0-6|-0.5)^2}{6} + \frac{(|0-2.5|-0.5)^2}{2.5} + \frac{(|5-2.5|-0.5)^2}{2.5} = 13.28$$

Tabulated (critical) value of χ^2 for (2-1) x (2-1) = 1 d.f. at 5% level of significance is 3.841. Since the calculated value is greater than the critical value, the null hypothesis (H_0) is rejected. Alternatively, Fisher's exact test gives a p-value of 0.00016, which is below the 5% significance level (rejecting the null hypothesis).

5. Conclusion

The results of the experiment strongly suggest that at least some primary decomposers ignore leaves in marcescence, even when they are buried in moist soil. This is a surprising result and hard to explain by established science. Given the absence of chemical signalling or the functional immune system, the result can certainly be interpreted as evidence for souls. However, even though the signal seems clear, the experiment was limited – in sample size, duration and technology. Further testing is thus desirable. It would also be interesting to try the experiment with non-toxic leaves to test if larger decomposers ignore marcescent leaves as well.

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