生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	獼猴使用簡單的投票過程來一起行動 (Macaques use simple voting process to stay together)
生物系統 LIVING SYSTEM	通金獼猴 *Macaca tonkeana* (Tonkean macaques)
功能類別 FUNCTIONS	#透過自我組織維持群落協調 #Coordinate by self-organization
作用機制標題	獼猴使用簡單、清楚、廣泛性的投票過程來以群組一起行動 (Macaques use simple, clear, inclusive voting process to stay together as a group)
生物系統/作用機制示意圖	

作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)

通金獼猴 (Tonkean macaques) 生活在印度尼西亞蘇拉威西島 (Sulawesi) 的森林中。牠們在覓食區塊 (food patches) 之間無縫地移動而不會造成衝突，即使是以多達 30 隻猴子的隊伍進行移動時也是一樣。你可能會想是一隻具主導地位 (dominant) 的雄性來決定接下來要去的果樹是哪棵，但這是錯誤的。相反地，任何一隻獼猴，雄性或雌性的，年幼或年長的，都可以幫助決策。而隊伍的每一個決定都是由投票來達成共識。

當一隻獼猴打算移動到另一個取食果實的區塊時，牠會透過朝向想去的方向踏步然後停止，再轉頭看向同伴們的方式，發出訊號給隊伍中其他獼猴。這使投票過程開始。在這個時間點，其他獼猴可能往不同方向移動，能有效地提議隊伍往另一採果區塊前進。然後其他的猴子會加入其中一位發起者 (initiator)，根據喜好或是牠們與每個群組中其他猴子的關係來進行投票。當投票的猴子不再回頭看其他隊伍成員，投票過程就有效地結束了。餘下的猴子只是加入最大的群組。投票給沒被採納路線的猴子之後亦會加入隊伍，以維持一起行動。

簡單而清楚地作出決策的過程，使所有群組成員都有機會表達個人意見，並在最終經常可以達成共識，能非常有效地將群組維持在一起。

Tonkean macaques live in the forests of the Indonesian island of Sulawesi. They move between food patches seamlessly, without conflict, even while traveling in large bands of up to 30 monkeys. You might think a dominant male makes the decisions about which fruit tree to visit next, but you'd be wrong. Instead, any of the macaques, male or female, young or old, can help make this decision. And the troop arrives at each decision through a consensus by voting.

When a macaque would like to move on to another fruit patch, it signals this to the rest of the troop by stepping towards the direction it would like to go, stopping, and then turning to look back at the rest of the troop. This begins the voting process. At this point, another macaque may move in a different direction, effectively proposing the troop travel towards a different fruit patch. Additional monkeys then join one or the other initiators, casting their vote for one direction or another based on preference and their relationships with the other monkeys in each group. Once a voting monkey stops looking back at the rest of the troop, the voting process is effectively over. The remaining monkeys simply join whichever group is largest. The monkeys that voted for the unchosen route then join the rest of the troop, in order to all stay together.

Simple, clear processes of decision-making, in which all members of a group have the opportunity to voice an opinion, and in which an ultimate consensus can always be formed, can be highly effective in keeping a group together.

文獻引用 (REFERENCES)

「這表明了提出最初方向的行為對第二個方向的影響，提出另一方向並不是一個獨立概率 (independent probability)。」(Sueur et al. 2011: 1699)

「這個結果確定了公布另一路線的個體是受到了公布最初路線的個體所影響。而第三個公布的個體，不論其提出方向，都會受到最初兩個公布個體的影響，如此類推。」(Sueur et al. 2011: 1700)

「這表示了公布個體 (notifying individuals) 中，方向 1 和方向 2 之間的絕對偏差 (absolute difference) 只需要等於或大於 1，發起者就會選擇有大多數公布個體的方向。」(Sueur et al. 2011: 1701)

「因此，關於加入一個行動，一個個體最初是被公布個體的法定人數 (Quorum) 所影響，然後才是受到已經加入行動的個體，以及與其緊密聯繫 (highly affiliated) 的個體所影響。」(Sueur et al. 2011: 1701)

「事實上，我們發現了當一個個體決定加入行動時，會結合兩個過程來作出一個決定。牠們在選擇時會同時考慮到公布個體的數目以及牠與已經表態個體的從屬關係 (affiliative relationships)。這兩個機制的協同作用使獼猴考慮到已啟程個體的數量增加，

由於群體仍保持凝聚，集體行動是不可避免的。這是一個與群體主流協調，以及與結盟或有著類似動機個體協調之間的調整。」(Sueur et al. 2011: 1702)

"This suggests an influence of the behaviour in the first direction on the second one rather than an independent probability to notify in the second direction." (Sueur et al. 2011: 1699)

"This result confirms that the first individual notifying in the second direction is influenced by the first individual notifying in the first direction. The third notifying individual, whatever the direction, is influenced by the two first notifying individuals, and so on." (Sueur et al. 2011: 1700)

"This means that the absolute difference in the notifying individuals between direction 1 and direction 2 only needs to equal 1 or more for the initiator to choose the direction with the majority of notifying individuals." (Sueur et al. 2011: 1701)

"So, as far as joining a movement is concerned, an individual is first influenced by the quorum of notifying individuals, then by the individuals who have already joined the movement and those with whom he is highly affiliated." (Sueur et al. 2011: 1701)

"In fact, we found that individuals combined the two processes in a single decision when deciding to join. They consider both the number of notifying individuals and their affiliative relationships with already moving individuals when choosing. The synergy of these two mechanisms allows macaques to consider the growing number of departed individuals and therefore the ineluctability of a collective movement, since groups remain cohesive. This is a modulation between being coordinated with the majority of the group and being coordinated with individuals with whom one has alliances or shares similar motivations." (Sueur et al. 2011: 1702)

參考文獻清單與連結 (REFERENCE LIST)

Sueur, C., J. L. Deneubourg, and O. Petit. (2011). From the first intention movement to the last joiner: macaques combine mimetic rules to optimize their collective decisions. *Proceedings. Biological sciences* 278: 1697-1704. (https://doi.org/10.1098/rspb.2010.2084)

延伸閱讀

生物系統延伸資訊連結 (LEARN MORE ABOUT THE LIVING SYSTEM/S)

https://en.wikipedia.org/wiki/macaca_tonkeana
https://www.onezoom.org/life/@macaca_tonkeana
https://eol.org/pages/323961

撰寫/翻譯/編修者與日期

譚國鎏翻譯 (2021/03/22)；沈聖峰編修 (2021/05/08)
AskNature 原文連結
https://asknature.org/strategy/macaques-use-simple-voting-process-to-stay-together/