11th Conference on Dynamical Systems Applied to Biology and Natural Sciences DSABNS 2020
Trento, Italy, February 4-7, 2020

INTERFERENCE COMPETITION ON GROUP DEFENSE WITH HOLLING TYPE IV COMPETITIVE RESPONSE

Hamlet Castillo Alvino*[1], Marcos Marva Ruiz[2]

[1]Pontificia Universidad Católica Madre y Maestra,
Dominican Republic

[2]University of Alcalá,
Alcalá de Henares, Madrid, Spain

hh.castillo@ce.pucmm.edu.do (*corresponding author),
marcos.marva@uah.es

Species competition is present under many different forms and strategies including aggressiveness [2], [3]. In particular, group defense has been observed among these mechanisms [10] [8] for both vertebrate or invertebrate animals. We redive a model that extend the classical interference competition model [4] (see also [1]) by incorporating a Holling type IV term [6], [7] that we call *Holling type IV competitive response on group defense*. In our framework the competition model takes into account the increase on the time spent to snatch resources to other species' individuals due to group defense strategy (of the other species). It can be seen as a continuation of our previous work [9], where the so called Holling type II competitive response was introduced in the classical interference competition model to incorporate the time spent in interfering with competitors. The resulting model expands the outcomes allowed by the classical Lotka-Volterra competition model by,

1. Enlarging the range of parameter values that allow coexistence scenarios.
2. Displaying dynamical scenarios not allowed by the classical model in the form of multi-stable scenarios: bi/tri-stable conditional coexistence (species can either coexist or one/any pf them go extinct), bi/tristable unconditional coexistence (there exist two or three possible coexistence steady states).

Our results lighten the balance between intra/inter species competitive pressure that is behind competing species coexistence that starting from the outcomes [11], [12]. Besides, the model presented herein displays stable alternative states in which the species coexist unconditionally as a result of the group defense strategy. This mechanism is an alternative explanation to empirical observations [5].

References

[1] Arrowsmith, D.K. (1992). *Competing species, Dynamical System, Differential equations,maps and chaotic behavior*, Springer.

 ISBN: 978-989-98750-7-4

[2] Balance, L. T. , Ainley, D. G., Hunt, G. L. (2001). *Seabird Foraging Ecology*. Encyclopedia of Ocean Sciences, **5**, pp. 2636-2644. https://doi:10.1006/rwos. 2001.0233.

[3] Dow, Douglas, D. (1977). *Indiscriminate Interspecific Aggression Leading to almost Sole Occupancy of Space by a Single Species of Bird*. EMU-Austral Ornithology,**77(3)**,pp. 115-121. https://doi.org/10.1071/MU9770115.

[4] Gause, G.F., *The struggle for coexistence*. Williams and Wilkins, 1934.

[5] Gunderson, H., Holling, C.S. *Panarchy Understanding Transformations in Human and Natural Systems*, pp. 26-62, Island Press, Washington, DC, 2002.

[6] Holling, C.S. (1959). *Some characteristics of simple types of predation and parasitism*, The Canadian Entomoligist, 91(7): 385-398.

[7] Koen-Alonso, M., *A Process-Oriented Approach to the Multispecies Functional Response*. In: Rooney N., McCann K.S., Noakes D.L.G. (eds) From Energetics to Ecosystems: The Dynamics and Structure of Ecological Systems. Springer, Dordrecht, pp. 2-32, 2007.

[8] Krause, J., Ruxton, GD. (2002) *Living in groups*, Oxford University Press.

[9] Marvá, M., Castillo-Alvino, H., *The competition model with Holloing type II competitive response to interference time.Sumited.*

[10] Miller,RC. , *The significance of gregarious habit*. Ecology, **3**, (1922), 122-126.

[11] Nunney, L., *Density compensation, isocline shape and single-level competition models*. J. Theor. Biol., **86**, (1980), 323-349.

[12] Zhang, Z., *Mututalism or cooperation among competitors promotes coexistence and competitive ability*. Ecol. Model., **164**, (2003), 271-282.

 ISBN: 978-989-98750-7-4