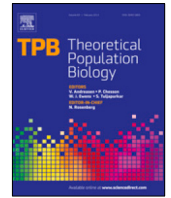




Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



## Editorial

## Population models, mathematical epidemiology, and the COVID-19 pandemic

The COVID-19 pandemic has been a singular moment for the core subject of *Theoretical Population Biology*: population models. The scientific press and broader public discourse often take notice of population models concerning such topics as demographic projections, ecological invasions, human evolution, and species extinctions. However, population models predicting and analyzing features of COVID-19 dynamics – the geographic spread of the disease, the temporal course of numbers of cases and fatalities, the load on health systems, and the effects of policy measures – have received a level of acute public attention that is perhaps unprecedented for any area of population biology modeling. Given the great global impact of the disease in the year since its emergence in late 2019, the significance of population models has rarely, if ever, been more salient.

In the *TPB* community, the emergence of COVID-19 as a worldwide problem has been accompanied by a dramatic shift of many with expertise in epidemiological modeling toward analyzing the dynamics of the disease and generating projections to guide policymaking and public understanding. The pandemic has also coincided with the 50th anniversary year for *TPB*, providing a stark example of the importance of theory in population biology, as documented in the anniversary special issue that went to press as the disease began its spread (Rosenberg, 2020).

First, the anniversary issue illustrates how theoretical work in population biology often proceeds in relative obscurity over many years, as theory frameworks are refined, sometimes well ahead of their time in relation to the associated empirical science, and sometimes breaking through to empirical applications only after substantial effort to communicate the work in different, less mathematical forms. Indeed, the anniversary issue makes the connection between theory work and Beethoven's response to a critique of one of his string quartets: some theory is not for its contemporaries, but "for a later age." The initial period of a new infectious disease – with epidemic modelers working urgently on policy-relevant problems – is not a time for production of theory, but rather for real-time application and dissemination. That such rapid applied work has been possible for COVID-19, however, is due in part to the foundation laid by modelers over many years of largely invisible theory efforts. With the pandemic, we are living in the later age.

Second, the anniversary issue documents links among the fields of population biology modeling that co-occur in *TPB*. Many *TPB* authors have contributed to mathematical epidemiology of

the pandemic. Their earlier *TPB* papers, however, are not necessarily epidemiological, and are instead often concerned with other areas of the journal: demography, ecology, evolution, and genetics. The connections among fields that have been facilitated by unified perspectives on theory in population biology have been central to the training of many who now have the skills to contribute to COVID-19 epidemiology.

Third, the anniversary issue comments on theoretical population biologists as motivated by interests both in solving obscure mathematical problems and in addressing applied population biology problems of the world. In the great shift of population modelers to COVID-19 epidemiology, it is not only the "later age" of the community's efforts on obscure problems, but also its depth of humanistic interest, that is revealed. The advice of *TPB* pioneer Mindel Sheps quoted in the anniversary issue resonates: "It would be well to approach all human problems with humility, with a strong sense of the limitations of our knowledge and of the existence of large areas of ignorance, and with readiness to admit the errors we may make... The only hope of solving the problems of this planet lies in the application of scientific understanding and skills in the service of human dignity, freedom and welfare. Neither science nor high ideals can do the job alone."

We can express gratitude for all the ways in which the *TPB* community has contributed, directly and indirectly, toward addressing the global problem of COVID-19; for deep motivation to promote public health, for urgently developing policy-relevant epidemic models, for providing theory that has made the urgent work possible, and for sustaining the interlocking ecosystem of theory work in demography, ecology, evolution, and genetics that has supported the epidemiological enterprise.

## References

- Rosenberg, N.A., 2020. Fifty years of *Theoretical Population Biology*. *Theor. Popul. Biol.* 133, 1–12.

Editor-in-Chief

Noah A. Rosenberg

Stanford University, United States

E-mail address: [noahr@stanford.edu](mailto:noahr@stanford.edu).

Available online 7 January 2021