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The Collapse and Regeneration of Complex Societies

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1 Introduction

The subject of societal collapse is a theme that, due to its political, social, economic, and ecological implications, still generates heated discussions. Researchers interested in developing a general theory of collapse face the challenge of identifying common patterns across human societies. This task is further complicated because multiple publications on the subject employ a case-by-case methodology, within which the causes of collapse are thought to be specific to each society. Such *historical particularism* persists to this day. Historical contingency is preferred to generalizable explanation. In response, some researchers have instead concentrated on examining how a society's internal dynamics predict the risk of collapse. For example, a society's institutional performance, macroeconomic yields, and level of collective action have been thought predictive of its structural integrity under adverse circumstances. Through this lens, external factors may lead to a sudden loss of sociopolitical complexity only when the system's capacity to address these conditions is compromised. Given variation in societies' level of cohesion and collective action, the case of

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societal collapse offers a unique glimpse into multilevel selection operating among social systems. This chapter describes critical elements developed in the collapse literature while providing an overview of the current multilevel selection perspectives on fluctuations in collective action. The present contribution also describes how institutional robustness and cultural innovations contribute to a society's regeneration capacity after experiencing a collapse.[1]

2 Defining Sociopolitical Collapse

Numerous publications have provided different descriptions of collapse. To circumvent the current overabundance of definitions in the literature, and because of its consonance with multilevel selection theory, this chapter will adopt J. A. Tainter's (1988) description featured in *The Collapse of Complex Societies*, wherein a society collapses when it features the following:

1. A decrease in social stratification and differentiation;
2. A decline in the society's economic specialism;
3. Lower regulation and integration among political and economic classes;
4. A fall in the allocation of resources to cultural phenomena such as art and architecture, among others;
5. Restricted exchange of information (e.g., at the level of individuals and groups and between the polity's core and its outskirts);
6. Limited trade and distribution of resources;
7. A loss of coordination within the system;
8. The emergence of smaller autonomous polities and a reduction in territory size.

In general, historical treatments of collapse frequently describe how external factors significantly and irreversibly disrupt a society's complexity. Natural catastrophes, invaders, resource depletion, and pandemics (Diamond, 2005; Fagan, 2009; Haug et al., 2003; Huntington, 1922; Kaniewski, Guiot, & Van Campo, 2015; Kennett et al., 2012; McNeill, 1998) are just a few of the commonly mentioned causes. Alternatively, other perspectives have suggested that collapse is instead the product of internal disruptions, including instances of interclass confrontations, accusations of maladministration, and other forms of legitimation crises, including using the state to attain economic, social, and political benefits at the expense of the rest of the population (Eisenstadt, 2017). The main limitation of these perspectives is that many societies repeatedly encountered these pressures without suffering from a sudden loss in sociopolitical complexity (Tainter, 1988; Turchin, 2003).

In response to some of the limitations of traditional collapse theories, Tainter (1988, 2004, 2006) developed a macroeconomic perspective wherein collapse resulted from the dynamic interplay between a society's complexity and the amount of energy required to sustain its organization. Tainter's (1988, 2006) theory rests on four principles: (1) human societies act as problem-solving systems; (2) these societies depend on a constant influx of energy to preserve their structural integrity; (3) as societies increase their level of sociopolitical complexity, they also experience rising per capita costs associated with preserving this organization; and (4) the benefits obtained from problem-solving institutions reach a point of diminishing returns over time, wherein the return on investment follows a negative quadratic trajectory.

Hence, for Tainter (1988), a sudden loss in sociopolitical complexity is caused by the system's internal economic dynamics. His model of marginal productivity claimed that the society's subsystems inescapably face a critical point of marginal returns where costs outweigh the benefits (Tainter, 1988, 2006). This dynamic permeates across social, political, and economic institutions. As social systems rise their level of complexity, they became increasingly dependent on the influx of information and material resources. To maintain an adequate flow of information and energy, the administration creates hierarchical institutions, coordinating and regulating how these resources spread within the system. The preservation and centralization of these connections rely on the labor of specialists. For example, in state-level societies, public institutions emerge to guarantee the production and distribution of goods and services to the population and to secure them against foreign and national threats (Tainter, 1988). Specialism ineluctably increases bureaucratization, with public servants proliferating as they specialize. In case any of its components are compromised, a society may also increase the number of redundant institutions. Tainter's (1988) theory also considered the challenge faced by academic and information processing institutions in producing new scientific and technological knowledge. For example, specialized information replaces general knowledge over time, a feature that subsequent publications identified in terms of evolved cognitive abilities (Woodley of Menie et al., 2017).

3 Multilevel Dynamics and Collapse

In addition to debates concerning the nature and the causes of collapse, another point of contention in the literature concerns the possibility of collapse operating sequentially over different social, political, and cultural units (Middleton, 2017) (Fig. 7.1).

Just as societies increase their level of sociopolitical complexity over time (e.g., band → tribe→ chiefdom→ state), so they can revert to a more primary level (Currie & Mace, 2011). As suggested by current perspectives on political evolution, collapse operates on different levels of

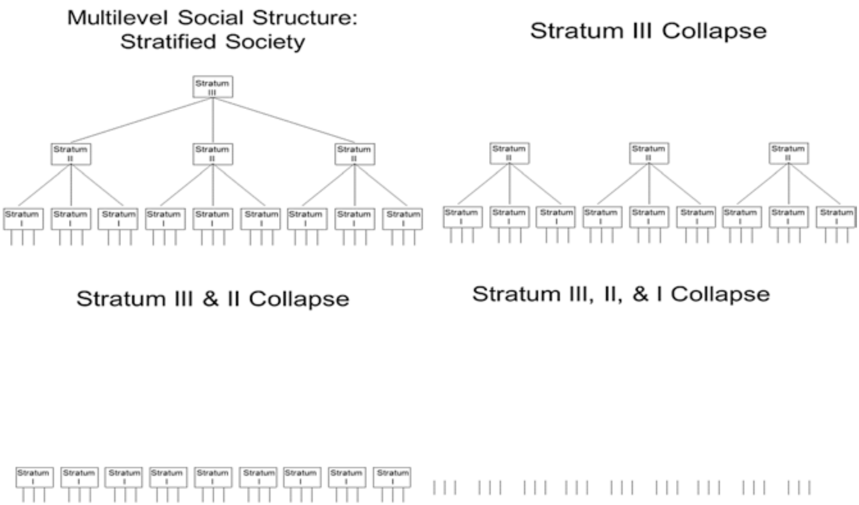

Fig. 7.1 Sequential multilevel social collapse operating on three different strata (I, II, and III)

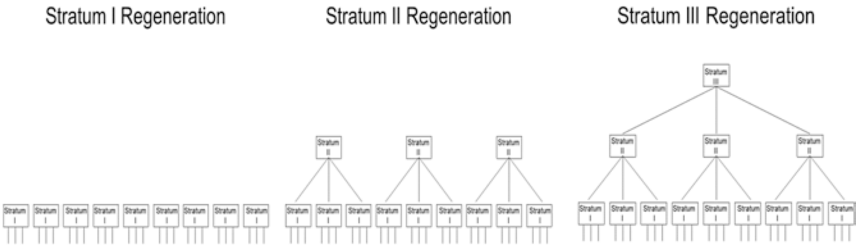

Fig. 7.2 Sequential multilevel social regeneration of strata I, II, and III

aggregation. Although complex societies often contain more than three strata (e.g., dyad/nuclear family → extended kin → neighborhood → district → city → prefecture→ province→ state), for the sake of illustration, consider a stratified society comprised of three hierarchical levels. As seen below in Fig. 7.2, the highest level, stratum III, corresponds to a fully autonomous superstructure featuring clear geopolitical boundaries. In this example, this highest stratum of the organization is governed by a group of individuals coordinating the efforts of lower-order components, including the distribution of information and resources. Although the subcomponents of stratum II can collect resources for local investment and spending, and are allowed other autonomous functions, they often respond to the instructions provided by stratum III.

In addition to implementing its own functions, stratum II acts as an intermediary between stratum III and stratum I. Indivisible elements[2] comprise stratum I, the lowest level of organization, as depicted in Fig. 7.1. In terms of collapse, the disappearance of stratum III does not imply the immediate elimination of the lower-level strata. If the disruption alters the integrity of stratum II, leading to its eventual collapse, the lowest level can persist despite the higher tiers experiencing considerable perturbations. Strata II and I could avoid collapse as long as their capacity to extract, process, and distribute resources remains relatively unaltered. Consistent with previous models, in this representation, collapse is not an outcome of internal or external perturbations, but rather the product of the strata's capacity to efficiently extract, process, and distribute resources in the face of changes and challenges. The survival of lower-level organizations also allows the eventual reemergence of higher-level organizations. This simplified model shown in Fig. 7.2 then views *regeneration*[3] operating sequentially on each level, with stratum II reliant on stratum I and stratum III reliant on stratum I and stratum II. Of course, each element within a level can contribute differently to the emergence of a higher-order level.

4 Cycles of Decline

From describing multilevel social organizations, we move on to consider multilevel temporal cycles. Traditionally, history is described as a series of events bound to contextual contingencies. Although such an approach provides insightful information into the particular features of a historical event, it also precludes the identification of general biohistorical patterns across contexts. In the last two decades, ecologists and demographers have begun working on such a general framework, displaying a renewed interest in those broad biohistorical dynamics initially broached by Toynbee, Spengler, and Huntington early in the twentieth century. Through this lens, historical events are no longer viewed as random occurrences but as parts of cycles embedded in a multilevel structure. Holling and Gunderson (2002), for example, theorized that complex ecological organizations experience a series of transformations through time. This theory viewed socioecological changes progressing from *exploitation* to *conservation*, to *release*, and on to *regeneration*, with each of these four stages, respectively, represented by the four mathematical functions: r, K, Ω, and α. Each stage differed depending on its level of intrinsic potential, the accumulated bioenergetic resources in the system, as well as on the subsystems' interconnectedness. The first stage, exploitation, is characterized by its low levels of interconnectedness and inherent potential. Under these circumstances, relatively unrestricted access to resources allows the population to increase in size (r). Eventually, the system expands its potential and connectedness, reaching the conservation phase with its accrual and storing of bioenergetic resources (K).[4] At some point, the accumulation of biomass and over-connectedness increases the system's vulnerability. Factors such as droughts, famines, pests, or fires release the structure's accumulated biomass (Ω). During the release phase, the system's connectedness declines while its intrinsic potential remains high. The end of this phase is followed by a period of reorganization. The remaining available resources are restructured to avoid unnecessary resource loss (α), generating the required conditions for the cycle to begin anew.

Other models emphasize destabilization as it occurs on one level and redounds to others. For instance, building on Holling and Gunderson (2002), Holling, Gunderson, and Peterson (2002) claimed that adaptive cycles operate within a nested organization of *economic*, *ecological*, and *institutional* systems, rather than occurring as isolated phenomena. Their view of collapse not only emphasizes interconnected systems but incorporates elements of chaos theory and is explicitly antihierarchical, both of which features are notable in their operationalization of *panarchy*, the title of their book, and the term describing their theory of *transformations in human and natural systems*. For Holling et al. (2002), each level in a system is linked to every other level through *panarchical* connections. Interconnectedness amplifies perturbations through all the system's levels. Consider three cycles: The first level is small and fast, the second presents moderate speed and size, and the third is large and slow. The first connection links the release phase of the small cycle to the conservation phase of the intermediate cycle and so on. These connections imply that disturbances at a lower level can impact a higher level. The likelihood of collapse then is proportional to the level's vulnerability and rigidity.[56]

In addition to the panarchy theory, a recent perspective inspired by multilevel selection theory describes biohistorical changes as *wheels within wheels* (Turchin, 2007), wherein a historical hierarchy is divided into four levels: (1) *business cycles*, (2) *father-son cycles*, (3) *secular cycles*, and (4) *asabiyyah cycles*. The lowest level in the hierarchy, business cycles, describes the macroeconomic fluctuations experienced by a society (Turchin, 2007) with each cycle lasting between five and twelve years (Korotayev & Tsirel, 2010; Turchin, 2007). Traditionally, business cycles are divided into *expansion* and *recession* phases, with the former referring to an increase in salaries, prices, and employment, whereas the latter refer to decreases in these same variables. The next level, father-son cycles, lasts approximately twenty-five years. It is manifested in the manner in which individuals from two contiguous generations differ in their involvement and responses to internal strife. The generation exposed to intense and often lethal intragroup competition, as through regional feuds and civil wars, eventually become exhausted by the atrocities perpetrated during the crisis. Survivors implement institutional safeguards to decrease the current conflict and avoid experiencing similar conditions in the future (Turchin, 2007). These sociopolitical changes generate a period of peace and intragroup cooperation. Under these conditions, a new generation arises. Sons are oblivious to the conflict experienced by their parents. The investment allocated to institutions involved in mediating intragroup confrontations is then redirected to other political or economic endeavors. Eventually, social tensions escalate into feuds and lethal confrontations, thus restarting the sequence. Secular and *asabiyyah* cycles, for their relevance and complexity, merit further discussion.

Located above father-son cycles, secular cycles last between 150 and 300 years. Turchin and Nefedov (2009) claimed that a population reaching an ecosystem's carrying capacity (*K*) experiences a series of social and economic *sequelae*. For instance, societies with higher population density approaching *K* are prone to experiencing food and land shortages, higher unemployment, and lower wages and display a decline in the consumption of goods and services (Turchin, 2007). Accelerated population growth also increases rents and property prices. These economic fluctuations reverberate within the system, with commoners and peasants partially or fully forfeiting their properties. The combined effects of downward social mobility, overpopulation, and the inability to store enough food increase the vulnerability of rural areas to famines. These dire conditions promote rural migration into urban centers (Turchin, 2003; Turchin & Nefedov, 2009). Although, initially, urban employers hire rural immigrants as craftsmen and traders, the continuous influx of peasants to cities eventually expands the number of unemployed immigrants (Turchin & Nefedov, 2009). Overcrowding and malnutrition generate the necessary conditions for the spread of pathogens. Demographic consequences ensue, with economic stagnation raising mortality rates, decreasing fertility rates, and decelerating population growth (Turchin, 2003). According to Turchin and Nefedov (2009), elites are not immediately affected by periods of resource scarcity, but often instead profit from the early stages of economic *stagflation*, which is an economic concept combining the phenomena of stagnation and inflation (Turchin, 2007; Turchin & Nefedov, 2009). In the absence of state regulation, landlords could raise rents or demand an increase in the rate of resource extraction without facing any significant opposition. Although peasants could rebel against their employers, the absence of alternative sources of income, as well as the threat of punishment, forces peasants to accept elite demands. During the early stages of the demographic-fiscal crisis, aristocrats experience a boost in wealth acquisition allowing an increased consumption rate (Turchin, 2007). Since the numbers of elites grow in conjunction with the rest of the population, resource scarcity eventually begins to affect the upper strata. Famines, epidemics, and violence interfere with the elite's revenues. Despite imminent financial crisis, the aristocracy's level of conspicuous consumption persists (Turchin & Nefedov, 2009). Decreasing profits and growing debts force elites to sell their properties to preserve their social standing. It is not uncommon for nobles to obtain loans from financial institutions or even request the state to provide financial assistance. These solutions temporarily buffer the nobility's financial crisis. However, the elite's inability or unwillingness to pay taxes forces the state to partially or fully halt any investment in public goods and services (Turchin & Nefedov, 2009). Among these services is the state's ability to provide internal and external security. Legal, penal, and military institutions operate at suboptimal levels. *Intra-elite* confrontations escalate from minor disagreements to lethal violence; feuding, dueling, and civil wars increase in frequency (Turchin, 2007). This state of internal turmoil leads to a drop in the numbers of aristocrats, diminishing the intensity of intra-elite competition and restarting the cycle. It is worth noting that even though secular cycles are described as an autocatalytic process,[7] they can be moderated by external factors (Turchin, 2007). The impact of these exogenous forces will depend on the timing of their occurrence. An event like a drought or an epidemic coinciding with a society's integrative phase may alter some demographic parameters, such as the rate of population growth, but will not impact the society's organization to the point of collapse (Turchin, 2007).

Finally, *asabiyyah* cycles rest above secular cycles, ranging between 1000 and 2000 years (Turchin, 2007). This sequence covers fluctuations in a society's collective action and social solidarity. Quantitative examinations of this concept have recently provided additional support to historical perspectives considering the role of declining collective efforts in the collapse of complex societies. Turchin (2003), for example, described the change of society's *asabiyyah* in the following formula (Formula 7.1)[8]:

$$\dot{S} = r\left(A\right)S\left(1-S\right) \tag{7.1}$$

where r is a relative growth rate, A is the society's area or territory size, and S is the society's average level of collective solidarity (a value that ranges from 0 to 1, with 0 indicating a system unable to cooperate and 1 indicating the maximum-level collective action). This formula also assumes that some individuals will act selfishly or altruistically depending on the number of free riders and altruists in the group. Hence, the society must reach a critical point for altruism to spread. For Turchin (2003), this autocatalytic process[9] is best represented as a logistic function. Like any mathematical model, Formula 7.1 is necessarily simplified and thus faces a trade-off between sacrificing its external generalizability or risk being mathematically intractable. Hence, it is worth noting that this representation is limited to a single cycle, excluding instances of multiple collapses and regenerations. Similarly, it does not take into consideration the influence of exogenous elements, such as the presence of rival societies.

Though later rectified,[10] these models initially failed to explicitly accommodate the possibility that levels of *asabiyyah* might differ among hierarchical levels within a multistratum society, such as those depicted in Figs. 7.1 and 7.2. For example, Ibn Khaldun (1377) was clearly describing the *asabiyyah* of the Arabs (formerly Bedouin), who constituted the elite stratum III of the Islamic Empire that they created. He was not referring to the *asabiyyah* of conquered stratum II national polities, such as Egypt, Syria, or Persia. Although Ibn Khaldun did not explicitly address this issue, it is self-evident that higher levels of *asabiyyah* on the part of the natives of these conquered territories would be inimical to the survival of the empire, whereas higher levels of *asabiyyah* among the dominant Arab elites would doubtlessly help to preserve it as described. We might thus imagine antagonistic dynamism and difficulty maintaining prevailing hierarchies as consequences of a multistratum society expressing differential levels of *asabiyyah*. This was certainly true of the so-called "Byzantine" (Eastern Roman) Empire, which had previously sought to dominate those same national polities and encountered much nationalistic resistance from them. At that time, Egypt and Syria were both stratum II provinces that hosted alternative versions of Christianity, such as the Monophysite and Nestorian "heresies" (Khouri, 2007), in opposition to the "Orthodox" Christianity of Constantinople. Under the contemporaneous Sasanian Dynasty, Persia represented a competing stratum III empire in a state of near-perpetual war with the Byzantine, practicing an often militant Zoroastrianism in complete opposition to Christianity (Shapur Shahbazi, 2005).[11]

Socioecological conditions, such as being close to an ethnolinguistic boundary, favor the development of institutions enforcing intragroup cooperation (Turchin, 2003). Higher levels of social integration not only allow the group to defend the area from foreign incursions, but it also facilitates the annihilation or annexation of territories occupied by rival groups (Soltis, Boyd, & Richerson, 1995). As territorial expansion proceeds, threat of foreign rivals invading the core dissipates. Central areas, relatively invulnerable to invasions, experience an increase in intragroup competition. The decline of cooperation within the society brings the territorial expansion to a halt (Turchin, 2003). Lower levels of societal coordination interfere with the group's ability to defend its borders and the physical area held by the society contracts. The level of social coordination could potentially stabilize or even slightly increase due to the presence of invaders and the smaller territory size. However, this change is not sufficient to counter the effects of an even swifter dynamic. According to Turchin (2003), the amount of available resources decreases as the society's territory diminishes, which in turn accelerates institutional decline, causing further territorial contraction. A society's inability to halt this feedback loop generates the necessary conditions for collapse (Turchin, 2003). Although intersocietal competition can have a considerable impact on the structural integrity of societies, its occurrence does not imply the inevitable collapse of the factions involved. Instead, the degree to which institutions adequately coordinate collective efforts and enforce cooperation influences the likelihood that societies currently involved in a conflict will eventually collapse. Thus, Turchin's *wheels within wheels* metaphorically represent cycles within cycles, with collapse coming reliably from a coinciding downturn in secular and *asabiyyah cycles*, leading to the eventual loss of sociopolitical complexity of the state (Turchin, 2007).

5 Cultural Innovations, Institutional Robustness, and Resource Availability

Contemporary evolutionary theories no longer describe the evolutionary process as a unidirectional dynamic. Instead, evolution operates as a bidirectional phenomenon wherein selective pressures influencing the frequency of phenotypes in a population interact with the actions of individuals and collectives, both of which are able to alter local environmental conditions through the process of *niche construction*[12] (Laland & O'Brien, 2011; Laland, Odling-Smee, & Feldman, 2001, 2005; Odling-Smee, Laland, & Feldman, 2003). Even though in the long run such modifications can have lasting fitness-enhancing effects, altering local ecologies can also have considerable fitness-reducing consequences (Odling-Smee et al., 2003). In human societies, niche construction is facilitated by our species' ability to accumulate socially transmitted knowledge while employing this information to adequately respond to environmental conditions, as specifically denoted by the term *cultural niche construction* (Odling-Smee et al., 2003). To illustrate the interplay between cultural selection, genetic selection, and ecology, consider the example of individuals inhabiting a collective, who have at their disposal an array of cultural variants obtained from other individuals within the group (Hoppitt & Laland, 2013). A subcluster of these variants provides some information regarding how the adopter should optimally interact with the ecology. At first, individuals, or collectives, use cultural information from the material culture to modify their ecology, resulting in changed selective pressures to which that individual or collective is subject, despite being the agent of change. In turn, these ecological alterations encourage further cultural evolution, allowing the system to respond to novel environmental circumstances, denoted by the phrase *culturally modified cultural selection*

(Odling-Smee et al., 2003). If the system is unable to generate cultural innovations and respond accordingly to these environmental alterations, then the selective pressures are predicted to operate on the system's gene pool (Odling-Smee et al., 2003).

As proposed in a recent book chapter on the work of Alfred Crosby (Hertler, Figueredo, Peñaherrera-Aguirre, Fernandes, & Woodley of Menie, 2018), a successful human biocultural group that has made an innovation in subsistence technology is expected to expand its geographic range to the limits of the ecological niche within which that novel subsistence technology confers a competitive advantage. This process occurs because human biocultural groups engage in active *niche construction*, coevolving with other species of animals and plants to create *symbiotic portmanteau assemblages* (SPAs) that support higher carrying capacities within the same physical habitat. These SPAs are limited in ecological hyperspace to the specific range of ambient conditions under which such niches can be constructed out of the raw materials provided by the native ecologies being encroached upon. During such SPA expansions, the human biocultural group may incorporate subordinate human biocultural groups and exchange nonhuman SPA elements with them, resulting in richer species assemblages within the constructed niche, just as the human groups often hybridize and augment the human genetic diversity of the new aggregate. This process of constructed niche enrichment assists in the further expansion of the culturally constructed species assemblages.

By so doing, however, the previously dominant groups wind up exporting their superior subsistence technology to the incorporated subordinate groups and, through trade and imitation, exchanging some SPA elements with the surrounding ones that have not been fully merged with the new complex. As a result, the dominant group may gradually lose its competitive advantage with respect to these other groups and, with that, its ability to dominate them socially. When innovations in subsistence technology were spread to the "barbarian" (originally meaning *foreign*) nations surrounding the late Roman Empire, these enabled them to eventually achieve a level of agricultural parity with Roman Italy itself. For example, the Roman introduction of agricultural technologies, such as the heavy wheeled mouldboard plough in the late third and fourth centuries AD that helped till otherwise difficult Northern European soils

(Margaritis & Jones, 2008), facilitated a new balance of economic power between the provinces and the capital. This generalization of the technologically constructed ecological niche thus sets the stage for the collapse of the dominant group as the central authority in the expanded sociopolitical structure.

Even though the theory of cultural niche construction by no means implies this phenomenon is the sole source of cultural evolution (cf. Chap. 3 of this volume), this framework counters alternative theories claiming that cultural innovations and ecology occur as independent phenomena. Demographic evidence, mathematical models, and computational simulations support the fact that the rate of technological innovations is constrained in part by socioecological conditions. As indicated by global paleodemographic and macroeconomic reconstructions, the temporal trajectory of world GPD per capita remained relatively horizontal and unaltered throughout most of human history after the Neolithic Revolution (De Long, 1998). Reconstructions of global population growth reflect a similar trend, with occasional fluctuations without evidencing any sudden expansion (Artzrouni & Komlos, 1985). Before the 1800s, any increase in macroeconomic growth led to a corresponding enlargement in population size, restricting any increment in the global productivity per capita (Currie et al., 2016).

More recently, Currie et al. (2016) developed a mathematical model examining the coevolution between population size (*N*) and the total amount of useful knowledge in a society (meaning the society's technologies and institutions: *T*). The model tracked fluctuations in *N* and *T* through a period of 10,000 years. Even though *N* remained initially under the ecology's carrying capacity (*K*), ultimately *N* reached *K*. The authors modeled *T* as an autocatalytic process, wherein the creation of new technologies and institutions depended on the preexisting amount of *T*. Assuming this to be the case, the authors derived a mathematical equivalency between *K* and *T*. The simulation showed *N* generally outgrowing *T*, even as, over most of the model's timespan, *N* and *T* grew at a slow rate. This imbalance occurred due to the small number of innovators[13] in a population already at carrying capacity. In the model, population growth also consumed any additional benefits attained through the slow accumulation of novel technologies. This interaction allowed the authors to assess the amount of surplus based on the ratio *T*/*N*, an indicator of per capita consumption. When *N* outgrew *T*, the population experienced lower fertility rates, higher mortality rates, and an overall decline in size (i.e., Malthusian regime; Currie et al., 2016). Although throughout most of the model's time, the covariance between *N* and *T* complied with Malthus' predictions, eventually, the society's *T* managed to surpass *N*, allowing it to escape from this Malthusian trap, a process that took at least 9500 years.

Independent examinations have reached similar conclusions. Turchin and Nefedov (2009) modeled the association between population size, total production of resources, and the amount of surplus generated by pre-industrial agricultural societies. The authors' model identified a linear relation between population growth and the resources allocated to subsistence. In contrast, surplus production followed a curvilinear trend with larger populations producing smaller quantities of surplus. In this representation, carrying capacity equaled the intersection between the subsistence line and the surplus curve depending on population growth. In a subsequent model, the authors determined that the quantity of surplus is zero when population density is zero and when the system reaches the ecology's carrying capacity. In a previous publication, Turchin (2003) concluded that

> Unless the population size can somehow be prevented from crossing the N_{crit} threshold, the state's expenses will inexorably grow beyond its means, and the state will inevitably become insolvent. Once this point is reached, increasing the tax rate or cutting expenses on nonessentials like court luxuries, can at most be a short-term term solution. (p. 126)

Although other forces are involved in cultural evolution, ecological and population factors constrain a society's cultural evolution and the diversity of its institutional repertoires. These restrictions have clear implications for the system's capacity to address either internal or external pressures based on the socioecological conditions necessary for cultural and institutional evolution. For example, Bednar (2016) refers to an institution's *robustness* as the ability to retain its functionality despite the occurrence of perturbations. Through this lens, Bednar and Page (2016) consider that robust systems are: (1) *diverse*, exhibiting a constant influx of novel information; (2) *modular*, with information compartmentalized and processed by the system's components; and (3) *redundant*, in case one component is unable to function adequately, another component may act as a fail-safe, performing the same task. Institutional robustness, however, is not equivalent to stability. For instance, Bednar and Page (2016) clarified that the former concept addresses the system's transformation capacity, whereas the latter refers to the system's consistency across contexts. Cultures, and not only institutions, exhibit robustness. Hence, cultures are robust as long as the introduction or modification of cultural variants or the emergence of social agents does not alter the overall integrity of the existing culture (Bednar & Page, 2016). Furthermore, from an empirical point of view, the degree to which a cultural variant remains unaltered during transmission could be employed as a proxy for robustness. In addition to learning biases influencing the likelihood of adopting cultural variants (cf. Chap. 3 of this volume), institutions and cultures spread between groups depending on the adoptees' existing institutional and cultural systems (Spolaore & Wacziarg, 2016).

Bednar and Page's (2016) description is consistent with the definition of robustness employed in evolutionary and developmental biology. For example, Nijhout (2002) defines robustness as a weak correlation between a trait's variation and either genetic or environmental variation, implying a variation in its fitness consequences. Similarly, Bateson and Gluckman (2012) defined this concept as an organism's characteristics remaining unaltered by environmental and genetic changes. According to Bateson and Gluckman (2012), phenotypic robustness is often achieved through various mechanisms. For instance, the system's responsivity is dependent on its ability to detect environmental change. The higher the *insensitivity*, the lower the likelihood the alternation will impact the system's organization. The presence of barriers also buffers the system against external perturbations. Evolutionary, developmental, and ecological constraints also increase robustness. For example, after reaching a particular stage of differentiation, it is not feasible for the system to revert to previous steps without compromising its overall integrity (Bateson & Gluckman, 2012). Relative to older structures, more recent innovations are more susceptible to experience further modifications. Although Bateson and Gluckman

(2012) did not consider the degree of responsiveness of social systems, their descriptions can be productively generalized to this level of analysis. Hence, societies may experience greater difficulty modifying older and more foundational institutions, such as those associated with a subsistence economy. A robust system could also rely on its elasticity, wherein a structure will temporarily alter its form when confronted with external pressures, regaining its original form once the force is removed (Bateson & Gluckman, 2012). For instance, as discussed in the previous chapter, to this day, republics can decree a temporary state of exception, limiting civil liberties in response to an internal or external threat (Giorgio & Kevin, 2005).

6 Summary

The academic controversy associated with the study of collapse continues unabated. To some extent, theoretical integration provides a way forward. Instead of exclusively concentrating on the impact of external factors, such as climatic fluctuations or natural catastrophes, contemporary theories of collapse seek to understand the role of institutional, cultural, and economic dynamics. Similarly, some cyclical models inspired by multilevel selection theory claim that societies experience multiple autocatalytic cycles with collapse resulting from fluctuations in collective action and social solidarity. At the core of these theories lies the assumption that human societies feature considerable levels of behavioral flexibility allowing them to address socioecological challenges. Societies alter their ecology to sustain their level of sociopolitical complexity. In time, however, returns on investment decline, compromising institutional performance. The system's inability to continue to modify its environment reverberates across society. Without either incentives or threat of punishment, coordination and cooperation decline, and this increases the likelihood of further defection. With suboptimal levels of institutional performance and waning collective action, a sociopolitical system is prostrate, exposed to both higher- and lower-order threats. Higher-order threats descend from other complex sociopolitical systems retaining optimal levels of institutional performance and collective action, while lower-order threats emerge from less complex substrata, often showing higher asabiyyah, kinship, and cohesion. These dynamics explain the cyclical nature of history, while the superior competitive abilities of robust complex systems in Red Queen competition with simpler societies explain observable linear trends toward growing complexity through time. Both cyclical and linear trends are best synthesized and understood through the lens of multilevel selection.

Notes

1. Even though multilevel selection theory did not inspire some of the perspectives covered by this chapter, contributions have direct implications for understanding social collapse under a multilevel selection lens.
2. Even though it would be tempting to view this level as individuals, little consensus exists concerning whether the individual is the most elemental social unit. For the purposes of this representation, the dyad/nuclear family is considered as the simplest form of social organization.
3. Regeneration concerns the reconstruction of urban and economic systems, ideologies, and institutions following a decline in political and social centralization (Schwartz, 2010).
4. Holling and Gunderson (2002) viewed exploitative organisms as *r*-selected strategists, exhibiting fast population growth, while organisms corresponding to the conservation phase as *K*-selected strategists, displaying a deaccelerated growth rate.
5. In addition to this bottom-up approach, Holling et al. (2002) also proposed a "remember" connection bridging the conservation phase of the largest cycle to the reorganization phase of the intermediate cycle. Resources accumulated at a higher-order level can be allocated to the reorganization phase of a lower level of the panarchy.
6. Previous perspectives reached a similar conclusion: societies featuring overspecialism, institutional rigidity, or mismatched with its local ecology have a higher likelihood of collapsing (e.g., Flannery, 1972; Renfrew, 1979; Service, 1975).
7. This is a metaphor taken from chemistry where the products of a chemical reaction subsequently act to promote the same reaction that produced them.
8. Turchin (2003) also derived the following formula for the average polity *asabiyyah*:

$$r(A) = \frac{1}{A}\int_{A}^{0} r(x)\,dx = r_0\left(1 - \frac{A}{2b}\right)$$

where *A* is the size of the polity, *r(x)* the relative growth rate of *asabiyyah*, and *b*= corresponds to the breadth of the polity's border,

9. As a complement to the current perspective, future studies could consider *asabiyyah* as a latent construct loading into clear indicators of institutional activity. This approach confers two significant advantages. First, it provides an avenue to empirically quantify the amount of a group's *asabiyyah* beyond the realm of mathematical modeling and computational simulations. Second, it avoids falling into traditional mystical perspectives often associated with fluctuations in a society's collective solidarity though time.
10. To be fair, Turchin (2007) did subsequently address the possible effects upon imperial dissolution of the *asabiyyah* of opposing biocultural groups along meta-ethnic frontiers in Chapter 14, *The End of Empire?*
11. Centuries later, a resurgent Arab nationalism also undermined the hegemony of the Ottoman Empire (Choueiri, 2000), despite religious similarities but exacerbated by ethnolinguistic differences.
12. Niche construction is not limited to an organism's actions reversing or neutralizing environmental pressures (*counteractive* niche construction; Odling-Smee et al., 2003), but it also occurs when an organism initiates a sequence of actions in the environment leading to its permanent or definite alteration (*inceptive* niche construction; Odling-Smee et al., 2003).
13. Previous research has concluded that demographic factors also predict cultural complexity and innovations (Bettencourt, Lobo, Helbing, Kühnert, & West, 2007; Kline & Boyd, 2010; Powell, Shennan, & Thomas, 2009). Similarly, population size predicts cultural extinction rates (Henrich, 2004). Consider, for example, two groups, group A which comprised ten individuals and group B containing one hundred. Suppose in both societies one-tenth of the individuals (i.e., models) are copied by other group members. While the death of one model in B could have no impact in the persistence of a cultural variant, as group B still contains nine other models, the elimination of the only remaining model in A represents the extinction of the cultural variant in the group.

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