

# Ecosymbiotic Complementarity, an Old Theory Applicable in Today's Ethnobiological Studies

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**Abstract:** Ethnobiology analyzes the interactions between people and their surrounding environments from various perspectives. Some studies have been criticized by social scientists, who argue that ethnobiologists have insufficiently considered the conflicts between the dominant economic and political model and rural communities' lives, which are often idealized. However, several ethnobiological studies have increasingly considered these aspects, and important initiatives in this direction have emerged from interactions with other research fields and frameworks, such as sustainability science, political ecology, agroecology, and social-ecological systems. To address criticism on what has been considered ethnobiological utopianism, it is valuable to theorize, develop methodological tools, and construct explanatory models. From such perspective, this work aims to recover an old theory called ecosymbiotic complementarity, which we propose can strengthen analytical approaches in the social-ecological systems framework. We recover the original proposal of the ecosymbiotic complementarity theory, emphasizing the relationships between rural communities and economic and political variables. We consider that the ecosymbiotic complementarity theory can contribute to the contextualization of rural societies analyzed in ethnobiological research.

**Keywords:** Social-ecological Systems Framework, Network Analysis, Natural Resources Management, Economic System, Key Area

**Resumen:** La etnobiología ha estudiado desde diversas perspectivas las interacciones entre las personas y sus entornos. Algunas de sus investigaciones han sido criticadas por sociólogos que consideran que la etnobiología no ha abordado suficientemente el conflicto entre la modernidad capitalista y cómo afecta la vida de las comunidades rurales, la cual es frecuentemente idealizada. Sin embargo, se han realizado varios estudios que sí consideran estos aspectos y han tomado impulso en la medida en que la etnobiología interactúa con otras disciplinas. Estas interacciones han derivado en marcos conceptuales como los de la ciencia para la sustentabilidad, la ecología política, la agroecología, y los sistemas socio-ecológicos. Para atender la crítica a lo que se considera utopismo en la etnobiología, es valioso teorizar, adoptar nuevas herramientas metodológicas y construir modelos explicativos. Así, el objetivo de este trabajo es recuperar una antigua teoría

Received: 3 July 2023; accepted: 3 February 2024;  
published online \_\_\_\_\_

denominada complementariedad eco-simbiótica, e incluirla en el marco de los sistemas socio-ecológicos. Para ello, explicamos la teoría, poniendo énfasis en su utilidad para analizar la relación de las comunidades rurales con variables económicas y políticas. En conclusión, hacemos un aporte metodológico para contextualizar mejor las investigaciones etnobiológicas.

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## Introduction

Ethnobiology analyzes the interactions between people and their surrounding environments (Albuquerque and Nóbrega Alves 2016). This research field has gone through several transitions: from documenting natural resources by studying traditional biological and ecological knowledge to promoting indigenous ethnobiology and reaching a phase of interdisciplinary collaborations to face current global environmental problems (Hunn 2007; McAlvay et al. 2021). Despite it being a scientific area in continuous change, some ethnobiological studies have been criticized by social scientists, who consider that the conflicts between the traditional lives of rural communities and modernity have been insufficiently considered by ethnobiologists (Durand 2000, 2002). Modernity refers to contemporary technological, cultural, political, and economic practices that influence the structure of present day societies (Cretney and Bond 2014; Mirenda and Lazos-Chavero 2008; Walker and Cooper 2011).

According to Durand (2000, 2002), utopian views of rural communities, which she calls “romanticism,” are an idealization of their ways of life, without considering the complex problems that arise from coexisting with modernity. Capitalist modernity, as the dominant economic and political model, is characterized by having a centralized power (i.e., its monetary power and decision-making are concentrated in particular groups), generating purchasing power asymmetry and livelihood inequality among social classes (Challenger et al. 2014; Walker and Cooper 2011). Failure to consider these conditions can mistakenly lead to the myth that rural communities are invariably ecologically sustainable (Durand 2002), or that they are fully autonomous in their decision-making, without considering that they are subjected to unequal conditions of power (Mirenda and Lazos-Chavero 2008). Some ethnobiological studies have certainly been conducted from the perspective criticized by Durand (2000, 2002), and the lack of political and economic contexts

has limited their scope. Still, ethnobiological research in rural contexts should be conscious of the need to integrate the sociocultural intersections between local people and the capitalist system.

Critical reflections on these issues have been developed; for instance, the ethnoecological perspective discussed by Toledo (Toledo and Alarcón-Cháires 2012), and other frameworks that have strongly influenced ethnobiology during the last decades, such as sustainability science, complexity science, political ecology, and agroecology, among others (Alexiades 2018; Altieri and Toledo 2011; Dietz et al. 2003; Kates 2011; Ostrom 2009; Siegenfeld and Bar-Yam 2020; Smith et al. 2011; Yam 2018). Frameworks like social-ecological systems have helped ethnobiology to explain the use and management of natural resources and ecosystems in a broad and complex context. This framework aims to promote an analysis from a systemic, holistic vision, and to break down historical barriers between the social and natural sciences by suggesting that human beings are integrated actors of ecosystems (Challenger et al. 2014; García-Jácome et al. 2020). However, some social scientists consider that the social-ecological framework should strengthen contextualized analyses of the adaptive structure of communities with issues like political and economic power relations, social classes conflicts, and property regimes (Cretney and Bond 2014; Mirenda and Lazos-Chavero 2008; Walker and Cooper 2011).

Along these lines, some authors have called attention to the need to understand the expansion of Western society and the capitalist system with rural communities (Bascompte 2009; Challenger et al. 2014; Durand 2002; Mirenda and Lazos-Chavero 2008; Ostrom 2009; Vespignani 2009), as well as to the need to continue theorizing, developing methodological tools, constructing explanatory models, and strengthening frameworks (Turner et al. 2020). Hence, this work aims to recover an old theory, ecosystemic complementarity (Condarco and Murra 1987), and integrate it into the social-ecological

systems framework. The ecosymbiotic complementarity theory analyzed traditional forms of economic articulation in Andean societies and delved into the management of ecosystems, cultural aspects, the role of markets, and multiple variables regarding political and economic systems. This background may help to describe the use of territory, management of resources, and relationships between human groups through the exchange of products. In addition, it analyzes power relations among actors as a central aspect of the relationships between the hegemonic economic system and rural communities.

In the first section of this work, we recover Murra and Condarco's thinking to explain the basis of their ecosymbiotic complementarity theory. We emphasize the economic and political aspects that are relevant to analyze the intersection between rural communities and capitalist modernity in the context of natural resources and ecosystem management. In the second part of this work, we argue why we consider it helpful to include the ecosymbiotic complementarity theory in the broader social-ecological systems framework. We propose that the social-ecological systems framework provides a theoretical and methodological background to strengthen the understanding of ecosymbiotic complementarity and, in turn, this theory can help characterize societies by analyzing the asymmetries and centralization in economic and political power.

### **Ecosymbiotic Complementarity Theory: Management and Socioeconomic Factors**

The ecosymbiotic complementarity theory proposed by Condarco and Murra (1987) emerged from the combination of two related approaches. Condarco proposed the “*simbiosis interzonal*” (interzonal symbiosis) defined as a collaborative use of ecological zones at different elevations in mountainous landscapes (Condarco 1970), while Murra proposed a “*control vertical de un máximo de pisos ecológicos*” (vertical control of a maximum of ecological levels), the simultaneous management of ecosystems in a wide range of mountain elevations (Murra 1975). Later, both authors proposed a new term, ecosymbiotic complementarity, which combined the management of ecosystems at different elevations and a set

of social relations. The ecosymbiotic complementarity theory explains an Andean model of precapitalist societies organized in confederate empires that expanded their territories to use a high diversity of resources. The complementarity occurred when people exchanged resources extracted from ecosystems at different elevations, and when small farmers migrated with crops to other lands to pay tribute to owners (i.e., the Andean landlords, owners of lands in the Andean Empire). Some examples of traded resources are alpaca and lama wool from the high elevations of the Puna zone, corn, and potatoes from high valleys, and citrus, sugar cane, and honey from lowland valleys (Condarco and Murra 1987).

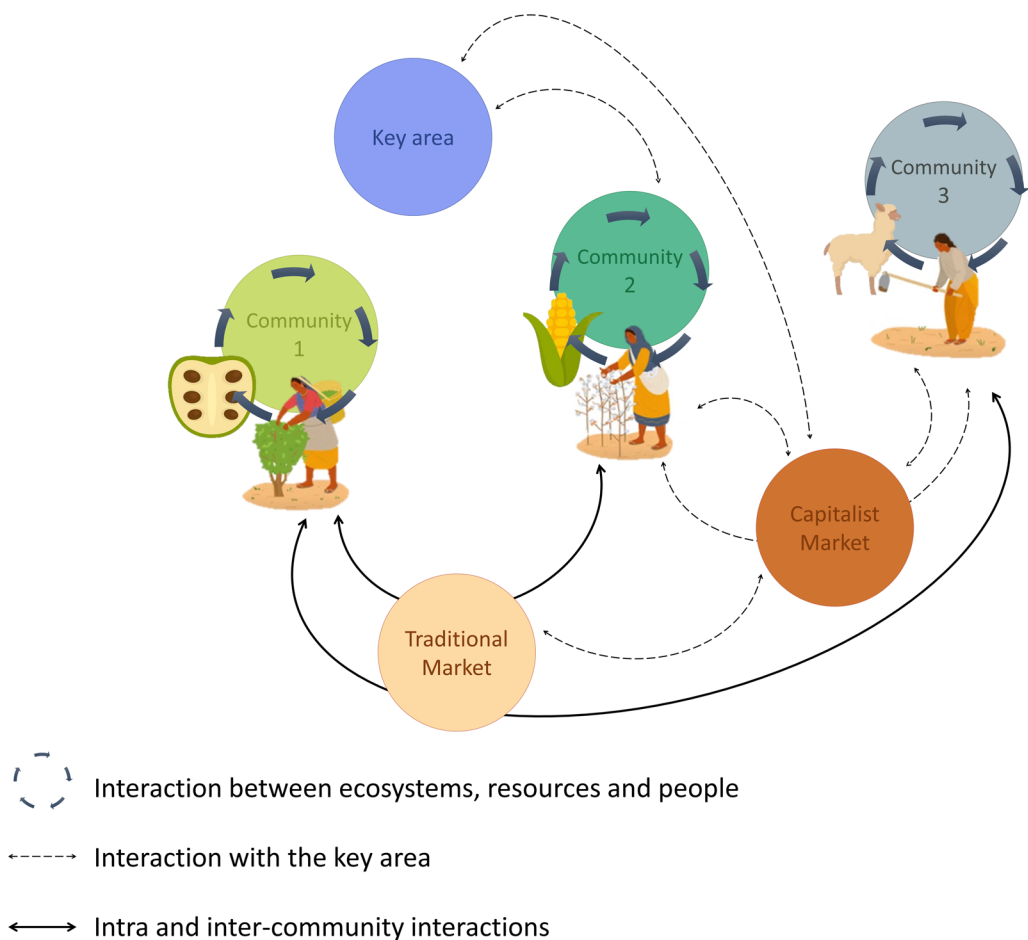
Ecosymbiotic complementarity theory and ethnobiology share epistemological approaches to understanding the cultural process of resources and ecosystem management. In fact, the proposal of the ecosymbiotic complementarity theory is similar to that developed by Toledo et al. (1976, 2003), called the multiple uses of ecosystems, which analyzes the complementarity of natural resources and environments in horizontal landscapes. From ethnobiological approaches, management has been defined as practices through which people make decisions, use, and/or transform ecosystems, landscapes, their components, and processes for different purposes (Blancas et al. 2013; Casas et al. 1997, 2007). Such decision-making is related to environmental, cultural, social, political, and economic processes. For instance, factors influencing the management of resources and ecosystems related to commercialization and interchange. The dynamics of supply, demand, and fluctuations of commercial value influence the resources' management strategies (Arellanes-Cancino and Casas 2011; Blancas et al. 2013, Rangel-Landa 2016; Farfán-Heredia et al. 2018). Consequently, several ethnobiological studies have documented markets and their role in rural economies. However, the theoretical economic aspects of the ecosymbiotic complementarity theory enrich ethnobiology by linking economic variables and resources' management strategies with their social and political context.

The ecosymbiotic complementarity theory was developed by Andinist scholars who were influenced by the substantivism school (Rabey et al. 1986; Ticona-Alejo 2003). Substantivism proposes that the economy does not imply rational decision-making, but instead is related

to how communities interact with their social and natural environments (Polanyi 2007). From this perspective, a society's livelihood strategy is an adaptation to the environment and the social and material conditions (Condarco and Murra 1987). Under this assumption, Condarco and Murra proposed different types of interactions: within communities, between communities, and with the "área clave" (key area) (Fig. 1). The key area, according to Condarco and Murra (1987), is the place where economic

and demographic power is centralized. It stands out for its urban development, large population, and the presence of relatively more complex means of production, communication, and transportation (Condarco and Murra 1987).

Today, the conceptualization of the ecosymbiotic complementarity theory (Fig. 1) can show the interactions between different actors (i.e., communities, the key area, traditional and capitalist markets) at different levels (i.e., intra- and inter-community relationships and with the key area).



**Fig. 1.** Ecosymbiotic complementarity theory. Nodes are the key area, defined as the place where economic power, urban development, and complex means of productions are centralized, the communities, the traditional markets, and the capitalist markets. Thick circular arrows represent the interactions between ecosystems, natural resources (corn, soursop, and lama wool), and people. Dotted lines show interactions between communities and the key area, either directly or through the capitalist market via traditional markets. Continuous lines denote inter- and intra-community interactions that are direct or through the traditional market

The interactions of the communities with the key area, as defined by Rabey et al. (1986), are the indissoluble relationships that rurality maintains with the state, its agencies, private companies, and intertwined institutions worldwide. These interactions involve agreements and regulations for access to land (Toledo 2008) and influence the availability of agricultural technologies that facilitate obtaining, processing, and storing resources (Casas et al. 2007). In addition, these interactions, together with the social, cultural, economic, and political pressures from the capitalist economic system, contribute to the monetization of rural economies, displacing systems such as barter, cooperation, and other collective relations (Kautsky 1974; Lote-Rayó 2016).

Different rural communities interact in different ways with the key area, leading to variations in management practices and unequal opportunities to reach markets. When a community accesses markets, people tend to intensify their agricultural and forest extraction practices (Casas et al. 1994; Toledo et al. 2008). In contrast, the most marginalized communities in socio-spatial terms are deprived of modern technological packages, agricultural services, and access to irrigation and road infrastructure, all of which limit their specialization in land use (Blancas et al. 2013, 2014; Casas et al. 1994; Poinot 2004; Toledo et al. 2008). The interactions of rural communities with the key area influence peoples' decisions regarding the governance of their resources, therefore rural communities are not fully autonomous, but commonly semi-autonomous societies. The decisions of rural communities are influenced by internal social dynamics and communitarian needs, but also by unequal power dynamics in the social, economic, and political contexts (Condarco and Murra 1987; Polanyi 2007).

There are two types of markets, traditional and capitalist. Traditional markets are those linked to local economies, while capitalist markets are those immersed in the prevailing economic system governed by an external and centralized economy. The interaction with the capitalist market drives changes in the local dynamics of rural communities. Globalization for instance has led to the introduction of products from around the world, some of which may not necessarily be locally

grown or sold (Arellanes-Cancino and Casas 2011), while the fluctuating dynamics of commercialization generate changes in the demand for products and in the forms of management and land use (Dressler and Roth 2011; Godoy et al. 1997, 2005, 1997; Gómez-Baggethun et al. 2010; Gössling 2003; Sierra et al. 1999; Vadez et al. 2004). Thus, the interaction of rural communities with the capitalist market reflects pressures from the key area over the way natural resources are accessed. This pressure causes modifications in people's perception, use, and management of resources (Blancas et al. 2010).

On the other hand, the interaction of communities with the traditional market includes all relationships at the intra- and inter-community levels (Condarco and Murra 1987; Palerm and Wolf 1972; Rabey et al. 1986). Inter- and intra-community relationships revolve around barter and some exchanges involving monetary transactions at small scale (Rabey et al. 1986). Today, traditional markets (Fig. 2) are institutions that still fulfill the function of resource complementarity in rural societies, and where barter and purchase are carried out by sellers from different regions (Arellanes-Cancino and Casas 2011). In rural areas, traditional markets have a fundamental role in subsistence and grant certain economic autonomy to the communities. They are central to the diversification of products, food sovereignty, and the maintenance of agrobiodiversity and local traditions. The exchange of resources between producers and consumers in traditional markets is facilitated by proximity, enabling mutual influence (Hernández et al. 2013).

In summary, ecosymbiotic complementarity theory analyzes rural societies, ecosystem management, and social processes through a contextualized economic system. We propose that this theory is helpful to understand rural communities' agricultural management and rural economies, which are influenced by the need to survive and carry out stratified social relationships in a contemporary society divided into classes in conflict. In addition, including the key area as an additional component in ethnobiology studies can help analyze the coexistence of traditional and modern social, economic, and political processes in rural contexts.



**Fig. 2.** Sellers and their products in a traditional market. The photos illustrate the commercialization of: (1) “manzana” *Malus domestica* Borkh.; (2) “águacate” *Persea americana* Mill.; (3) “nopal” *Opuntia ficus-indica* Haw.; (4) “té-limón” *Cymbopogon citratus* (DC.) Stapf.; (5) “bahkiliti” *Amaranthus hybridus* L.; (6) “bahkiliti” *Leucaena esculenta* (DC.) Benth.; (7) “tzopeliquiliti” *Cestrum nocturnum* L.; (8) “plátano” *Musa × paradisiaca* L.; (9) “café” *Coffea arabica* L.; (10) “tekiliti” *Peperomia peltimbica* C. DC. ex Trel.; (11) “mototi” *Calyptranthes megistophylla* Standl.; (12) “ixtaxochitl” *Spathiphyllum cochlearispathum* (Liebm.) Engl. in the traditional market of Coyomeapan, Puebla, Mexico

## Ecosymbiotic Complementarity Theory in the Social-Ecological Systems Framework

We consider that the ecosymbiotic complementarity theory can be better understood today with the help of theoretical and methodological bases from the social-ecological systems framework. It is possible to deepen Condarco and Murra's theory by considering concepts such as adaptation, resilience, and vulnerability, as well as methodological tools such as network models. In turn, the ecosymbiotic complementarity theory can enhance the social-ecological framework by addressing the concerns expressed by some social scientists.

Adaptation, resilience, and vulnerability are key concepts of the social-ecological systems framework. Adaptation is defined as a process of adjustment of social systems, in which people moderate damage and take advantage of beneficial opportunities or applied strategies to ensure subsistence and reproduction of life (Adger et al. 2009; Mirenda and Lazos-Chavero 2008; Steward 1955). Resilience is the capacity of systems to recover from disturbance (Holling 1973), but it has been used in various ways; for instance, it has defined as the ability of social-ecological systems to learn and live in constant change to last over time (Folke 2016). Finally, vulnerability refers to the probability of a system experiencing damage due to a disturbance (Turner II et al. 2003). All these aspects of the social-ecological systems framework are pertinent to consider in ethnobiological studies. However, theories, hypotheses, and explanations addressing these concepts have been criticized because, according to some authors, they do not integrate both the social and environmental dimensions of social-ecological systems (Hinkel et al. 2015; MacKinnon and Driscoll-Derickson 2012; Olsson et al. 2015; Turner et al. 2020).

The most cited problem is that scientists have defined social systems ignoring the context of social inequalities (Cretney and Bond 2014; MacKinnon and Driscoll-Derickson 2012; Olsson et al. 2015). This issue results in reductionist and biological deterministic theories (e.g., social Darwinism) and "top-down" strategies (i.e., raised by state agencies and academics towards communities) shaped by unequal power relations with low permeability in environmental management and conservation strategies (MacKinnon

and Driscoll-Derickson 2012). Also, some social-ecological systems studies keep neoliberal ideas of production and accumulation (Challenger et al. 2014; MacKinnon and Driscoll-Derickson 2012; Mirenda and Lazos-Chavero 2008; Walker and Cooper 2011). In response to criticism about the social-ecological systems framework and its applicability, some authors have found it helpful to use models (Turner et al. 2020).

Models help to understand systems by focusing on specific variables. In addition, models constructed through methodological approaches such as network analysis may offer the opportunity for scaling up to integrative proposals and applications (Bascompte 2009; Bodin and Crona 2009; García-Amado et al. 2012; García-Jácome et al. 2020; Rockenbauch and Sakdapolrak 2017; Salpeteur et al. 2017). Network analysis involves a variety of actors and institutions interacting at different scales and in heterogeneous ways (García-Jácome et al. 2020). The integration of models and network analysis with the ecosymbiotic complementarity theory offers novel ways to study adaptation, resilience, and vulnerability in the context of rural communities' management of resources and ecosystems. In addition, it allows: (1) highlighting the multiscale nature of socio-ecological systems, showing the internal articulations (i.e., intra- and inter-community interactions) and ranks of greater economic and political power (i.e., the key area); (2) describing patterns of inter-individual connections (e.g., barter and sale) (García-Amado et al. 2012); and, (3) predicting patterns of the socio-ecological systems by understanding the structural features of the network (Bodin and Crona 2009; Newig et al. 2010; Siegenfeld and Bar-Yam 2020; Wang et al. 2022). For instance, it is possible to evaluate which community-market connections are more robust for facing external shocks (e.g., migration, entry of external markets, monetization), and to analyze how the increase in monetization pressure of a capitalist market can break the complementarity of a traditional market, or how the system can adapt to climatic disturbances.

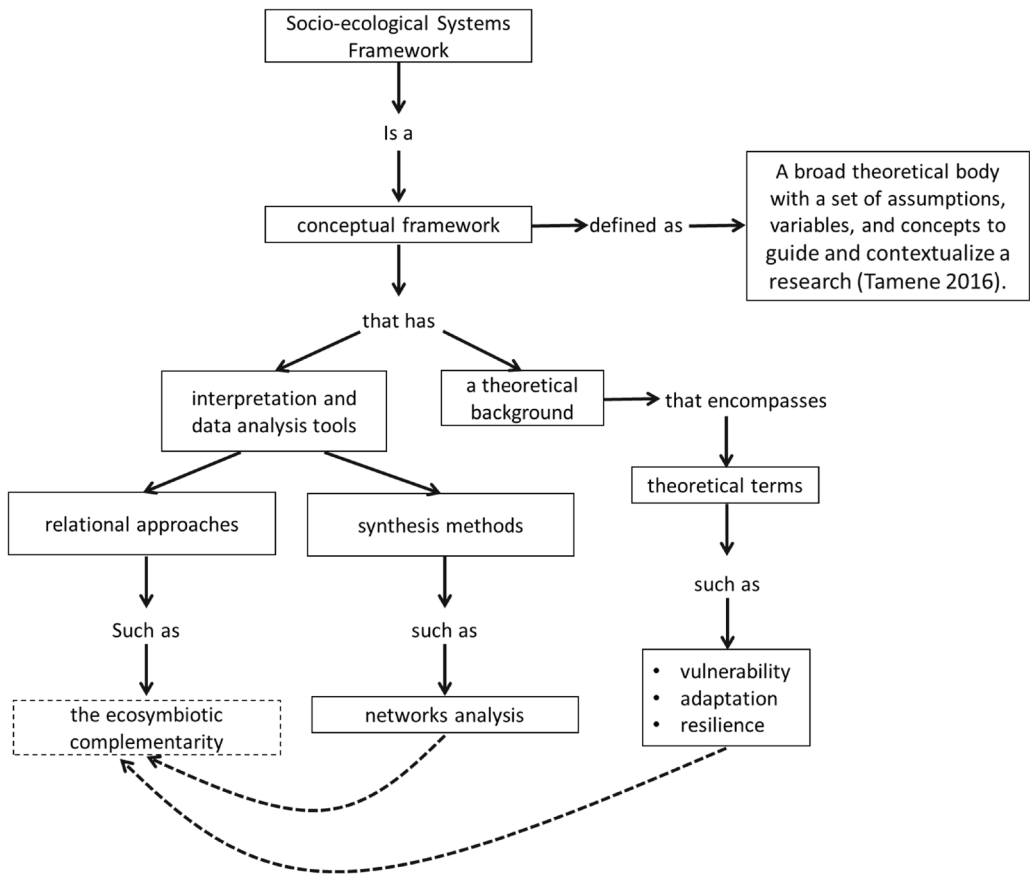
In summary, integrating the ecosymbiotic complementarity theory into the social-ecological framework allows for more complete and contextualized analyses of the relationships between social and ecological systems with the key area of centralized power, as well as understanding a system as a related assembly of

structures and processes. In addition, the concept of a key area facilitates analysis of the relationships and structures of social-ecological systems by acknowledging the ecological domain of capitalism and its influence at different scales. The ecosymbiotic complementarity theory can contribute to strengthening the social-ecological systems framework and, at the same time, take advantage of its methods and concepts. Therefore, ecosymbiotic complementarity theory is a relational approach that can be included in the broad framework of social-ecological systems (Fig. 3). This inclusion can be helpful in

the study of resource governance, capital circulation, local management, and contribute to design viable conservation strategies that help rural communities to face pressures from the hegemonic economic system.

### Conclusions

This work is an effort to recover the ecosymbiotic complementarity theory and to integrate it into the social-ecological systems framework. We consider that the ecosymbiotic



**Fig. 3.** Components of the Social-Ecological Systems Framework and the proposed inclusion of the ecosymbiotic complementary theory. The concept map is structured to be read from top to bottom following the direction of the arrows. It explains the social-ecological systems framework as a research structure with a theoretical background (Tamene 2016) that encompasses the terms referred to in the main text. The framework also makes use of methodological tools such as networks analysis. The dotted box indicates the ecosymbiotic complementary theory as a new incorporation in the social-ecological systems framework as a relational approach, that is, an analysis tool. The dashed arrows show the theoretical concepts and tools that help analyze the ecosymbiotic complementarity theory



complementarity theory encompasses the management of different ecosystems and complex social relationships between communities and with the political and economic system. The concept of a key area, as the place where economic power, urban development, and complex means of productions are centralized, promotes the inclusion of additional variables in ethnobiological studies. Integrating the ecosymbiotic complementarity theory in social-ecological research will help to understand how social groups interact, collaborate, exchange, and mobilize information, resources, and social capital, and how this permeates environmental management. We point out that this can be a methodology to open opportunities in ethnobiology to analyze the interactions between people and the environment considering the logic of capitalist development.

#### Acknowledgements

This paper is part of the requirements for obtaining a doctoral degree at the Posgrado en Ciencias Biológicas, UNAM. Elisa Lotero Velásquez thanks Emilio Mora Van Cauwelaert for his unconditional company, help, and patience during the process of writing and discussing this work, and Alejandra Duque for reading and helping in the edition of this manuscript.

#### Funding

Financing was granted by CONACyT scholarship (925661) and PAPIIT project IN210723 *Manejo y comercialización de recursos vegetales y fúngicos en economías rurales de México*.

**Data Availability** N/A.

#### Declarations

We state that no part of the manuscript has been published or considered for publication. We state that we do not need to take specific actions to achieve compliance with funder and institutional open access mandates. We accept the subscription publication route and the standard licensing terms. This paper is part of the requirements for obtaining a Doctoral degree at the *Posgrado en Ciencias Biológicas, UNAM*. ELV wrote the paper with the edition and revision help of AMB, AC and EVVP. The ideas and theoretical background are authors' contributions. We consent to publish it and accept the guidelines.

**Ethics Approval** N/A.

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